

A-0008 The clinical outcomes and patient satisfaction following treatment in a 'see and treat' hand surgery clinic

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The National Health Service faces the challenges of rising costs and increasing demands whilst continually improving the quality of patient care. The time from referral to surgery was 9 months in our trust (3 months for a new patient clinic appointment and 6 months for surgery). We established a clinic where patients had a consultation and surgery the same day.

Summary of the Purpose: The study aim was to evaluate the 'see and treat' hand surgery clinic service to assess whether it reduced waiting times whilst maintaining good clinical outcomes and patient satisfaction.

Method: Patients were selected on the basis of standard referral letters, contacted by telephone and (following screening questionnaires) invited to the see and treat hand surgery clinic. A single consultant hand surgeon assessed the patient, performed nerve conduction studies and, if indicated, offered surgery the same day. Disabilities of Arm, Shoulder and Hand (DASH) and patient evaluation measure questionnaires were evaluated.

Results: Twenty-four patients (17 females and 7 males; mean age 55.73 years; mean DASH score 47) attended 19 weeks after referral. Twenty-one open carpal tunnel decompressions and three trigger finger releases were performed under local anaesthesia. Mean follow-up time was 9.72 weeks in 16 patients (8 were then discharged, 4 listed for a contralateral operation and 4 followed up). There were no complications. Patient satisfaction was high.

Significance: The period from referral to surgery was reduced from 9 months to 19 weeks. The see and treat hand surgery clinic is a safe, efficient and cost-effective prudent healthcare service which fulfils patient needs and avoids wasteful care.

A-0014 Surgical reconstruction for a forearm deformity caused by multiple osteocartilaginous exostoses

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Objective: We report the outcomes of surgical reconstruction for a forearm deformity caused by multiple osteocartilaginous exostoses.

Methods: The subjects comprised 30 cases and 33 arms. Removal of exostoses and distraction osteogenesis of the ulna using external fixation were performed in all cases. The cases included 22 boys and 8 girls with an average age at surgery of 8.3 years. The average follow-up duration was 45 months. The outcomes were assessed using percentage of radial bowing (%RB), the radial articular angle (RAA), and carpal slip (CS) using plain X-ray at preoperation and final follow-up. Assessments are used for (1) all cases and (2) cases followed for more than 6 years (7 cases and 8 arms) postoperatively.

Results: In all cases, %RB improved from 14.5 to 11.8, RAA improved from 38.5 to 34.1, and CS improved from 55.4 to 44.1. In cases followed for more than 6 years, %RB improved from 8.9 to 6.5, RAA improved from 36.8 to 35.2, and CS improved from 67.4 to 48.2. Significant improvements were obtained in %RB, RAA, and CS for all cases and in %RB and CS for cases followed for more than 6 years.

Conclusions: The present findings indicate that this surgical technique is effective for improving the deformities not only of the ulna but also of the radius.

A-0017 Sky Line view: A ultrasonography case-control study to evaluate this radiographic view

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Purpose: Extensor tendons rupture is a recognized complication of volar plate fixation of distal radius fracture. The skyline view (SLV) has been proposed to visualize the dorsal epiphyseal cortex so as to detect screw perforation intraoperatively. The aim of this study was to evaluate in vivo the efficiency of the SLV using an ultrasonic postoperative control.

Methods: A case-control study was conducted from January 2014 to June 2015. Inclusion criteria were distal radius fractures scheduled for open reduction and internal fixation by volar plating. Anteroposterior (AP) and lateral fluoroscopic views were used for the control group, and AP, lateral, and skyline fluoroscopic views (SLV) were performed for the case group. A postoperative ultrasonography examination was performed to evaluate the number and length of prominent dorsal screws and the presence or absence of extensor tenosynovitis.

Results: The case group consisted of 28 patients, and the control group included 40 patients. The proportion of prominent dorsal screw exceeding 1 mm was 14.9% for case group. There was 11.85% for control group. The difference was not significant. Average length of the prominent dorsal screws was 1.59 mm for the case group and 2.4 mm for the control group. The difference was not significant. The number of extensor tenosynovitis was 11 for case group (39.2%) and 12 for control group (30%).

Conclusion: The SLV incidence does not provide a sensitive and reliable detection of the dorsal screw penetration.

A-0021 Hand and body radiation exposure during mini C-arm fluoroscopy in hand and wrist surgical procedures

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Introduction: In recent decades, hand surgeons have increased their use of mini C-arm fluoroscopy during surgery. The risks of radiation exposure are well documented and include malignancies, dermatological lesions, cataracts, and hematological aberrations. The International Commission on Radiological Protection have set the yearly radiation limits for nonoccupational workers at 1 mSv/y for whole body and 50 mSv/y for the hands. The purpose of this study is to quantify the amount of radiation exposure to the surgeons' hands and body during routine intraoperative use of mini C-arm fluoroscopy in hand and wrist surgical procedures.

Methods: During a 5-month period, hand and body radiation exposure was measured intraoperatively

during all hand and wrist procedures in which mini C-arm fluoroscopy (Orthoscan HD-flat panel detector) was used. Each procedure was carried out by one hand surgeon (surgeon 1) together with one resident (surgeon 2). Whole-body radiation exposure was measured by two different types of dosimeters, a photon dosimeter and a Raysafe real-time dosimeter. For both surgeons, lead skirts and thyroid lead protectors were prepared with one photon and one Raysafe dosimeter. To quantify the hand radiation exposure, both surgeons wore a ring dosimeter around their nondominant index finger.

Results: Mini C-arm fluoroscopy was used in 93 surgical procedures, which involved 36 finger, 26 hand, and 31 wrist procedures. Fluoroscopy time varied greatly between each surgical procedure, ranging from 1 to 152 sec (average 21 sec). All four photon dosimeters did not exceed their threshold limit of 0.01 mSv for both positions. The Raysafe real-time dosimeters gave a cumulated dose for surgeon 1 and surgeon 2 of 28.94 and 11.48 μ Sv, respectively, for the epigastric position and 12.15 and 11.32 μ Sv, respectively, for the thyroid position. The ring dosimeters showed a cumulated dosage of 1.28 mSv for surgeon 1 and 0.20 mSv for surgeon 2.

Conclusion: Surgeons' hands and body are exposed to acceptable scatter radiation exposure during intraoperative use of the mini C-arm when all safety precautions are taken into account. Surgeon 1 received the highest radiation exposure: 28.94 μ Sv over a 5-month period for the epigastric position, which corresponds to 2.89% of the 1 years limits and 12.15 μ Sv for the thyroid position, which is 1.21%; and 1.28 mSv for the hand which is 2.56% of the yearly limits. Surgeon 2 received less radiation exposure, 1.14% of the yearly limits for the epigastric position, 1.13% for the thyroid position and 0.40% for the hand.

A-0022 MRI for wrist ligament injuries should not be used: A cost-benefit analysis of MRI and clinical examination

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Objective: Andersson et al. published a systematic review on the diagnostic performance of magnetic resonance imaging (MRI) for wrist ligament injuries, showing that a negative MRI cannot rule out the possibility of an injury to the triangular fibrocartilage complex (TFCC)-, scapholunate (SL)-, or LT ligaments.

To become a dedicated wrist MRI examiner, approximately 100 surveys are considered necessary to assess, according to the head of the Radiology Department at Sahlgrenska University Hospital. The current gold standard – arthroscopy – is still the preferred diagnostic technique when it comes to wrist ligament injuries. Still many MRI investigations are performed. The purpose of this study was to compare the costs of referrals for MRI in our catchment area with a thorough clinical examination by an experienced hand surgeon at the Department of Hand Surgery, Sahlgrenska University Hospital.

Methods: The total number of wrist MRIs ($N = 757$) in the catchment area (1,723,000) during 1 year (July 2014 to June 2015) was analyzed, together with the referrals and the related questions. The frequency of surveys at the six radiologic departments in the area was analyzed and individually scrutinized, in terms of MRI investigations intended for wrist ligament injuries and others. The average cost of a regular wrist MRI (axial T2 and T1, coronar STIR + PD FS + T1) was €566, and the time allotted to each investigation was 45 min. The cost for an outpatient clinical appointment and examination at the Hand Surgery department was €188.

Results: The cost for MRI is 3 times higher (€378) than a referral and clinical evaluation at the hand surgery department. The total costs for wrist MRI in the region last year was 429.000 Euros. In average, 54.3% of the examinations were dedicated to wrist ligament injuries, and the costs for these assessments was €233,000. The difference in costs between MRI and a systematic clinical wrist examination by an experienced hand surgeon was €155,500. Of the MRI examinations, 77.5% were referred from nonwrist specialized orthopedic surgeons. The mean waiting time for an MRI investigation was 26 days. The total time consumed at the radiology departments for wrist MRI with the question of wrist ligament injury was 38.5 working days.

Conclusion: The cost for unnecessary wrist MRIs was €233.000, €155.500 more than that for a clinical examination. We therefore recommend MRI only to be used in specific cases and in other issues than wrist ligament injuries. Patients with suspected wrist ligament injuries should be referred to an experienced hand surgeon capable of performing a standardized wrist examination, a diagnostic arthroscopy, and at the same time adjust the arthroscopic therapeutic surgery to the findings or converting to open surgery, in the operating theater. At least in Sweden, this algorithm could save time for the patient and for the radiology department and could also apparently save costs. Health care is at least partly about priorities nowadays. Future research could focus on the trinity

of a thorough history, careful physical examination, and thoughtful consideration of imaging studies in aggregate, rather than focusing solely on the MRI report.

A-0024 Diagnostic performance of the ECU synergy test to detect sonographic extensor Carpi Ulnaris pathology in chronic dorsal ulnar-sided wrist pain

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Objective: Specifying the cause of chronic dorsal ulnar-sided wrist pain is difficult because of the close proximity of small structures, including triangular fibrocartilage complex, lunotriquetral ligament, distal radioulnar joint, and extensor carpi ulnaris tendon (ECU), and the lack of invaluable provocative maneuver. The ECU synergy test is a simple and unique diagnostic maneuver for the evaluation of the chronic dorsal ulnar-sided wrist pain, using isolated tension to the ECU without greatly stressing other structures,¹ and this study aims to investigate the diagnostic performance of the ECU synergy test to detect ECU pathology with reference to ultrasonography.

Methods: During the 2-year period, consecutive patients who visited our clinic with dorsal ulnar-sided wrist pain continuing for more than 1 month were enrolled in this study. Patients with rheumatoid arthritis, dialysis treatment, wrists with a history of local surgery, or major hand trauma were excluded. A total of 40 affected wrists from 39 consecutive patients (22 men and 17 women; age, 14–79 years; mean age, 44.4 ± 19.4 years) were examined with the ECU synergy test and sonography. Sonographic evaluation was focused on the sixth dorsal compartment and on the distal of the compartment between the level of ulnar head and triquetrum in the longitudinal and transverse images. Images were created on a display showing a side-by-side comparison of the right and left wrists. We considered the patient had ECU pathology if the sonography showed more than one of the following abnormal findings: tendon sheath effusion, tenosynovitis, and tendinosis. The sensitivity, specificity, positive predictive value, and negative predictive value of the ECU synergy test to detect ECU pathology were calculated. We compared the results of the ECU synergy test between the group with and without ECU pathology and also compared age, gender, and symptomatic duration of the patients between the group of a positive and negative ECU synergy test and between the group with and without ECU pathology.

Results: Tables in Figure 2 present the results. The sensitivity, specificity, positive, and negative predictive values were 73.7%, 85.7%, 82.4%, and 78.3%, respectively. There was significant difference in the result of ECU synergy test between the group with and the group without ECU pathology ($p < 0.01$). No unaffected wrist showed ECU pathology. There was no significant difference in age, gender, and symptomatic duration of the patients between any two of the groups.

Conclusions: One-to-one correspondence of sonography and the ECU synergy test showed good diagnostic performance for detecting tendon sheath effusion, tenosynovitis, or tendinosis of ECU. The results of this prospective study may support the hypothesis that the ECU synergy test is a useful provocative maneuver to detect ECU pathology in chronic dorsal ulnar-sided wrist pain.

Reference

1. Ruland RT, Hogan CJ. The ECU synergy test: an aid to diagnose ECU tendonitis. *J Hand Surg.* 2008, 33A: 1777–82.

A-0038 Hand impairments and their effects on the daily activities and well-being of leprosy patients in Indonesia

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Objectives: The *Mycobacterium leprae* infiltrates the peripheral nerves causing inflammation that leads to progressive loss of nerve function, which is responsible for most of the patients' disabilities especially in the eyes, hands and feet.

The aims and objectives of this study were:

1. To assess the prevalence of hand impairments in leprosy patients who have completed their treatment in Indonesia.
2. To assess how many of them had neuropathic pain.
3. To study their effects on patients' daily activities and functional capacity.
4. To study their impact on patients' general well-being.

Methodology: A cross-sectional survey was carried out, and a total of 71 leprosy patients, older than 18 years, who had completed their treatment were recruited from a hospital in Indonesia. All patients had a detailed history and careful examination to map areas of pain and motor and sensory loss. Four

questionnaires were used: Douleur Neuropathique 4 (DN4) Questionnaire to assess for neuropathic pain, Brief Pain Inventory (short) (BPI) to assess the burden of pain on daily activities, the Salsa (short) Questionnaire to assess the impact on functional capacity and the General Health Questionnaire (GHQ-12) for their general well-being.

Results: Of 71 patients, 25 (35.2%) reported to have pain in their hands only, which included 17 (68%) males and 8 (32%) females. The mean age was 36.3 years. All had multi-bacillary leprosy, and 14 (56%) had World Health Organization Grade 2 Disability. Nine of 13 who had reactions were Type 2 reactions. The ulnar nerve was most commonly affected – 88% nerve thickening, 56% tender nerves, 68% weakness, and 92% sensory loss. The median nerve was the next involved with 4% nerve thickening, 12% nerve tenderness, 40% weakness and 80% sensory loss.

Seven (52%) of 13 patients who had claw hands were bilateral, 1 (4%) had a wound on his hand and 3 (32%) of 8 had bilateral shortening of the digits.

Eight (32%) of them had neuropathic pain by DN4 criteria, with a mean score of 5.3, and 22 (88%) had BPI score that was moderate to severe, with the greatest effect on their mood and sleep. The Salsa score specifically showed the hand functions most affected were opening screw-capped bottles and lids (80%) and doing fine movements such as picking up small objects and doing up buttons (68%). The GHQ-12 showed 12 (48%) had poor sleep and felt constantly under strain and 12 (48%) felt unhappy or depressed.

Conclusions: There is a high percentage of hand impairments in leprosy patients mainly involving the ulnar nerve. The daily activities are limited by pain affecting mood and sleep, and a third of them suffered from neuropathic pain. The Salsa score was a good tool to demonstrate limitation of hand functions. There is a strong association with sleep problems and depression. These patients may benefit from rehabilitation and psychological counselling. It is important for early detection of nerve involvement to prevent further nerve function impairment.

A-0041 Peripheral nerve regeneration using Bio 3D conduits

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The treatment of peripheral nerve injuries remains challenging for surgeons. When an interstump gap exists, autologous nerve grafting is considered to be the gold standard treatment of such nerve injuries. However, autologous nerve grafting has several disadvantages, including sacrificing native function, neuroma formation at the donor site, mismatch of the caliber diameter, and limited supply. Therefore, alternative treatments are needed. The repair of nerve defects by bridging the gap with tube-like materials (tubulization) has been widely performed, both experimentally and in clinical practice. Several nerve conduits have been developed for improving the quality of regenerated nerves using an extracellular matrix and stromal cells. However, the seeding efficacy and the viability of support cells injected in nerve grafts are controversial. In addition, the regenerative capacity of the nerve conduits remains inferior to that of autografts. In the present study, we focused on Bio 3D printing technology and created a completely biological tissue-engineered and scaffold-free conduit (Bio 3D conduit). We developed a novel method to create scaffold-free tubular tissue from multicellular spheroids using a Bio 3D printer-based system. The purpose of the present study was to evaluate peripheral nerve regeneration using the Bio 3D conduit in a model using rat sciatic nerves.

Normal human dermal fibroblasts alone were used to construct 8-mm Bio 3D conduits. After mid-thigh-level transection of the right sciatic nerves of rats with immune deficiency, we bridged the nerves with a 5-mm interstump gap using the constructed conduits ($n = 5$). In rats in the control group, the right sciatic nerve was simply transected at the mid-thigh level. In rats in the conduit group, degradation of the conduit was confirmed macroscopically at 6 weeks after surgery. Eight weeks after surgery, an electrophysiological study showed compound muscle action potentials in the pedal adductor muscles in the conduit group. The wet muscle weight of the anterior tibial muscle in the conduit group was significantly greater than that in the control group. In the conduit group, a morphological study demonstrated that many well-myelinated axons were present in the mid-portion and at 0.5 cm distal to the conduits. In the control group, no regenerated nerves were seen. In the present study, we confirmed that the Bio 3D conduits contributed to the peripheral nerve regeneration. Further studies of the Bio 3D conduits using

support cells (e.g. bone marrow stromal cells) as multicellular spheroids, and their application for a longer peripheral nerve gap, are warranted.

A-0044 Early tendon transfer using modified Stiles-Bunnell procedure for claw hand deformity in ulnar nerve palsy

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Objective: The claw hand deformity is an abnormal hand position that develops after ulnar nerve injury. Hyperextension of the metacarpophalangeal (MCP) joints and flexion of the proximal and distal interphalangeal (IP) joints, especially at the ring and small fingers, are noted. If claw hand deformity recovery was not satisfactory after 2 or 3 years, tendon transfer for function reconstruction could be performed. Due to claw hand deformity, there were difficulties in daily works and activities for manual workers. We performed early tendon transfer to improve hand function under the request of manual workers. Tendon transfer could replace motor functions that assist in daily activities and improve balance for the best functional use of the residual active muscle tendon units. The tendon transfer does not cause deformity when nerve function is recovered

Methods: Tendon transfer using modified Stiles-Bunnell procedure was performed in four patients during early period after nerve injury. We harvested long finger flexor digitorum superficialis tendon and splitted into four slips. The tendon slips were anchored to the lateral bands of index, long, ring, and small fingers. Distal palmar fascia was used as pulley in tendon transfer surgery. At 4 weeks after surgery, the therapist began the rehabilitation program. Mobilization started with gentle active and assisted range of motion exercises. Full activity could be started at 12 weeks after surgery.

Results: After tendon transfer, the patients could keep fingers in position of MCP joint flexion and IP joint extension. The claw hand deformity was corrected, and hand function was improved with better daily works.

Conclusions: Tendon transfers with modified Stiles-Bunnell procedure could correct claw hand deformity in ulnar nerve palsy patient and enhance hand function. The synergistic muscle tendon unit in tendon transfer will be able to use spinal reflex arcs and other autonomic feedback mechanisms to enhance reeducation. After operation, the patients regained hand function successfully.

A-0054 Clinical evaluation before and after the removal of the volar locking plate in distal radius fracture

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Objective: Patients with distal radius fracture who undergo treatment with a volar locking plate occasionally exhibit problems of the flexor pollicis longus (FPL), including friction, pain, and contracture of the thumb. In this report, we describe the clinical outcome before and after the removal of the volar locking plate in distal radius fractures.

Methods: We reviewed all cases wherein the author was involved in the removal of the distal radial volar locking plate between January 2009 and July 2015. A total of 77 patients were included, including 21 men and 56 women. The average patient age was 56.8 years (range, 17–83 years). The mean duration of implantation was 32.9 weeks (range, 11–91 weeks). The duration of follow-up after plate removal was 22.4 weeks. A total of 31 patients were treated with Acu-LocR (Acumed), whereas 46 patients were treated with VA-TCP (Synthes). The reasons for hardware removal included pain, difficulty in thumb or wrist movement, and the patient's desire.

Results: Symptoms related to the FPL were observed in 24 patients. Among these patients, pain was observed during active thumb motion in 14, and difficulty in thumb movement was encountered in 13. Remarkable intraoperative findings at the FPL were noted during plate removal in 16 patients. The FPL was damaged superficially in 5 patients, and the FPL tendon adhered to the surrounding tissue in 16 patients. In all these cases, the symptoms present before plate removal disappeared after plate removal. Of the patients who did not report difficulty in thumb movement, 67% could move the thumb more easily after the removal of the volar locking plates. Hand 20 – an illustrated, self-administered questionnaire comprising 20 short and easy-to-understand questions for assessing upper limb disorders – was administered to all the patients. The average score after plate removal (9.7) was significantly lower than that before plate removal (23.3; $p < 0.001$). Moreover, the arc of dorsiflexion at the wrist after plate removal was significantly greater than that before plate removal.

Summary points: The removal of the volar locking plate facilitates a reduction in friction at the FPL as well as the removal of mass formation due to plate implantation. Hence, plate removal could lead to a good outcome, including ease of thumb movement,

good range of motion at the wrist, and suitable Hand 20 scores. Therefore, removal of the volar locking plate should be considered as early as possible once union of the fractured bone is achieved.

A-0059 Relationship between 'hourglass-like fascicular constriction' and the idiopathic anterior interosseous nerve palsy

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Hypothesis: An hourglass-like fascicular constriction, which is a focal fascicular lesion observed at one or a few places in one or a few fascicles of a peripheral nerve trunk around the elbow joint and usually affects the anterior interosseous nerve (AIN) or posterior interosseous nerve, is improved with the relief of symptom.

Materials: Seven consecutive patients who were diagnosed with idiopathic AIN palsy based on clinical findings and had hourglass-like fascicular constrictions in the AIN revealed by the ultrasonographic examination were included. We used the high-resolution device with a 14–6 MHz linear probe and observed nerve fascicles in the median nerve trunk in a transverse and longitudinal fashion around the site of tenderness at the elbow joint level, confirming the presence of fascicular constriction.

The age at the time of diagnosis ranged from 19 to 56 years. The duration between the onset of symptoms and ultrasonographic examination ranged from 7 days to 8 months, and the duration between examination and operation ranged from 3 days to 1 month. All but one case took interfascicular neurolysis, and we followed up all cases clinically and ultrasonographically every 1 month. At the time of examination, we calculated constriction ratio, which was obtained by the division of the involved fascicular diameter at the constriction by that at the proximal nonconstricted site.

Results: The number of constrictions ranged from one to eight, and all constrictions revealed ultrasonographically were confirmed intraoperatively. In the five cases with the operative treatment, recovery from paralysis began from 3 weeks to 4 months after surgery and was completed (M0–M4 or M5) 5 to 7 months after surgery. Postoperative ultrasonography revealed the constrictions subsided. The other one treated operatively got little recovery (M0–M2) at 10 months after surgery, and the severe constriction still remained. In one conservative treated case, the

paralysis began to recover at 9 months and recovered completely (M0–M5) at 14 months after the onset. On the ultrasonographic examination, its constriction incompletely subsided.

Discussion: The hourglass-like fascicular constriction subsided with the relief of the paralysis both in the operatively and in the conservatively treated cases. The cause of constrictions is still unknown; however, it may play a significant role in this type of paralysis.

A-0060 Clinical results of a percutaneous technique for trigger digit release using a 25-gauge hypodermic needle combined with corticosteroid infiltration

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Objective: Clinical results of a technique of percutaneous trigger digit release (PNTDR) using a 25-gauge needle with corticosteroid infiltration are reported.

Methods: This prospective study assessed 35 patients with 52 digits who underwent PNTDR and were classified by modified Quinell's grade as follows: grade III = 8, grade IV = 19, and grade V = 25 digits. Results were compared to the control group who had the only administration of steroid injection (35 patients of 41 digits). Patients who underwent PNTDR were divided into diabetic and nondiabetic groups and assessed after 1 week and after 1, 2, 3, and 6 months. According to modified Quinell's grade, results were classified as excellent, good, fair, or poor. The Quick Disability of the Arm, Shoulder, and Hand (QuickDASH) questionnaire and visual analogue scale (VAS) score for pain were completed preoperatively and at each clinical follow-up visit. Complications, including recurrence (type 1 = persistent triggering, type 2 = painful tenosynovitis without triggering), were documented.

Results: PNTDR showed statistically better results than control group in both subjective and objective parameters. In the majority of all outcomes of PNTDR, 94.2% were rated as excellent or good at the final follow-up. There were no statistical differences in percentage of satisfactory results (excellent or good) between nondiabetic patients and diabetic patients (96.4% vs. 91.7%). QuickDASH and VAS pain significantly decreased at final follow-up. Recurrence was observed in 3 digits: one type 1 and two type 2. QuickDASH scores (preoperative/1 week after PTDR) significantly decreased (overall: 33.1/6.8; nondiabetic: 31.0/5.9; diabetic: 37.4/8.7) and were 0.9, 0.8, and 1.2, respectively, at final follow-up. VAS pain scores (preoperative/1 week after PTNDR) significantly

decreased (overall: 4.7/1.5; nondiabetic: 4.5/1.2; diabetic: 5.1/2.1) and were 0.2, 0.1, and 0.4, respectively, at final follow-up.

Conclusions: PNTDR, using a 25-gauge hypodermic needle combined with corticosteroid infiltration, was effective, easily performed, less invasive, safe for outpatient clinics, and provided rapid recovery from pain and clinical symptoms; it was equally effective for mildly or well-controlled diabetic patients.

A-0062 A New complication in volar locking plating of distal radius: longitudinal fractures of near cortex

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Objective: To document a new complication in volar locking plating (VLP) of distal radius fractures (DRFs) with Acu-loc® (FGP) or Acu-loc 2® (SGP) (Acumed, Hillsboro, Oregon, USA) wrist plating systems.

Methods: A retrospective review was carried out of patients with DRFs treated with FGP or SGP in our institution between January 2007 and January 2014. All patients were operated by the same team of surgeons. Patients younger than 18 years old, operated with other implants, and those with longitudinal fracture lines (LFLs) in preop X-rays were excluded. For radiological evaluation, the X-rays taken at the time of injury, postoperative X-rays, and those taken at the time of follow-ups were assessed. All radiographs were examined by three independent surgeons. An LFL extending plate proximal in any of postoperative X-rays was cross examined among the surgeons and accepted as a complication when all of them conformed. In addition to descriptive analysis for age distribution, *t* tests were used for age means and LFL observation. Correlations of age group and LFL observation were evaluated with χ^2 test.

Results: Department's surgical database identified 223 patients (123 females and 100 males) (median age 50.7; range 19–89 years); 124 of them were operated with FGP and 99 with SGP. Mean follow-up was 37.9 months (range 12–80 months). An LFL extending plate proximal in any of postoperative X-rays was observed in 36 patients (mean age 66.3). There were 187 patients without an LFL (mean age 47.67). There was a statistically significant difference between mean ages of LFL group and the other patients ($p < 0.05$).

Age-group descriptives for fracture group patient exhibit a lower bound of 62.55 years in a 95%

confidence interval for mean. Thus, patients over 60 years old were reevaluated. There were 68 patients (55 females and 13 males) over 60 years of age (mean: 69.6, range: 60–89 years) in both implant groups. Twenty-eight of them had LFLs. Correlation between categorical (age over 60 and LFLs) variables was significant ($p < 0.05$).

Conclusion: By aging, thinning and weakening near cortex may be more brittle. When plate is reduced on the bone with a nonlocking screw, the conical head of diaphyseal locking screws can brim over plate thickness and insert into near cortex acting as a screwing wedge. Additional divergent configuration may promote this effect and crack cortex.

A-0063 Radiofrequency energy does not reach appropriate temperature level for substantial shrinkage of scapholunate ligament: A cadaver study

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Objective: The safety and benefit of radiofrequency energy (RFE) for thermal shrinkage in wrist arthroscopy remain unclear. The purpose of this study was to investigate whether applied radiofrequency energy for shrinkage of the scapholunate interosseus ligament (SLIL) reach temperatures required for ligament shortening.

Methods: Standard wrist arthroscopy was performed on seven pairs of cadaveric arms with continuous irrigation, using saline 0.9% solution and gravity-assisted outflow through an 18-gauge needle. Fourteen scapholunate ligaments, seven in each group, were treated with either a monopolar or a bipolar device. Thermal shrinkage starts at about 60°C so the temperature was recorded simultaneously inside the dorsal part of the scapholunate ligament at a depth of 0.9 + 0.1 mm and at six other landmarks in and around the wrist.

Results: We observed an increase in the temperature corresponding to the time of energy application. The highest measured peak temperature at the scapholunate ligament was 42.9°C (monopolar) and 32.2°C (bipolar). The mean temperatures at application of 30 s were 28.56°C + 6.7°C (monopolar) and 27.65°C + 2.84°C (bipolar).

Conclusions: Sufficient temperatures to cause ligament denaturation were not reached with either monopolar RFE or bipolar RFE. Furthermore, we did not find any harmful temperature for cartilage or surrounding tissue in this setting.

A-0064 In vitro biomechanical study comparing side-to-side tendon repair with the modified Pulvertaft weave

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Introduction: Side-to-side (SS) and Pulvertaft tendon (PT) repairs are both designed to permit early postoperative mobilization of a transferred muscle, but SS repair with cross-stitch suture technique has been found to be mechanically stronger than the PT repair using a mattress suture technique. The aim of this study was to compare the biomechanical strength of SS repair with modified PT technique in fresh turkey tendons keeping the number of stitches, type of suture, repair technique, and length of repair similar in both the groups.

Methods: We used 40 FDP tendons harvested from the turkey legs for repair of transected tendons. For SS repairs, the tendon was woven through one incision and was joined with simple sutures at eight points using 3-0 braided stitches on round body needles. For PT repairs, the tendon was woven through two incisions with similar suturing technique ensuring equal length (1.8 cm) of overlapped repaired tendons. Two investigators at random performed the repairs during one summer month independently, ensuring equal number in both the groups. We tested the tensile strength of repair using INSTRON machine under standard conditions. The tendons were mounted vertically and repairs were tested at a distraction rate of 50 mm/min to failure. Variables measured were maximum load, load to first failure, modulus, load at break, mode of failure, site of failure, tensile strain, and tensile stress.

Results: The mean maximum load tolerated by SS repair was 50.3 (standard deviation (SD) 13.7) and by modified PT repair was 46.9 (SD 16.4) N. The tensile stress at maximum load for SS and modified PT repair was 4.7 (SD 4) MPa and 4.2 (SD 3) MPa, respectively. The tensile stress at yield was 5.5 (SD 3) MPa and 4.1 (SD 3) MPa, respectively, for SS and modified PT repair. The tensile strain at maximum load for SS and modified PT repair was 7.8 (SD 3) % and 7.8 (SD 4) %, respectively. We found no statistical difference between two repairs for strength, load to first failure, and maximum load to failure. All failures occurred at the site of repair and suture cut through was the commonest mode of failure.

Discussion: Our study attempts to compare the strength of these two methods of repair keeping other variables similar in both the groups. There was no significant difference in tensile stress, first load to failure, and ultimate load between the two groups.

There is no advantage of pulvertaft weave over the side-to-side repair, but SS repair is simpler to learn and practice.

A-0067 Angular stable mini-plate fixation of chronic unstable scaphoid nonunion: Is it the future?

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Objective: Management of scaphoid nonunion after failed surgical or conservative treatment presents a challenge to the treating surgeon. Healing of scaphoid nonunions is essential for prevention of carpal collapse and subsequent progressive osteoarthritis. It is believed that failed previous surgery and long duration of nonunion adversely effect outcome of surgery. We hypothesized that treatment of chronic unstable scaphoid nonunion with a volar angular stable mini-plate and cancellous bone grafting is a successful technique, regardless of length of time of nonunion or previous surgery for scaphoid nonunion.

Methods: We prospectively enrolled patients with a chronic unstable scaphoid nonunion. All patients underwent clinical and radiological examination preoperatively. Clinical examination included determination of range of motion (ROM) and grip strength. All nonunions were diagnosed on multiplanar reconstruction computed tomography (MRCT) preoperatively. For determination of possible avascularity of the proximal pole, a magnetic resonance imaging (MRI) was made.

Operative technique involved open reduction through a volar approach and internal fixation of the scaphoid using an angular stable mini-plate and autologous cancellous bone graft. Follow-up included physical examination and MRCT at a 3-month interval until union was confirmed, using the criteria by Singh et al.

Results: Fifteen patients (all male) with a mean age of 34 years (range 17–73) were included in this study. All patients had chronic unstable nonunion of the scaphoid. There were five proximal pole nonunions. Seven of 15 patients preoperatively showed a dorsal intercalated segment instability (DISI) of the wrist. Eight of 15 nonunions had previous surgery. Three nonunions showed signs of avascularity of the proximal pole on preoperative MRI. Mean duration of nonunion was 46 months (range 4–183 months). Mean follow-up was 19 months (range 6–30 months). Fourteen (93%) of 15 nonunions were united at follow-up CT scan. Average time until union was 5 months (range 3–12). Mean preoperative ROM was 72°. Mean ROM

at final follow-up was 103°. Mean grip strength was 35% (range 20–50%) preoperatively and 62% (range 40–100%) postoperatively. No serious complications were observed during follow-up.

Conclusions: Angular stable plate fixation supplemented with autologous cancellous bone grafting is a successful technique for treatment of chronic unstable scaphoid nonunion. We believe that rigid fixation is the most determining factor for successful treatment of unstable scaphoid nonunion, regardless of length of duration of nonunion or previous surgery.

A-0069 Peroneal artery perforator flap transfer for soft tissue reconstruction of the hand

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Objective: To report utility of peroneal artery perforator flap transfer for soft tissue reconstruction of the hand.

Methods: From 1990 to 2015, soft tissue reconstruction of the hand with peroneal artery perforator flap transfer was performed in 28 patients at our hospital. Long pedicle graft, meaning peroneal artery and veins are used as vascular pedicle, was performed in 18 cases and short pedicle graft, meaning just perforator vessels are used as vascular pedicle, was performed in 10 cases. The length of vascular pedicle ranged from 6 to 12 cm in long pedicle graft and from 3 to 6 cm in short pedicle graft. Flap size ranged from 5 × 2 cm to 21 × 10 cm. All cases of short pedicle graft were applied to finger soft tissue reconstruction.

Results: A case of long pedicle graft was failed and salvaged with pedicled radial forearm flap transfer. Other 27 flaps survived completely. Secondary defatting of the flap was performed in 14 cases. Skin graft at the donor site was performed in 15 cases. There were no complications at the donor site.

Conclusions: Peroneal artery perforator flap was developed from osteocutaneous fibular flap. There are several perforator vessels from the peroneal artery and veins at the lateral aspect of the lower leg. Skin flap without the fibula can be raised utilizing the perforator vessels. Flap size can be arranged by choice of the number of perforator vessels that are included in the flap. When just perforator vessels are used as vascular pedicle, operative procedure is minimally invasive.

A-0070 Evaluation of the URAM questionnaire in a UK population

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Introduction: We conducted an Internet survey on 167 people with Dupuytren's disease to assess the validity of the URAM questionnaire and an open-ended survey of patient-reported effects of Dupuytren's.

Materials and methods: Participants completed the URAM and subsequently assessed the relevance of the questions to themselves. Next, we asked them to list the three most important problems their Dupuytren's causes and the severity. Finally, they were asked to list all the ways in which Dupuytren's affects them using free text. The responses were categorized for analysis.

Results: The mean URAM score on the affected side was 11.39. Significantly lower scores were found in questions 3 and 9. Participants varied in their assessment of the URAM questions with approval ratings from 43% to 68%. Question 8 had the highest approval and question 1 the lowest. Among the free-text responses 'holding things' came highest (18.05%) followed by pain (15.79%). For second-ranked responses, pain was scored highest with 16.8%. Overall, 59% reported 'holding things' as one of their top problems with 58% reporting pain and 35% their fingers catching. Questions 5, 6, 7, and 8 of the URAM score were hardly mentioned at all in patient free-text responses (0.6%, 0.45%, 0.22%, and 0.45%, respectively). Cosmesis scored higher than we expected.

Conclusions: Generally, the majority of patients report that the questions of the URAM usefully assess the impact of Dupuytren's in their life. In the open-end questions, results were quite different. Some of the URAM items were reported by a very small number of participants and many of the free-text items were not included in the URAM scale, especially pain, concern for future worsening of the problem, cosmesis and catching of the finger on items. All other hand and upper limb PROMS include pain due to its importance. With over 50% of our respondents reporting pain, we believe it should not have been excluded from the URAM scale. The cosmetic psychosocial impact of the deformity is also important. We explored question 1 of the URAM and realized that the French word refers to a specific type of washing glove rather than a flannel. This perhaps explains the low relevance of this question in the English version. In conclusion, we believe that the URAM whilst useful has not been shown to adequately capture the range of disability caused by Dupuytren's, and we suggest further validation is required.

A-0072 Repair damaged nerve by implanting a new type of prosthesis, based on acellular allogeneic nerve grafts

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Introduction: When a nerve section occurs with great distance between proximal and distal ends to make a direct suture, it is necessary to use a prosthesis, as a bridge, to connect the two ends of the neurectomy. The best graft is a segment of autologous nerve, but it has a high morbidity. Biocompatible conduits are considered one of the possibilities to consider in the repair of these lesions. Our goal is to compare the effectiveness of simple suture with tubulisation for implanting an allogeneic acellular nerve segment.

Materials and methods: We used three groups of young adult rats. Group 1 received the implant suture, end to end. Group 2 received the implant in a polylactic-co-glycolic tube. Group 3 received a similar group 2 implant through a polycaprolactone tube. The effectiveness of the implant has been evaluated after 3 weeks of animal survival. We evaluated the motor function by sciatic index, step test in motion and extent of regeneration by histological study of regeneration in different nerve lengths.

Results: The results show that regeneration has been uneven in the three groups, so that in all groups, there are implants that regenerate the maximum studied length of nerve fibers (15 mm) and others in which the regeneration is scarce. Statistical analysis of the rate of regeneration is significantly higher in group 1, end-to-end suture, in contrast to groups 2 and 3, with biopolymer tubes. We found no significant difference between the two groups with polymer tubes.

Conclusion: These results indicate that, for the implementation of acellular allogeneic nerve prosthesis, the end-to-end suture is more effective than the biopolymer tubulisation.

A-0075 Joint survival analysis and clinical outcome of total joint arthroplasties with the ARPE implant in the treatment of trapeziometacarpal osteoarthritis with a minimal follow-up of 5 years

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Objective: The ARPE joint arthroplasty was introduced in 1991 for the treatment of symptomatic trapeziometacarpal (TMC) osteoarthritis and consists of an uncemented cup inserted into the trapezium and an uncemented stem inserted into the thumb metacarpal. The primary outcome of this prospective study is to report medium- to long-term joint survival, and our secondary outcomes are the clinical and functional results.

Methods: A prospective, consecutive case series study was done at the Hand Unit of the general hospital of Kortrijk (Belgium). Patients included in the study had at least 5 years of follow-up after a total joint arthroplasty for arthritis of the TMC joint using the ARPE implant (BIOMET). Clinical and radiological assessment was recorded prospectively: preoperatively and at 1 and 5 years postoperatively. Clinical examination consisted of the range of motion, grip strength, and thumb opposition using the Kapandji method. The Kaplan–Meier method was used to estimate survival probability over time. Continuous variables were assessed by means of the mean or median and range of data. We used the Turkey's range test to compare the means of the thumb opposition and the grip strength.

Results: We included 166 prosthesis (in 156 patients, 10 bilateral) in the survival analysis with a mean follow-up of 80 months. Five prosthesis (3%) required revision surgery and one (0.6%) implant failed. Therefore, Kaplan–Meier survival probability was 96%. A total of 121 arthroplasties (5 bilateral) from 116 patients were included in the clinical analysis. The majority of patients were female (101 patients, 87%). The median age at surgery was 58 years (range 36–78). At 5 years postoperatively, the median Disabilities of Arm, Shoulder and Hand score was 4.55 (range 0–86.63), the median VAS pain score was 0 (range 0–9, mean 0.9), and the median VAS satisfaction was 10 (range 0–10, mean 9.3). There was a significant improvement in the mean opposition and grip strength of the affected thumb at final follow-up in comparison to the preoperative values. Radiographic studies at the final follow-up evaluation showed one (0.8%) prosthesis with cup loosening. Four (2.4%) patients had recurrent dislocations after a minor trauma, treated successfully with conservative cast immobilization.

Conclusion: In our series, the ARPE prosthesis of the thumb TMC joint has proven to be a reliable and safe operation. The Kaplan–Meier survival probability was 96% in 5 years. Mean motion and strength increased whereas pain decreased. Mean VAS satisfaction at 5 years postoperatively was 9.3.

A-0077 Risk factors of carpal tunnel syndrome for male patient undergone carpal tunnel release

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Purpose: The major etiology of carpal tunnel syndrome is idiopathic. But most male CTS patients tend to have specific risk factors for their disease, but the accurate analysis of that propensity has not been reported. The purpose of study is to detect related risk factors of CTS for male patients who underwent surgical treatment.

Methods: A retrospective review of 445 patients with CTS was performed to investigate risk factors for male CTS patients. They were grouped as female ($n = 398$, 89.4%) and male ($n = 47$, 10.6%), and their mean age was 54.5 (range: 27–85 years). Each patient's medical history related to known CTS risk factors was obtained, and the possible causes were categorized as anatomic, neuropathic, inflammatory, and alteration of fluid balance causes to compare female and male in section. And we gathered the occupational information to evaluate occupational risk factor also. If a patient is not related to any risk factors, we considered that the patient's CTS is idiopathic.

Results: All variables were analyzed with χ^2 test. The male patients were shown a certain tendency to have risk factors other than idiopathic. In all, 39 (83%) male patients had risk factors for CTS compared to 81 (20.4%) female patients ($p < 0.001$). The occupational risk factors were most strongly associated with male patients (40.4%), and significant statistical differences were revealed when compared to the female patients ($p < 0.001$). Male patients also had more neuropathic, inflammatory and alteration of body fluid histories than female and significant statistical differences were present when compared to each other ($p < 0.001$).

Conclusions: The male patients were shown a certain tendency to have risk factors other than idiopathic, and we can have benefit to choose the treatment option with understanding that risk factors.

A-0078 Open reduction and internal fixation for intraarticular fractures of the metacarpal head in the MP joint of the hands

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Purpose: Intra-articular fracture of the metacarpophalangeal joint has complicated issues related to the sophisticated functional aspects of the hand. Injury to the metacarpal head in metacarpophalangeal joint may have devastating effect on hand function, but little research has been conducted on the

management. Authors applied open reduction and internal fixation for displaced intra-articular fracture of metacarpal head, and this study reports the clinical and radiographic outcomes of our experience.

Methods: Thirteen patients (12 men and 1 woman) were included in this study, and medical records and radiographs were reviewed retrospectively. The mean age was 22 years and the average follow-up period was 15 months. Range of motion and Disabilities of Arm, Shoulder and Hand (DASH) scores were analyzed as functional results, and serial radiographs were investigated for maintaining articular congruity and fracture union.

Results: Injured fingers were five long, four small, two ring, one index, and one thumb. Eight cases had oblique, four cases had vertical, and one case had comminuted fractures. Five cases were fixed with K-wires, five cases with headless screws, and three cases with screw and wire. The average range of injured MP joint motion was 84°, TAM was 255°, and average DASH score was 5.6 at the last follow-up. All patients showed fracture union on the radiographs, and no patients showed significant articular surface incongruence or degenerative change.

Conclusion: Open reduction and internal fixation of the metacarpal head fracture showed favorable results from our study. Authors suggest accurate reduction and stable fixation for better functional results in the intra-articular fracture of metacarpophalangeal joint.

A-0079 Peripheral nerve regeneration using tissue-engineered nerve conduits in combination with induced pluripotent stem cell technology in mice

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Introduction: There has been dramatic progress in research regarding induced pluripotent stem (iPS) cells for regenerative medicine in the recent years. In 2014, Japan carried out the world's first iPS cell implant surgery for eye disease. However, the therapeutic potential of iPS cell therapy for peripheral nerve injury is largely unknown. In the present study, we applied the tissue-engineered nerve conduits combined with iPS cells to peripheral nerve regeneration in vivo that can be used in place of an autograft, which sacrifices other intact peripheral nerves.

Methods: The nerve conduit (external diameter 2 mm, internal diameter 1 mm, and length 7 mm) was composed of an outer layer of a polylactide mesh and an inner layer of a porous sponge composed of 50% L-lactide and 50% ε-caprolactone. Mouse iPS cells were neurally induced in vitro using a published protocol. The secondary neurospheres derived from mouse iPS cells were suspended in each conduit (4,000,000 cells per conduit) and cultured in the conduit for 14 days. We then implanted them in the left sciatic nerve gap (5 mm; iPS group; $n = 18$). Bridging of the nerve gap using the nerve conduit alone was designated as the control group ($n = 18$) and using autogenous nerve grafts as the autograft group ($n = 12$). Motor and sensory function recovery in mice was assessed by walking-track analysis and the hot water behavior test, respectively, at weeks 4, 8, and 12. Nerve regeneration and the grafted iPS cell-derived neurospheres were evaluated by histological analysis.

Results: At 4, 8, and 12 weeks after the implantation, the fastest functional recovery and the greatest axon regeneration occurred in the autograft group, followed in order by the iPS group, and control group until 12 weeks after reconstruction. The grafted iPS cell-derived neurospheres differentiated into Schwann-like cells in the nerve conduits and survived in the adjacent to sciatic nerve stumps to contribute to peripheral nerve regeneration.

Conclusion: The nerve conduits combined with iPS cell-derived neurospheres promoted regeneration of peripheral nerves and functional recovery in vivo. The combination of iPS cell technology and bioabsorbable nerve conduits shows potential as a future tool and useful alternative to nerve autografts for peripheral nerve repair without the necessity of sacrificing intact nerves. Further studies are necessary to elucidate the exact mechanisms with respect to how the iPS-derived neurospheres promote the regeneration of peripheral nerves.

A-0082 Donor site morbidity on the knee following harvest of medial femoral trochlea osteochondral flaps for carpal reconstruction

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Objective: The medial femoral trochlea (MFT) has been used as a donor site for vascularized osteochondral flaps for reconstruction of carpal defects. These new

procedures demonstrate promising results for challenging carpal disorders such as proximal pole scaphoid nonunion and advanced Kienböck disease. This study examines the donor site morbidity on the knee after these procedures.

Methods: The retrospective study included 45 patients who had undergone MFT flap harvest for scaphoid or lunate reconstruction. Chart review, patient questionnaires, and validated knee function assessment tools were utilized: the International Knee Documentation Committee (IKDC), Subjective Knee Form, and the Western Ontario and McMaster Universities (WOMAC) osteoarthritis index. Most of the patients additionally underwent radiological examinations. X-rays in three planes and magnetic resonance imaging (MRI) scans were done as well as clinical examination.

Results: The average patient age was 35.9 years. The postoperative follow-up was on average 27 months. Thirty patients had been operated because of scaphoid nonunion and 15 because of Kienböck's disease. All patients had a stable knee without signs of patella subluxation or luxation with normal range of motion. The average duration till reporting normal knee function was 90 days. The average IKDC score was 96 and the average WOMAC score was 6%. Radiological examination showed no signs of arthritis in the X-rays and no bone bruise in MRI. There we could also see that the defects in the medial femoral trochlea were filled up with scar tissue and fibrous cartilage.

Conclusions: The MFT osteochondral flap harvest results in minimal donor-site morbidity in the majority of the patients' symptoms are limited. Intermediate-term follow-up demonstrates excellent results in subjective outcome measures and clinical and radiological examinations.

A-0085 Comparison of wrist motion between normal Chinese and Caucasian populations

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Objective: Normal values for wrist and finger range of motion (ROM) have been established and are useful in practice for evaluation of disability, pathology,

assessment of results after treatment, and for comparison of outcomes. Anatomical and functional differences between Chinese and Caucasian populations have been described and may affect our ability to tailor wrist treatment to the patient. The purpose of this study was to compare normal Chinese and Caucasian wrist motion and strength. We hypothesize that a normal Chinese population will have a greater wrist ROM and smaller grip strength than a normal Caucasian population.

Methods: One hundred seventy-one normal Chinese and 156 normal Caucasian wrists were evaluated.

Inclusion criteria: All normal wrists seen consecutively in the hand clinic and all wrists in normal volunteers. In patients with pathology, the normal wrist was only evaluated.

Exclusion criteria: Bilateral wrist pathology, wrists or hands with prior surgery or injury.

Information collected included demographics, occupation, body mass index (BMI), history of wrist trauma, and pathology. Measurements included wrist extension, flexion, radial, ulnar deviation, and grip strength. Wrists were also evaluated for a mid carpal clunk and scaphoid shift test. Mixed models accounted for the evaluation of both hands in the same individual and for the relative contribution of different factors to the outcome measures of ROM and grip strength.

Results: The two groups differed in height, BMI, and the distribution of occupation. The Chinese group had more flexion, less extension, and similar radial/ulnar wrist deviation when compared to the Caucasian group. Ethnicity was a significant predictor of wrist joint flexion and extension significantly predicting grip strength. Age was associated with ROM, while occupation, hand side, and gender were not significant factors in the mixed model.

Conclusions: There were significant differences between normal Chinese and Caucasian wrists in motion and grip strength. These differences should be taken into account when planning treatment for wrist conditions. Further study is necessary to understand the reason for these differences and to separately evaluate challenges and outcomes of specific procedures in the different populations.

A-0086 Leap motion controller: A comparative study in innovative wrist joint range of motion measurement

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Objective: Accuracy and reliability in measurement of wrist range of motion (ROM) is necessary in clinical examination and evaluation. The Leap Motion Controller may be an easy and effective device for evaluating wrist ROM. The objective of this study was to determine the effectiveness and reliability of Leap Motion Controller in the measurement of wrist ROM as compared with universal goniometer.

Methods: A comparison of wrist joint motion range measurement was performed in 33 healthy volunteers using a randomized method. Wrist ROM measurement was compared between Leap Motion Controller and universal goniometer. Volunteers had no previous history of wrist injury and/or surgery.

Results: Significant interobserver and intraobserver reliability was found in the measurement of wrist angle using the Leap Motion Controller. Average intraclass correlation coefficient (ICC) comparing Leap Motion Controller and goniometer was flexion 0.86, extension 0.92, radial deviation 0.53, and ulnar deviation 0.76 for examiner 1 and flexion 0.83, extension 0.92, radial deviation 0.69, and ulnar deviation 0.80 for examiner 2. For examiner 1, limits of agreement were -3.76 ± 10.56 for flexion, -0.21 ± 10.11 for extension, -3.88 ± 9.58 for radial deviation, and -2.45 ± 9.00 for ulnar deviation. For examiner 2, limits of agreement were -3.21 ± 12.15 for flexion, 0.45 ± 10.05 for extension, -0.15 ± 9.78 for radial deviation, and -0.15 ± 9.02 for ulnar deviation.

Conclusions: Leap Motion Controller was found to be a reliable and precise tool for measurement of wrist motion as compared with universal goniometer, the current standard bedside technique.

A-0088 Epidemiology and evolution of management of hand and upper extremity burn contractures in Cambodia: A 15-year experience

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Objective: Burns in developing countries are the leading causes of disability-adjusted life years. In Cambodia, there are over 20,000 incidences of permanent burn disabilities per year and an estimated 2,000 cases of burn-related death. Nearly 40% of all burn injuries involve the hand and upper extremity. Such high volumes of patients pose a challenge, necessitating the development of methodical management protocols. Initial care of these injuries, if inappropriate or insufficient, often result in contractures of the

affected extremity, often with devastating functional consequences. The objective of this article is to illustrate the type of cases seen with an emphasis on the methods of reconstruction utilized and management of burn contracture patients.

Methods: Case notes of burn patients were identified and reviewed retrospectively from the electronic medical records at the Children's Surgical Centre (CSC) in Phnom Penh, Cambodia. For each burn patient who received operations on the upper limb, the types of operative procedures were reviewed and outcomes assessed.

Results: From August 2000 to November 2015, a total of 753 burn contracture patients who underwent operations were identified. Of these, 527 (70%) are burn injuries affecting the upper extremity. A total 111 (14%) had operations at multiple sites on the upper limb, 364 (48%) had an operation on the hand, 11 (1.5%) on the wrist, 22 (3%) on the elbow, and 19 (2.5%) on the axilla. For hand deformity management, K-wire fixations and full-thickness skin graft operations were the commonest methods used. As visiting hand surgeons cooperated with local Cambodian surgeons in consecutive humanitarian missions, more technically challenging operative procedures were utilized, including various local, regional, and pedicled flaps. Pre- and postoperation ranges of motion were evaluated, and satisfactory outcomes were achieved in most of the patients.

Conclusion: This study shows the anatomical areas of burn contracture encountered in patients, the types of operations performed in cooperation, and the evolution of reconstruction methods initially utilized by the local Cambodian surgeons that were modified in cooperation with visiting hand surgeons. A more focused development of a hand surgery curriculum in Cambodia, with a wider repertoire of reconstructive methods, should lead to better patient management and outcomes.

A-0097 A percutaneous sonographically assisted technique as a minimally invasive treatment of trigger finger patients: Clinical outcome

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Objective: To develop and clinically evaluate a new minimally invasive technique in the treatment of trigger finger's disease, the ultrasound-guided release of the annular pulley, by inserting a cutting device

proximal to the metacarpophalangeal joint and advancing it distally, intrasheath.

Methods: This is a prospective, comparative, single-center, clinical study of 41 patients with trigger finger or trigger thumb, grade II–IV according to Green classification system. Group A (18 patients) was treated with an ultrasound-guided percutaneous release of the affected annular pulley under local anesthesia. In addition, group B (23 patients) underwent surgical opening of the A1 pulley, through a 10–15 mm incision. The technique in group A included a sonographically guided percutaneous insertion – through negligible section <1 mm – of an ophthalmic corneal/scleral V-Lance knife (Alcon, Novartis company), over flexor tendons (Verdan's zone 3, proximally to the A1 pulley) and toward their longitudinal axis. Then, the knife was advanced distally, just below A1 pulley, and pressed palmar so as to loosen the thickened pulley (the intersecting part). Thus, after having withdrawn the V-Lance knife (which had created the necessary space intrasheath), a thin hook with a long neck was introduced under the – now extended – A1 pulley. The hook penetrated the annular ligamentous structure facing palmar in order to protect the flexor tendons and subsequently removed proximally (in a steady quick move) carrying along and dissecting the A1 pulley. The patients were assessed pre- and postoperatively (follow-up: 2, 4, and 12 weeks) by physicians blinded to the procedures. Resolution of triggering (primary variable of interest) was expressed as the 'success rate' per digit. The time for taking postoperative pain killers, range of motion recovery, Quick Disabilities of Arm, Shoulder and Hand (QuickDASH) test scores (Greek version), return to normal activities (including work), cosmetic results of the scar, and complications were assessed.

Results: The success rate in group A was 88.9% (16 of 18) and in group B was 100% (23 of 23). Mean times in group A patients were 4 days for taking pain killers, 4.7 days for returning to normal activities, and 7.4 and 4.3 days for complete extension and flexion recovery, respectively. Mean QuickDASH scores in group A were 45.8 preoperatively and, 7.9, 0.8, and 0.3 after 2, 4, and 12 weeks postoperatively. Mean times in group B patients were 2.7 days for taking pain killers, 17.4 days for returning to normal activities, and 5.3 and 2.8 days for complete extension and flexion recovery. Mean QuickDASH scores in group B were 43.6 preoperatively and 8.4, 1.5, and 0 after 2, 4, and 12 weeks postoperatively. The cosmetic results was found to be excellent or good in 83.3% (15 of 18) of group A patients while in 60.8% (14 of 23) of group B patients were evaluated as fair or poor.

Conclusions: Ultrasound-guided release of the A1 pulley yielded better results compared to the traditional

open technique, in respect to fewer working days lost and improved cosmetic results. It is a method that represents excellent results without major complications so that it can be established as a first-line treatment in the trigger finger's disease.

A-0099 Basal thumb arthrosis: Clinical outcome of sonographically guided versus empirical corticosteroid infiltrations

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Objective: To establish the superiority of ultrasound-guided intra-articular corticosteroid injections to 'blind' injections in the treatment of the basal thumb arthritis.

Methods: This is a single-center, prospective, randomized, comparative, clinical study that includes 36 patients with clinical and radiographic osteoarthritis of the first carpometacarpal joint (TMJ) grade I–IV, according to Eaton and Littler classification system. The members of group A (18 patients) were subjected to two ultrasound-guided, intra-articular methylprednisolone-xylocaine injections, from which the second was done 15 days after the first. Furthermore, two 'blind' injections of the same dose and content with those in group A were done in the patients (18) of the group B according to the same timetable. The patients were evaluated before and after injections (follow-up: at 6 and 12 weeks) by physicians blinded to the procedures. For the evaluation of the clinical course, the visual analogue scale 0–100 mm and Quick Disabilities of Arm, Shoulder and Hand (Q-DASH) score were used (the reduction >25% of which was considered as improvement). Statistical analysis was performed using paired *t*-test on SPSS v. 10.0. A *p* value <0.05 was considered significant.

Results: Prior to the infusion, the diseased articular cartilage with osteophytes and erosions, as well as the possible existence of effusion (increased amount of joint fluid), was recognized with the ultrasound. Also, special care was taken for the correct placement of the needle tip within the joint, without penetrating the articular cartilage. Then, the synovial swelling during and after the injection was recorded, for confirmation of the correct application of the technique. Six weeks after the completion of treatment, complete relief of symptoms was recorded (VAS: 0–20 mm) in 12 of 14 patients of the group A

and in 5 of 15 patients of the group B. In addition, at 12 weeks of follow-up, seven patients of the group A remained free of symptoms, while the other seven returned to their initial clinical status. Instead, at 12 weeks of follow-up, no patient from Group B was free of symptoms, as 12 of 15 had already fully returned to their initial clinical status. The Q-DASH mean score of the group A, from 51.2 initially, was found to be 16.4 at 6 weeks and 24.3 at follow-up end point of 12 weeks. In contrast, the mean Q-DASH score of the group B, from 58.5 initially, was found to be 30.9 at 6 weeks and 47.8 at 12 weeks.

Conclusions: Ultrasound-guided injection of methylprednisolone in the basic joint of the thumb offers short-term to mid-term relief of symptoms of osteoarthritis and represents a valuable tool for the symptomatic treatment of the disease, which appears to be superior to blind injection.

A-0100 Ultrasound-guided versus 'blind' infiltrations in the management of persistent lateral epicondylitis

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Objective: To establish whether the guided – in outer limits of ECRB – injection of betamethasone is superior to 'blind' empirical infusion for the treatment of chronic epicondylopathy.

Methods: This is a prospective, randomized, blinded at initial and follow-up evaluation, clinical trial that includes 44 (40 women and 4 men, mean age: 48 years) patients with a history of chronic persistent epicondylopathy, lasting >6 months without responding to protective remedies, such as non-steroidal anti-inflammatory drugs, functional splints, and physiotherapy. As a next step, the local injection of betamethasone combined with xylocaine (1 + 3 ml, respectively), in three sessions with an interval of 10 days per session, was selected. The patients were randomly divided into 2 groups of 22 people, of which group A included those to whom three ultrasound-guided injections were done, while group B included those who underwent three 'blind' injections, centered at the palpable point of maximum pain. It is noted that both guided and 'blind' injections were performed by the same orthopedic resident of our department. Then, rest of the limb followed for 3–4 days after each injection. The evaluation was done before and after (4 and 12 weeks) the end of infusions: (a) at rest, (b) during daily activities, and (c) at work, using the

visual analogue scale (VAS; 0–10), the Nirschl and Pettrone's grading system, and the Roles and Maudsley score. Statistical analysis was performed using paired *t*-test on SPSS v.10.0. A *p* value <0.05 was considered significant.

Results: It was observed that the patients of group B showed better response rates to treatment (VAS at rest: 5.9, before the injection, to VAS: 1.5, after 1 month and VAS: 2.1, after 3 months) compared to those of group A (VAS at rest: 6.4, before the injection, to VAS: 3.3, after 1 month and VAS: 3.8, after 3 months). The preoperative Roles and Maudsley score for group A was acceptable in 2 cases and poor in 20 cases and was changed to excellent in 5 cases and good in 2 cases at the end point of the trial, while in group B was acceptable in 3 cases and poor in 19 cases and was changed – after 3 months – to excellent in 10 cases, good in 2 cases, and acceptable in 1 case. According to the grading system by Nirschl and Pettrone, at the end point of the follow-up, in group A, four cases were excellent, three cases were good, eight cases were fair, and seven cases were failure, while in group B, eight cases were excellent, four cases were good, two cases were fair, and the remaining eight cases were failure. Overall, 7 (31.8%) cases of group A and 13 (59.1%) cases of group B achieved satisfactory results.

Conclusions: It has been proved that the paratendinous-guided injection of a corticosteroid to treat chronic epicondylitis is inferior to the blind injection to an extent that the use of the former cannot be supported.

A-0102 Patient satisfaction after Xiapex

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Purpose: To establish patient satisfaction after collagenase clostridial histolyticum (CCH) injection.

Methods: In a cross-sectional study, 213 patients who has been treated for Dupuytren's disease with CCH were reviewed between 37 and 1421 days after injection.

Results: In all, 73% were very satisfied or satisfied and 21% were dissatisfied; 75% would probably or definitely have CCH again, whereas 17 probably or definitely would not. We found that satisfaction and willingness to undergo treatment reduced over time and correlated negatively with recurrence. Dissatisfaction was greater in those with a poor initial outcome but not in those with an initial complication. Of 212 patients, 78 had previously experienced surgery for DD of whom 71% would prefer CCH to surgery and 15% the converse. Satisfaction correlates with function as measured by both Quick Disabilities

of Arm, Shoulder and Hand and the Southampton Dupuytren's Scoring Scheme.

Conclusions: Patient satisfaction with CCH is generally high but deteriorates over time as the disease recurs. In order to manage patient expectation, this issue should be made explicit to patients in the consent process.

A-0103 Multiplanar reformatting computed tomography for diagnosis of scaphoid fracture malunion and carpal instability: A prospective cohort analysis of interobserver agreement and intraclass correlation

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Objective: Conservative treatment of scaphoid fractures can result in malunion, leading to flexion deformity of the scaphoid bone, carpal malalignment, and impaired clinical function. Scanning along the longitudinal axis of the scaphoid with multiplanar reconstructions of sagittal and coronal views (multiplanar reformatting computed tomography (MPRCT)) has been demonstrated to be accurate in assessing scaphoid fracture union and displacement. Studies on reliability of MPRCT imaging techniques for assessment of scaphoid malunion and carpal malalignment are not available in the literature. The purpose of this study was to determine reliability (interobserver agreement) of MPRCT for diagnosis of scaphoid malunion and carpal malalignment, using a novel technique to assess scaphoid morphology and carpal alignment.

Methods: Fleiss' κ statistics were used to measure interobserver agreement of four observers determining scaphoid morphology and carpal alignment on 39 sets of MPRCT scans of 39 conservatively treated scaphoid waist fractures 24 weeks after injury. Additionally, intraclass correlation (ICC) was used to define reproducibility of the measurements. Osseous union of all fractures had been confirmed on MPRCT. The scans were reconstructed using an average intensity projection rendering algorithm.

Axial length (AL) of the scaphoid was determined for assessment of scaphoid morphology, and the scapholunate gap (SLG), scapholunate angle (SLA), and radiolunate angle (RLA) were determined for assessment of carpal alignment.

Results: Fleiss' κ interobserver agreement for categorical results based on cutoff values most frequently used in literature varied from moderate agreement

for AL (κ 0.59; 95% confidence interval (CI) 0.49–0.69) and SLG (κ 0.53; 95% CI 0.40–0.66) to substantial agreement for SLA (κ 0.65; 95% CI: 0.52–0.78) and RLA (κ 0.68; 95% CI: 0.55–0.80).

ICC coefficients were significant for measurements of AL (ICC 0.939), SLA (ICC 0.926), and RLA (ICC 0.946). ICC coefficient was substantial for measurement of the SLG (ICC 0.85).

Conclusions: Our results suggest that multiplanar reformatting computed tomography is a moderately reliable method for assessment of scaphoid malunion and carpal malalignment. However, uncertainty surrounding the definition of scaphoid malunion and carpal malalignment in literature emphasizes the need for more focused studies regarding imaging of carpal morphology.

A-0109 Microsurgical repair of simultaneous traumatic median and ulnar nerve complete transection at the wrist and distal forearm: Clinical outcome of 29 patients

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Objective: Traumatic wrist and distal forearm injuries resulting in two peripheral nerve complete transection have usually a worrisome clinical outcome. These injuries have a great impact on patient's life while return to work activity may be jeopardized. The aim of this study was to present the functional outcome of microsurgical repair in patients sustaining simultaneous traumatic median and ulnar nerve complete transection at the wrist and distal forearm.

Methods: We present 29 patients (mean age, 29 years; range, 17–39 years) with simultaneous median and ulnar nerve complete transection at the wrist and distal forearm after glass injury (13 patients), spike tools (4 patients), labor accidents (8 patients), and motor vehicle accidents (4 patients). Microsurgical primary end-to-end repair was done in all patients within 24 h after their injury. Postoperatively, a splint was applied for 4 weeks, followed by physical therapy for 1 month, and sensory reeducation thereafter. The mean follow-up was 5.8 years (range, 4–7 years). We evaluated progression of nerve regeneration with the Tinel sign, function with the Mayo Wrist Score, motor

strength (M) and sensation (S) at the hand, two-point discrimination, and Moberk pick-up test.

Results: The mean Mayo wrist score was 17 points; results were excellent (M5-S4) in 3 patients, very good (M4-S3+) in 6 patients, good (M3-S3) in 9 patients, and fair/poor in 11 patients. Sensory reeducation was helpful to restore functional sensation of the hand in all patients with excellent, very good, and good results at 6- to 12-month follow-up.

Conclusions: The outcome of the patients with simultaneous median and ulnar nerve complete transection and the wrist and distal forearm should be regarded with caution. Results are often fair or poor, despite adequate microsurgical end-to-end nerve repair.

A-0110 Palmar subcutaneous single versus dorsal two injections block for finger anesthesia in hand surgery: Randomized prospective comparison application pain and efficacy

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Objective: Digital nerve blocks are commonly used to allow a variety of operations in hand surgery. This randomized prospective study compared the pain during application and efficacy of the palmar subcutaneous single injection (P-1) and the traditional dorsal two injections (D-2) digital block.

Methods: A total of 190 patients were randomized either to undergo a palmar subcutaneous single injection of local anaesthetics at the palmar crease of the finger (96 patients) or a traditional dorsal two-injection block at the base of the finger (94 patients). Initially, 3 ml of mepivacain 1% was administered for anesthesia of the injured finger. Pain during application was evaluated on the visual analogue scale (0 = no pain, 10 = maximum pain), the efficacy of the nerve block was rated 5 min after injection as complete, sufficient, or insufficient analgesia, and further local anaesthetics were administered if necessary. Finger pathologies distal to the first palmar crease included acute wounds ($n = 123$) and bites ($n = 3$), infections ($n = 21$), nail bed injuries ($n = 13$), foreign bodies ($n = 15$), joint dislocations ($n = 10$) and distal amputations ($n = 5$). Thumb injuries and progressive infections were excluded. Statistical analysis was performed using the chi-quadrat and *t*-test, and significance level was set at $p < 0.05$.

Results: A total of 190 patients with a mean age of 43 (range, 19–82) years were included during a 2-year period. Digital anesthesia was performed by 29 dif-

ferent residents of an emergency department. A total of 96 patients (72 males and 24 females) received a palmar subcutaneous single injection, and 94 (55 males and 39 females) had the dorsal two-injection block. There was no significant difference in terms of analgesic efficacy ($p = 0.096$), while the P-1 technique was more reliable: Complete analgesia was achieved by the P-1 method in 93% (vs. 79 % in the D-2 group), and only 2% required a second injection (vs. 9% in the D-2 group). Application pain was rated as significantly less painful when the P-1 method was used ($p = 0.00156$).

Conclusions: This study shows that the single subcutaneous digital block has an equally good analgesic potential, yet the pain during application is significantly lower when compared to the dorsal two-injection block. We recommend the P-1 technique as it is reliable, easy to learn and reproduce, also by residents, less invasive, and has a very low risk of digital neurovascular injury.

A-0112 Predictive factors of Rubis II trapeziometacarpal prosthesis dislocation: Case-control study of 16 cases and 48 controls

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Objective: The Rubis II prosthesis has provided good short-term and medium-term results and survival, but prosthetic dislocation occurred in about 9% of cases in our previous series. The objective of this study was to find risk factors for Rubis II dislocation.

Methods: The Rubis II is an uncemented reverse total trapeziometacarpal prosthesis made of a screwed circular plate topped by a sphere that articulates with the metacarpal stem. Sixteen never reoperated prostheses with at least 1 dislocation were reviewed clinically and radiologically according to a standardized and detailed protocol. Forty-eight controls, paired on age and sex, and which never have been dislocated, were assessed with the same protocol. Implant positioning, thumb length, and adjacent joint arthritis were assessed.

Results: Forty percent of cases lacked bearing of the plate on the trapezium bone versus 4% in the control group ($p = 0.0015$). Cases were painful in 80% of case versus 37.5% of controls ($p = 0.0067$). Prostheses were more frequently on left hands (81% vs. 54%;

$p = 0.077$) although it was not significant. Other clinical and radiographic parameters did not differ between the groups.

Conclusions: A technical error could have been involved in some of our prostheses, but implant positioning did not seem in cause for the other implants. The Rubis II prosthesis has a high rate of dislocation but a low rate of loosening, possibly related to its unconstrained design. Changes in the prosthetic neck and head could be studied to improve the implant stability while keeping its longevity.

A-0117 Decrease in kinesiophobia improves the functional level of hand after tendon repairs

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Objective: According to our clinical observations, patients with tendon repairs experience fear of movement to avoid reinjury and that indicates kinesiophobia. In our previous study, we provided evidence for kinesiophobia in those patients, as they showed an obvious mismatch between patient-reported and clinical assessment results. While clinical performances were generally adequate, patients' perception of performance was lower. As a second step study, we hypothesized that kinesiophobia level may decrease and functional level may improve with daily use of hand. Thus, the aim of this study is to examine the effects of use of hand in daily life on kinesiophobia and functional level in patients with tendon repairs.

Methods: Forty patients with primary tendon repairs participated in the study. All the participants received regular physiotherapy twice a week and wore dynamic splint for 5 weeks postoperatively. Home exercises were also instructed. Patients were encouraged to use their hands in light daily life activities after fifth week. Splint use was reduced at the fifth week and stopped at the sixth week. Assessments were performed at three consecutive time points: at the end of fifth, sixth, and eighth weeks postoperatively. Grip and pinch strengths were measured, and Nine-Hole Peg Test (NHPT) was performed. Disabilities of Arm, Shoulder and Hand (DASH) and Tampa Scale for Kinesiophobia (TSK) were filled by patients in all 3 assessments. Results were analyzed by comparison of three results with analysis of variance.

Results: Grip strength improved in both hands ($p < 0.05$), while pinch strengths and NHPT performance improved significantly only in the injured hand ($p <$

0.001). DASH scores improved in each assessment ($p < 0.001$). TSK scores were also better in the eighth week than fifth and sixth weeks ($p < 0.05$). However, there was no difference in kinesiophobia levels between fifth and sixth weeks. No ruptures or complications occurred with the use of hand in daily life.

Conclusions: Hand functions and kinesiophobia improved with the use of hand in daily life. However, lack of difference in kinesiophobia levels between fifth and sixth weeks may reflect the incomplete physiological process of tendon healing. Consequently, patients with tendon repairs should be encouraged to use their injured hand in daily life as soon as possible. By this way, fear of reinjury may decrease and further complications originating from kinesiophobia may be prevented.

A-0120 Analysis of carpal tunnel pressure in patients with distal radius fractures: Relationship between increased carpal tunnel pressure and median nerve injury

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Objective: Carpal tunnel syndrome is a common condition following distal radius fractures, although the pathophysiology remains unknown. Furthermore, previous studies showed that the pressure within carpal tunnel was elevated after distal radius fracture and suggested that the neuropathy of median nerve following distal radius fracture could be caused by the elevated pressure within carpal tunnel as well as the direct injury of the nerve. The purposes of this study are (1) to evaluate carpal tunnel pressure (CTP) before and after reduction during the surgeries for distal radius fractures and (2) to analyze whether CTP is related to the symptoms due to median nerve neuropathy in the patients with distal radius fractures.

Methods: The patients were 56 consecutive patients (12 men and 44 women) with dorsally displaced radius fractures due to low-energy trauma and managed with volar locking plates. The patients' mean age was 68.2 (range 21–86) years. Preoperatively, we recorded the symptoms involved in nerve injuries to the finger of affected side such as numbness and tingling, particularly at area dominated by median nerve. During surgery, CTP was measured by catheter connected to tube of arterial line tubing and a pressure monitor both before and after reduction and internal fixation. CTP before reduced fracture was compared to that after fixation using *t*-test.

Additionally, CTP was analyzed between patients with median nerve symptoms (group S) and without symptoms (group N) and between Type-A and Type-C according to AO classification using Mann-Whitney *U* test.

Results: There were 11 (19.6 %) patients who complained of median nerve symptoms before surgery and 3 (5.3%) patients even after plating. The mean CTP was 52.4 mm Hg (range 2–165) before reduced fracture and was significantly decreased to 10.9 (0–34) mm Hg after plate fixation ($p < .001$). Moreover, 7 of 29 patients with AO type-A fracture had numbness on injured hand as median nerve symptom. In type-C, 4 of 26 patients had median nerve symptoms. The mean CTP before reduction was 43.6 (range 2–129) and 62.9 (range 7–165) mm Hg in type-A and type-C, respectively, without significant difference. Furthermore, the mean CTP in group S was 81.7 (range 24–165) mm Hg before reduction in fracture. This value was not only significantly decreased to 15.4 (range 5–34) mm Hg after plate fixation but was also significantly high compared to the mean CTP of 45.2 (range 2–129) mm Hg in group N.

Conclusions: The present study showed that the mean value of CTP was clearly high to 52.4 mm Hg in dorsally displaced fracture of distal radius, since CTP was about 10 mm Hg in healthy volunteers in the previous reports. Additionally, reduction and fixation of fractures decreased CTP to 10.9 mm Hg without dependence on fracture type. The data appeared to indicate importance of the proper reduction for protection of median nerve following distal radius fracture through the decrease in CTP. Interestingly, the patients with median nerve symptom had significantly higher CTP than those without nerve injury, suggesting that the increased CTP could be one of the cause of the symptom derived from median nerve injury following distal radius fracture.

A-0121 Long-term results after arthroscopic treatment of central traumatic lesions of the triangular fibrocartilage complex

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Objective: Injuries of the triangular fibrocartilage complex (TFCC) are of high clinical relevance, yet the clinical evidence for treatment is poor and long-term results are rarely published. The purpose of this study is to evaluate the long-term clinical outcome of symptomatic central traumatic lesions of the TFCC (Palmer 1a) following arthroscopic debridement.

Methods: Between 2007 and 2013, 87 patients were arthroscopically diagnosed with Palmer 1a lesion and treated accordingly with debridement and Lipotalon injection. Follow-up was available for 43 patients (mean follow-up at 42.5 months, range 5–70 months). The mean age of the patients (22 males and 21 females) at time of surgery was 41 ± 15.85 years. Pain was evaluated with visual analogue scale (VAS 0–10). Grip strength and wrist motion were assessed with conventional techniques. Activities of daily living were measured with the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. Also, a patient satisfaction questionnaire was completed at follow-up.

Results: No major complication occurred during surgery and follow-up. The DASH score improved significantly (preoperatively 49.84 ± 19.28 vs. postoperatively 14.09 ± 17.89 , $p < 0.05$). The pain also improved significantly on an 11-point numeric rating (preoperatively 7.21 ± 2.03 vs. postoperatively 1.35 ± 1.63 , $p < 0.05$). Wrist extension did not change after surgery (preoperatively 59.60 ± 17.38 vs. postoperatively 59.5 ± 12.14 , $p = 0.985$). Wrist flexion improved from $53.80^\circ \pm 18.95^\circ$ to $67.44^\circ \pm 12.88^\circ$ ($p < 0.05$). The grip strength measured by Jamar dynamometer (second handle position) was satisfactory after surgery (19.60 ± 13.11). Improved symptoms were reported by 41 (95.3) of 43 patients, and 40 (93%) of 43 patients would undergo surgery again.

Conclusions: Arthroscopic debridement of central traumatic TFCC lesions significantly improved the quality of life (DASH score) and reduced pain at long-term follow-up. Patient satisfaction and acceptance of the procedure is high. Central traumatic TFCC lesions can be safely treated by arthroscopic debridement and Lipotalon injection resulting in long-term pain relief and restoration of motion and function.

A-0122 Complications after surgical treatment of fractures of the distal end of the radius in elderly: ORIF with a fixed-angle plate versus external fixation

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Fractures of distal radius are the most common fractures of the upper extremity. In older and osteoporotic patients, simple falls on an outstretched hand can cause distal radius fracture. Surgical treatment is indicated for displaced and unstable fractures in active patients.

Materials and methods: We retrospectively analyzed treatment outcomes of unstable distal radius fractures in the elderly. One hundred forty-eight wrist fractures in 147 patients aged 60 years or older (34 males, 113 females, range 60-88yrs) with distal radius fractures were treated in our operating room between 2008 and 2013. Fall from a standing height was the most frequent mechanism of injury. There were 22 cases with associated multiple fractures: 15 of the proximal femur, 6 of the humeral head, 1 of the contralateral humeral diaphysis. Preoperative computed tomography was obtained in 78 cases, either to triage or to plan surgical treatment. We performed ORIF with a fixed-angle plate in 131 cases (group I) and external fixation in 17 cases (group II). Surgical approach in case of ORIF was volar in 125 cases and dorsal in 6 cases. Fractures were classified as follows: (AO-ASIF) – 20 type A, 72 type B, and 56 type C (19 C3).

Results: A total of 135 patients (136 fractures) returned to follow-up (122 cases in group I and 14 cases in group II). Mean follow-up was 12 months (range 4–26 months). Results were evaluated according to a scheme that analyzed radiographic measurements, MW Score, Quick Disabilities of Arm, Shoulder and Hand (Quick-DASH) score, and Grip test. Radiographic measurements showed good results in 109 (89%) cases in group I and 10 (72%) cases in group II. In group I, Quick-DASH, the result was deemed optimal in 88 (72%) patients, good in 29 (24%), and fair in 5 (4%); in group II, they were deemed optimal in 6 (43%), good in 4 (29%), fair in 3 (21%), and poor in 1 (7%). In group I, results of MWS were deemed optimal in 84 (69%) patients, good in 34 (28%), fair in 3 (2%), and poor in 1 (1%). In group II, results with MWS were deemed optimal in 7 (50%) patients, good in 4 (29%), fair in 2 (14%), and poor in 1 (7%).

Complications: Early complications are as follows: Group I – two reoperations for loss of reduction, 1 reoperation for breaking device, 2 extensor longus pollicis (ELP) tendon rupture, and two other tendon injuries. Group II – two infections and one reoperation for loss of reduction and fishes loosening. Late complications are as follows: Group I – two neuropathies, five stiffness, and one CRPS. Group II – two neuropathies, three stiffness, and three CRPS.

Conclusions: Our study, in accordance with published literature, revealed higher rates of infection,

hardware failure, and neuritis with external fixation, but higher rates of tendon complications and early hardware removal with internal fixation. In our opinion, external fixation continues to have a role in managing distal radius fractures in the elderly patients, particularly in the presence of severely comminuted fractures or high perioperative risk. However, ORIF with a fixed angle plate facilitates accurate reduction and allows to resume activity earlier, especially in osteoporotic bone. Operative treatment of unstable distal radius fractures is widely successful but can have more postoperative complications. In general, most of the complications are related to incorrect surgical technique and can be prevented with careful attention to detail during surgery.

A-0145 Arthroscopic evaluation of regeneration of the TFCC after ulnar shortening procedure

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Ulnar shortening procedure is widely indicated to degenerative tear of the triangular fibrocartilage complex (TFCC) with the positive ulnar variance. Tatebe et al. described that degeneration of the TFCC could be recovered after ulnar shortening from radio-carpal arthroscopic findings. We evaluated recovery of the degenerative TFCC through first- and second-look arthroscopy both on RCJ and on distal radioulnar joint (DRUJ) arthroscopy.

Methods: In all, 663 wrists had undergone ulnar shortening by single surgeon in our institute. Among them, 282 wrists of 276 patients who indicated Palmer 2A to 2D degeneration on the TFCC were included in this retrospective analysis. There were 128 males and 148 females with an average age of 42 (24–78) years. Right wrists were 140, left 136, and 6 bilateral. Preoperative ulnar variance indicated 2.48 (0–11.5) mm. All patients claimed pain and 25 wrists indicated loss of forearm rotation. Eighty-one wrists indicated mild DRUJ instability compared to the intact side and moderate DRUJ instability in 37. There was no severe DRUJ instability case, and 164 wrists indicated no DRUJ instability. All wrists underwent wrist arthroscopy including DRUJ arthroscopy at the time of ulnar shortening (first look), then the ulnar was shortened by an average of 2.6 (2–11) mm. At the time of plate removal, all wrists underwent second-look arthroscopy. We evaluated the first- and second-look arthroscopic findings and clinical outcome using DRUJ evaluation system (Nakamura et al., 2011).

Results: The first look showed Palmer 2A in 173 wrists, 2B in 33, 2C in 68, and 2D in 8 via radiocarpal arthroscopy. DRUJ arthroscopy indicated partial dorsal RUL avulsion in 9 wrists and degeneration of the proximal surface of the TFCC in 266. The second look demonstrated recovery of the Palmer's classification in 115 (41%) wrists and perforation at the triangular fibrocartilage (TFC) was fully covered by synovium in 55 (73%) wrists among 76 perforations. Recovery of proximal surface of the TFC was noted in 250 wrists among 266 (94%) through DRUJ arthroscopy. Final clinical outcomes obtained was excellent in 261, good in 20, and fair in 1 and no poor clinical results.

Conclusion: Ulnar shortening indicated recovery of the degeneration of the TFCC more in the proximal surface than the distal side of the TFCC. Perforation of the TFC was recovered in 73%.

A-0146 Biomechanical evaluation about stability of distal radius fractures fixed with palmar locking plates according to the length of distal locking screw: A finite element analysis

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Objective: When fixing the distal locking screws in patients with distal radius fractures, surgeons face a dilemma how long distal screws are necessary to achieve acceptable fracture stability and avoid the complications related extensors. The aim of this study was to investigate the biomechanical properties according to the varied length of distal locking screws relative to the dorsal-palmar width of radius by a finite element analysis.

Methods: From a set of computed tomographic data of radius, a 3-D finite-element model was reconstructed. After reconstruction of radius, we made a 1-cm dorsal wedge defect of distal radius, which is representing a dorsally comminuted distal radius fracture (AO/OTA type 23 A3). Palmar locking plate with four distal locking screws was fixed at distal radius fracture model. The distal locking screw length of testing groups were full length, 75%, half, and 25% length of the distance from volar plate to the dorsal cortex. The mechanical properties including failure load, stiffness, and von Mises stress values of bone around distal locking screw were evaluated by a

fine-element analysis. The biomechanical test using synthetic distal radius bone was performed to verify the result of a finite element analysis.

Results: Bicortical full length of distal screws provides maximum mechanical strength of distal radius fracture fixed with palmar locking plate. The stiffness and failure load reduced slowly until 50% length of distal screw, however, rapidly below 50% length. The von Mises stress of bone around distal screw was lowest in the full length of screw. This value increased slowly until 50% length of distal screws, however, rapidly increased below 50% length. This finding was consistent with biomechanical study using synthetic radius bone.

Conclusions: This study showed that full length of distal locking screws (bicortical) has maximum mechanical stability in distal radius fracture fixed with palmar locking screw. However, this study also showed that over half length of screws have similar mechanical strength compared to the full length of screw. These results suggest that unicortical fixation over 50% length of distal locking screws for avoid extensor tendon problems can provide sufficient mechanical strength in distal radius fractures fixed with palmar locking plate.

A-0150 Long-term outcome of scaphocapitate arthrodesis with excision of lunate for the advanced Kienböck's disease

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Purpose: Limited carpal fusion is the preferred surgical procedure for advanced Kienböck's disease. After limited carpal fusion, carpal bone translation toward the ulnar side may be a risk factor for early development of radioscaphoid arthritis. The purpose of this study is to analyze clinical and radiologic outcomes after lunate excision, scaphocapitate arthrodesis, and carpal bone translation in advanced Kienböck disease through the long-term follow-up.

Methods: Nineteen cases were treated with lunate excision and scaphocapitate arthrodesis (17 cases with Lichtman's stage IIIB and 2 cases with early Lichtman's stage IV). For clinical evaluation, wrist range of motion, visual analogue scale (VAS) for pain, Mayo wrist score, and disability of arm, shoulder, and hand (DASH) scores were measured preoperatively and at last follow-up. For radiological evaluation, carpal height ratio (CHR), ulnar carpal distance ratio (UDR), scaphoid translation ratio (STR), and radioscaphoid angle (RSA) were measured at preoperative, immediate postoperative, and last follow-up

period. Degenerative change in the radioscaphoid joint was also evaluated at last follow-up. Statistical analysis was performed using SPSS (version 20; IBM, New York, New York, USA)

Results: The average follow-up period was 5 years (range, 36–119 months). At last follow-up, average wrist pain score decreased from VAS 4.7 to 1.1 (p value = 0). The average wrist range of motion increased from 108° to 112° (64% compared with normal side). The average Mayo and DASH score improved statistically from 53.1 (poor) to 76.1 (satisfactory) and from 34.0 to 12.0, respectively. No further collapse was progressed after the operation (p value > 0.001). However, the carpal bones were translated to ulnarward during follow-up periods with positive UDR and STR parameters (average ulnar translation = 2.1 mm, p value = 0). In 74% among the all cases, early staged radioscaphoid arthritis developed.

Conclusion: Lunate excision and scaphocapitate arthrodesis for advanced Kienböck disease provided satisfactory clinical outcomes regarding pain relief and functional improvement, despite no significant improvement in wrist ROM. Our study shows progressing ulnar translation of carpal bones and early-stage radioscaphoid arthritis, despite significant functional improvement. Lunate excision and limited carpal fusion including the scaphoid and capitate is the recommended surgical treatment in advanced Kienböck disease.

A-0156 Diagnostic accuracy of MRI and MRI-arthrography in detecting TFCC lesions of the wrist.

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Objective: In case of clinical suspicion of triangular fibrocartilage complex (TFCC) injury, different imaging techniques are used for further evaluation. The gold standard diagnostic investigation is arthroscopy; however, this is an invasive procedure. Due to the lack of evidence regarding the superiority of sensitivity and specificity, both magnetic resonance imaging (MRI) and MRI-arthrography (MRA) are used for diagnosis of TFCC injuries. Furthermore, it is unknown whether 3T MRI has better diagnostic accuracy compared to 1.5T MRI. Finally, it is the question whether musculoskeletal (MSK)-specialized radiologists have better agreement with the arthroscopic findings than nonspecialized radiologists.

Methods: Between January 2009 and April 2014, 105 patients underwent arthroscopy for ulnar-sided

wrist pain. Of this cohort, 80 had a preoperative MRI or MRA of 1.5T or more. Nineteen were excluded because the interval between MRI and arthroscopy was > 6 months, had a new trauma between MRI and arthroscopy, or had a systemic disease (ie, gout or rheumatoid arthritis). The remaining 61 patients were retrospectively evaluated and compared to findings at arthroscopy. Sensitivity and specificity were calculated for 1.5T MRI ($n = 15$), 1.5T MRA ($n = 12$), 3T MRI ($n = 23$), and 3T MRA ($n = 11$). Differences in sensitivity and specificity between these groups were analyzed by means of ROC curves. Cohen's κ was used to calculate the agreement between assessment of the radiologist and findings at arthroscopy.

Results: For the total sample, 27 (69.2%) of 39 TFCC lesions were detected correctly by MRI/MRA. MRA was superior to MRI in sensitivity (0.80 vs. 0.75; 0.75 vs. 0.64) and specificity (1.00 vs. 0.86; 1.00 vs. 0.73) in both the 1.5T and the 3T group.

Compared to the 1.5T group, the sensitivity and specificity of 3T group (0.73–1.00; 0.75–0.80) tended to be slightly lower (0.64–0.75; 0.86–1.00). No significant differences were found in agreement between non-MSK and MSK radiologists and the arthroscopic findings (κ 0.55 vs. 0.47).

Conclusions: The diagnostic accuracy of MRA seems slightly superior to MRI. However, one could question whether this difference in diagnostic accuracy outweighs the burden and risks of an invasive procedure (as is MRA) for patients and its additional costs. Results of the current study could not confirm the superiority of 3T compared to 1.5T in contrast to (limited) available current evidence.

The difference in accuracy between MSK and non-MSK radiologists in the assessment of TFCC lesions has not been studied before. In this study, a large spread in accuracy was found between the individual radiologists: In conclusion, the accuracy of MRI/MRA depends on the individual skills of the radiologist.

A-0157 Stability of different approaches for triangular fibrocartilage complex foveal repair: A cadaveric biomechanical study

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Objective: In this cadaveric study, we hypothesized that the arthroscopic transosseous suture is able to achieve comparable biomechanical results to the open triangular fibrocartilage complex (TFCC) foveal

repair technique. Another purpose of this study was to evaluate the feasibility of the new aiming device for arthroscopic transosseous suture.

Methods: Six matched pairs of 'fresh-frozen' forearm cadaver specimens were prepared to test. The specimens were mounted vertically in a custom-designed stabilization tower using the AO external fixator. Group I specimens were treated by open repair technique with suture anchor. Group II specimens were treated by arthroscopic transosseous suture with new aiming device aid. This new aiming device could make two bone tunnels simultaneously, and this would let the procedure of arthroscopic transosseous suture easier. Before and after the disruption of TFCC fovea, dorsal and palmar translations of ulna were measured in response to the load (3 kg) in a palmar and then in a dorsal direction. Furthermore, these measurements were also recorded after repair of TFCC foveal tear in both groups. Three consecutive loads in each direction were applied to measure the translation of ulna. The total translation of the ulna was calculated as the sum of the mean dorsal and palmar translations.

Results: One cadaveric specimen has preexisting TFCC pathology. The remaining 11 specimens presented significant increase in the total translation of the ulna following disruption of the ulnar attachment of TFCC ($p = 0.003$). The median percentage of total translation eliminated following TFCC repair of group I (open repair) and II (arthroscopic repair) specimens was 19% and 46%, respectively. There was no significant difference between the two groups.

Conclusions: In this study, we found that disruption of the TFCC resulted in a significant decreased in distal radioulnar joint stability. Furthermore, we showed the feasibility of new aiming device for arthroscopic transosseous suture. In summary, no surgical procedure is proven to have biomechanic advantages compared to another.

Conflict of interest statement: In support of their research for or preparation of this work, the authors received outside funding or grants from the Ministry of Science and Technology, Taiwan (MOST 103-2320-B-650-003) and E-DA hospital, Taiwan (EDPJ103059).

A-0165 Neurophysiological evaluation 5 years after carpal tunnel release in patients with diabetes

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Objective: To compare median nerve recovery, 5 years after open carpal tunnel release, in diabetic and nondiabetic patients. Clinical outcome has previously been published (Thomsen et al. 2014)

Methods: In a prospective study (2004–2007), we included 35 consecutive diabetic patients, (median age 54 (31–73) years) with carpal tunnel syndrome (CTS), who were age and gender matched with 31 nondiabetic patients (median age 51 (35–77) years) having idiopathic CTS. In the present extended study, performed from 2010 to 2012, patients were included for a follow-up at least 5 years after carpal tunnel release. Preoperative, 1, and now 5 years after surgery, nerve conduction studies on the median nerve included distal motor latency (DML), motor conduction velocity (MCV), compound muscle action potential (CMAP), orthodromic sensory nerve action potentials (SNAP) from digits I and III, and fractionated antidromic sensory conduction velocity (SCV) over the carpal tunnel segment. Presence of neuropathy was based on abnormal preoperative neurophysiologic values in both the sural and the peroneal nerves. Differences in continuous data between groups and within groups were tested using nonparametric Mann–Whitney U test and Wilcoxon signed-rank test, respectively. The value $p < 0.05$ was considered statistically significant.

Results: The overall attendance rate at the 5-year follow-up was 86%. It consisted of 27 diabetic patients with CTS (13 type 1 and 14 type 2 diabetes) divided among 16 females and 11 males. There were 30 non-diabetic patients having idiopathic CTS, which included 19 females and 11 males.

From 1 to 5 years after carpal tunnel release, both diabetic and nondiabetic patients demonstrated a significant improvement in nerve conduction parameters. However, except for CMAP wrist and elbow to wrist SCV, all measurements were still significantly impaired for diabetic compared to nondiabetic patients. Despite significant improvement, DML at 5 years was still prolonged for 21 (78%) of 27 diabetic patients and 12 (40%) of 30 nondiabetic patients, compared to 28 (80%) of 35 and 15 (48%) of 31 at 1 year, respectively. Wrist to palm SCV over the carpal tunnel segment, at 5 years, was reduced for 23 (85%) of 27 diabetic patients and 13 (43%) of 30 nondiabetic patients, compared to 32 (91%) 35 and 18 (58%) 31 at 1 year, respectively. In general, normal nerve conduction values at 5 years was only reached for those who had less severe preoperative nerve conduction impairment and for diabetic patients without polyneuropathy.

Conclusion: The clinical implication and conclusion is that although diabetic patients with CTS have significantly impaired nerve conduction parameters

compared to nondiabetic patients with CTS, they obtain the same degree of neurophysiologic recovery after surgical carpal tunnel release. Improvement continues from 1 to 5 years after nerve decompression. However, patients with marked neurophysiologic impairment of the median nerve, or signs of peripheral neuropathy, seldom reach normalization of values. The majority of patients who regain normal nerve conduction do so within the first postoperative year.

Reference

Thomsen et al. *J. Hand Surg. Am.* 2014, 39: 713–720.

A-0169 Results of daily use of hand since postoperative fifth week after tendon repairs: A report of 52 patients

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Objective: Numerous studies of tendon rehabilitation protocols exist in the literature. Despite different aspects and results, majority of them agree on starting use of hand in daily life at the end of the 8th week and measuring strength at the 12th week postoperatively. According to our clinical observations that tendon suture is strong enough, we decided to modify the tendon rehabilitation protocol. In an absolute consensus with our hand surgeon, we reset our protocol at earlier time points.

Methods: Patients with primary flexor or extensor tendon repairs conducted for physiotherapy within the first postoperative week participated in the study. They received regular physiotherapy twice a week. Patients wore dynamic splints during the whole day for 5 weeks and were instructed to exercise according to the passive early mobilization protocol. At the end of the fifth week, splinting time was reduced and patients were encouraged to use their hands in light daily life activities such as using mouse, dressing, and eating. During the sixth week, patients were instructed to do active tendon gliding and blocking exercises. At the end of the sixth week, splinting was terminated and patients were free to use hands at work and home with a careful protection from heavy activities. Light resistance putty and rubber band were added to the exercise program. Assessments of grip and pinch strengths and Nine-Hole Peg Test were performed at the end of the fifth, sixth, and eighth weeks. Patients filled Disabilities of Arm, Shoulder and Hand (DASH) questionnaire.

Results: We treated 60 patients with tendon repairs according to our modified protocol. Eight patients were excluded for various reasons: 3 for nonattendance, 4 for cognitive or compatibility problems, and 1 for cerebral palsy. Functional outcome results of 52 patients improved at each time point with the use of hand in daily life ($p < 0.05$). Not only grip and pinch strengths but also Nine-Hole Peg Test and DASH scores improved significantly in each assessment ($p < 0.05$). Three patients who were noncompliant with our treatment protocol had ruptures due to high-energy incidents at work. No ruptures occurred with hand use during follow-up period.

Conclusions: Early rehabilitation has been strongly emphasized after tendon repairs to accelerate functional recovery. As our previous clinical experiences led to a modification in our tendon rehabilitation protocol, starting use of hand at the end of fifth week did not cause any ruptures. Decision of early use absolutely depends on the interaction between hand surgeons and therapists. If the surgeon confirms the strength of tendon suture, therapist may modify the protocol to optimize the functional recovery.

A-0180 The 'Te' technique for correcting extensor lag in vascularized toe PIP joint transfers

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Objective: From our study in 2013, we have found different extensor mechanisms existed in the lesser toes. Type I toes have an attenuated central slip, whereas type II toes present with a strong central slip. We have demonstrated subsequently in our clinical series that this extension lag associated with poor central slip formation in the toe can be corrected using central slip reconstruction methods such as the Stack's method. However, the Stack's method of central slip reconstruction which involves the dorsal passing of a distally based FDS slip through bone is often a cumbersome procedure for a VJT intraoperatively. The need to drill an extra hole along with extensive manipulation of periosteum can increase the risk of damage to the perfusion of the transferred joint. As such, we present a novel, simple, and effective technique to correct extensor lag in vascularized toe joint transfers.

Methods: In our technique, the lack of a central slip in type I toes can be compensated by anchoring the lateral bands to the middle phalanx of the transferred PIPJ. When transferring a PIPJ of the second toe for the reconstruction of PIPJ defect in a finger, osteosynthesis is first performed passing cerclage

wire through two holes drilled through the distal and proximal ends of the joint complex. Recreation of the extensor insertion to the middle phalanx is performed by anchoring the lateral bands down to bone with sutures. Tenorrhaphy of extensor digitorum longus to central extensor of the finger at zone IV is performed utilizing Pulvertaft weaving.

Results: The use of this novel technique in our institution has seen equivalent results in range of motion when comparing to the use of Stack's technique ($67.0^\circ \pm 19.6^\circ$ vs. $54.4^\circ \pm 11.8^\circ$) in the reconstruction of PIPJs using VJTs. This technique is also safe and quick to perform compared to our prior adopted method in central slip reconstruction and no injury to neurovascular structures have been seen in our institution. The anchored lateral bands sufficiently enhance the axial pull of the extensor mechanism and corrects the inherent extensor lag of the type I toe joints. Only by correcting this inherent extensor lag can we maximize the full potential range of motion of the toe PIPJ.

Conclusions: Our method achieves similar outcomes to the Stacks' procedure but has the advantage of minimizing additional bone drilling and soft tissue manipulation, hence making the procedure markedly easier to perform.

A-0185 Measurement properties of the EQ-5D questionnaire to assess quality of life in patients with carpal tunnel syndrome

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Objective: The EQ-5D is a questionnaire including five items to assess quality of life. However, its measurement properties have not been investigated yet in patients with hand disorders. The aim of this study was to investigate the reliability, validity, and responsiveness of the EQ-5D in patients with carpal tunnel syndrome.

Methods: Sixty patients with carpal tunnel syndrome completed the EQ-5D twice at baseline and 6 weeks after carpal tunnel release. Furthermore, they filled out the Short Form 12 (SF-12) and the Michigan Hand Outcomes Questionnaire (MHQ). The measurement properties of the EQ-5D were analyzed by calculating test-retest reliability (intraclass correlation coefficient [ICC]), internal consistency (Cronbach's α), construct validity (Spearman's correlation coefficient [r]), and responsiveness (effect sizes).

Results: The EQ-5D demonstrated good test-retest reliability with ICC = .80 and excellent internal consistency with $\alpha = 0.84$. There was a strong correlation

with the SF-12 ($r = .7$) and a moderate correlation with the MHQ ($r = .5$). The responsiveness for the EQ-5D was moderate with ES = 0.5.

Conclusions: The EQ-5D presented satisfactory measurement properties and can therefore be recommended to be used as an outcome measure to assess quality of life in patients with carpal tunnel syndrome.

A-0187 Prospective evaluation of a cohort of 81 Patients treated for distal radius fractures with variable-angle volar locking plates

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Objective: Distal radius fractures (DRFs) are frequent. Secondary loss of reduction after osteosynthesis is a frequent complication. The fixation with variable-angle volar locking plate (VAVLP) would be a reliable alternative. Objective of this study is to prospectively evaluate the radiographic, objective (range of motion and grip strength), and subjective outcomes of VAVLP fixation for displaced and/or unstable DRF.

Methods: Between April 2013 and April 2014, we have supported 112 patients with a recent DRF with VAVLP. The protocol was the same for all patients: a Henry type volar approach, an osteosynthesis using a Aptus Distal Radius 2.5 (Medartis®) plate, and an early mobilization to 1 month. Patients were scheduled on J0, J45, J90, J180, and 1 year. Patients whose follow-up was incomplete were excluded. The primary objective was to evaluate the difference in the assessments at J0 and J90 of volar tilt, radial inclination, and ulnar variance. Clinical analysis comprises measuring the range of motion and evaluation of the grip strength of the wrist, compared to the contralateral side. Two functional scores were used: the Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) and the Patient-Rated Wrist Evaluation (PWRE).

Results: We included 81 patients (59 women and 22 men). The average age at time of surgery was 64.3 years (15–94 years). There was no significant difference between the radiological assessments on J0 and J90 for the volar tilt and radial inclination. However, we noted a statistically significant difference ($p = 0.013$) on the average ulnar variance (J0 = -2.0 mm/J90 = 1.4 mm). Clinical end points were significantly improved at every maturity postoperative follow-up. At 1 year, the average wrist strength was 80.9% compared to the healthy side. At 1 year, the average scores Quick-DASH and PRWE were, respectively, 22.2 of 100 (range, 0–81.8) and 16.8 of 100 (range, 0–80).

Conclusions: VAVLP represents a therapeutic alternative with excellent functional result for the care DRF. Nevertheless, the risk of loss of reduction is not entirely ruled out.

A-0188 Organ saving surgery in metastatic lesions of upper limb long bones

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Objectives: Evaluating the effectiveness of organ-saving surgeries in metastatic lesions of upper limb long bones.

Methods: From 2009 to 2015, 26 patients with metastatic lesions of the upper limb long bones were observed. Men amounted 13 and women 10. The average age of patients was 59.8 years. According to the localization, the following metastatic tumors were observed: cancer of the kidney – 10 patients, breast cancer – 7, lung cancer – 5, multiple myeloma – 3, and rectal cancer – 1. Reinforced fixation with bone cement was applied in 10 (43.5%) patients, transosseous osteosynthesis with Kostiuik apparatus of external fixation in 6 (13%) patients, arthroplasty of the elbow using individual oncological implants in 4 (17.4%) patients, joint replacement of the diaphysis of the humerus in 4 (17.4%) patients, and joint replacement of the shoulder joint in 2 (8.7%) patients. Patients received pre- and postoperative radiation therapy, intravenous chemotherapy, hormone therapy, immunotherapy, and bisphosphonates in the schemes of complex therapy of this disease. Limb function was measured by the MSTS system. The degree of pain was measured by Watkins RG scale. Quality of life was measured according to the questionnaire EORTC QLQ-30. Survival rate of the patients was measured by Kaplan–Meier method.

Results: As a result of the treatment, postoperative complications were observed in 1 (4.3%) patient, tumor recurrence in 2 (8.7%) patients, and new metastatic lesions in the bones of the skeleton in 13 (56.5%) patients. The function of the upper limb (system MSTS), after the use of external fixation, amounted 66%, reinforced osteosynthesis – 70%, joint replacement of the shoulder joint – 68%, elbow joint replacement – 76%, and diaphysis of the humerus arthroplasty – 82%. The degree of pain (on a Watkins RG scale) after the use of external fixation devices has decreased from 90% to 20%, after reinforced osteosynthesis decreased from 67% to 33%, and after arthroplasty from 88% to 35%. Quality of life improved from 40 to 80 points, and 13 patients died during the period from 6 to 36 months. The

3-year survival rate of patients amounted $32.6\% \pm 0.76\%$.

Conclusions: Organ-saving surgeries in metastatic lesions of upper limb long bones alongside with complex treatment allow to restore limb function, reduce pain, and therefore improve the quality of life of patients.

A-0191 Is short-arm cast appropriate for stable distal radius fracture in the elderly? A randomized prospective multicenter study: Short-arm cast versus long arm cast

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Introduction: We conducted a prospective randomized, multicenter study to compare short-arm and long-arm casts for the treatment of stable distal radius fracture in elderly patients.

Methods: We randomly assigned patients over the age of 55 who had stable distal radius fracture to either short-arm cast group or long-arm cast group. Radiographic and clinical follow-up were conducted at 1, 3, 5, 12, and 24 weeks. Radiologic evaluation included radial inclination, length, and volar tilt. Functional evaluation was carried out using the Disabilities of Arm, Shoulder and Hand (DASH) score at 12 and 24 weeks. Also, degree of disability caused by each cast immobilization was evaluated at the patient's visit to remove cast.

Results: There were no significant differences in radiological parameters between the groups except for volar tilt. Despite these differences in volar tilt, neither functional status as measured by the DASH nor visual analogue scale was significantly different between the groups. However, the mean score of disability caused by cast immobilization and the incidence rate of shoulder pain was a significant difference.

Conclusion: Our findings suggest that short-arm cast is as effective as a long-arm cast for the stable distal radius fractures in the elderly. Furthermore, it is more comfortable and introduced less restriction on daily activities.

A-0193 Lateral joint stability in patients treated with a CapFlex-PIP© implant

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Objective: Lateral joint stability of the proximal interphalangeal (PIP) joint is an important aspect for

preserving joint function, especially in the index and middle fingers. CapFlex-PIP® (KLS Martin Group, Germany) is a novel modular surface replacing implant, which preserves bone stock and collateral ligaments. With its anatomical shape, it provides higher intrinsic stability than silicone implants, resulting at least in theory, in a better lateral stability. The aim of this study was to examine the lateral joint stability and the longitudinal joint axis deviation in patients, which were treated with a CapFlex-PIP® prosthesis.

Methods: At our institution, all patients treated with a CapFlex-PIP® implant are prospectively documented in a clinical register. Before surgery and at 6 weeks, 3, 12 and 24 months post-surgery, lateral joint stability was judged by the clinician testing valgus-varus stability clinically. The degree of instability was described in the three categories no, low, and high radial or ulnar instability, which was compared to contralateral side. Range of motion (ROM) and the brief Michigan Hand Questionnaire (briefMHQ) were assessed. Standard anteroposterior and lateral radiographs were also taken at follow-up to examine the longitudinal joint axis deviation, which was divided in the categories minimal (0°–5°), moderate (>5°–15°), and large (>15°). The interactions between instability, axis deviation, and surgical approach were calculated using Fisher's exact test.

Results: To date, 97 patients (64 females and 33 males; 101 PIP joints) suffering primary or secondary osteoarthritis of the PIP joint were treated with a CapFlex-PIP® implant. The dorsal approach was used in 52% and the palmar approach in 48% of the treated fingers. At baseline, 36% and 14% of the PIP joints, respectively, showed a radial and ulnar instability, and 9% and 3% of these were high. At follow-up period, a high radial instability was seen in one finger after 2 years, which showed a longitudinal joint axis deviation of more than 15° with an ROM of 80°. This patient showed a good functional outcome based on the briefMHQ (83 points). No high ulnar instabilities were registered. A low radial instability was seen in further two cases. Two other cases showed low ulnar instabilities and one PIP joint had a low radial and ulnar instability. At 12 and 24 months follow-up, 74% and 88% of the fingers, respectively, with preoperative moderate or large longitudinal joint axis deviation improved to minimal deviation. The radial instability interacted significantly with the longitudinal joint axis deviation after 2 years ($p = 0.038$). Moreover, there was no significant interaction between radial instability and the surgical approach ($p > 0.05$).

Conclusions: In majority of the patients, enhanced lateral joint stability and the correction of longitudinal joint axis deviation were observed with the CapFlex-PIP® implant in PIP joint replacement.

Only one high radial instability occurred postoperatively in a finger with poor preoperative stability with insufficiency of the radial collateral ligament. The implant's congruent joint surfaces, together with the minimal bone resection and the preservation of collateral ligaments, provide good lateral stability and the possibility to correct preexisting longitudinal joint axis deviation.

A-0194 Minimally invasive plate osteosynthesis of comminuted proximal phalanx fractures

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Introduction: Minimally invasive plate osteosynthesis (MIPO) technique is usually used for the treatment of comminuted long bone shaft fractures in order to reduce soft tissue damage. Although there are a number of studies on humeral, femoral, and tibial fractures, our literature review revealed no studies of phalangeal fractures. The purpose of this study was to evaluate functional outcomes of MIPO for comminuted proximal phalangeal fractures.

Materials and methods: MIPO technique was performed in nine patients (nine males; mean age 37.6; standard deviation (SD) 7.5) with closed comminuted proximal phalangeal fractures between January 2012 and March 2013. The patients were followed up for a mean of 14.5 months. Fracture healing was assessed by standard anteroposterior and lateral X-ray film on postoperative weeks 1, 4, 8, 12, and 16 and at the final follow-up. For functional assessment, total range of motion (TRAM) and grip strength on the injured side and the contralateral side were measured. According to Duncan score, TRAM between 260° and 220° was considered as excellent, between 219° and 180° as good; between 179° and 130° as fair, and below 130° as poor. The grip strength was measured using the JAMAR hand dynamometer. The Mann-Whitney *U* test was used to compare the results of the Jamar measurements and the range of motion in the injured versus the contralateral sides.

Results: The mean union time was about 3 months. The mean injured side TRAM was 204° (SD 13) at the final follow-up. TRAM averaged 78% of the uninjured side. A statistically significant difference was noted in TRAM values between the injured and the contralateral fingers ($p < 0.05$). Based on the Duncan classification, the results were excellent in five fingers and good in four fingers. The injured side mean grip strength was reduced by 25% (SD 8) in the operated hand compared to the contralateral side.

Discussion: MIPO technique enables fixation without impairing bone vascularization in comminuted fractures and leading to surgical trauma. Plate fixation with minimally invasive interventions following reduction in comminuted phalangeal fractures is a technique enabling early mobilization and good clinical results.

A-0197 Extension block technique for mallet fractures: A comparison of one and two dorsal pins

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Objective: Our aim is to compare the clinical and radiological outcomes of dorsally placed one and two pins for extension blocking of mallet fractures.

Methods: Forty-seven consecutive patients with mallet fracture treated with extension block technique in our clinic between 2012 and 2015. Fractures less than one-third of joint surface, open and comminuted fractures, physeal injuries, patients with more than 6 weeks delay after injury, and patients with less than 6 months follow-up were excluded. Finally, 34 patients with 36 mallet fractures were included into the study. In our clinic, some surgeons were using two dorsal pins for extension block technique while others one. Thus, 19 fractures had been treated with one dorsal pin (Group 1) and 17 fractures with two dorsal pins (Group 2). All patients were evaluated according to Crawford outcome score. Extensor lag and complications as nail ridging, dorsal bump, pin site infection, cold intolerance, paresthesia, and swan neck deformity were also noted. Radiologically, fracture size, articular and dorsal gaps, volar subluxation, and rotation of dorsal fragment were measured in lateral X-rays. Mann-Whitney *U* test was used to compare preoperative and postoperative radiological measurements and extension loss between the groups. On the other hand, χ^2 test was used to compare clinical outcome and complication rates.

Results: Mean age was 33.6 (16–61) and average follow-up time was 12.2 months. All fractures united with a mean time 6.0 (4–9) weeks in group 1 and 6.1 (4–7) weeks in group 2. Union with dorsal rotation was determined in six patients in group 1 and seven patients in group 2. But we did not find any relation between dorsal rotation and union time. We obtained 73.6% and 70.6% excellent and good outcome scores in group 1 and group 2, respectively. Final extension lag was 6° in group 1 and 7° in group 2. Reduction

loss was seen 1 week after surgery in two fractures in group 1. No loss of reduction was encountered in group 2, but there was no difference between pin count and loss of reduction. There was one pin site infection in group 1 and two infections in group 2 which resolved with pin care and oral antibiotic treatment. No difference was found between two groups in terms of clinical outcomes, radiological values, and complications.

Conclusions: We found no difference between one and two dorsal pins in the treatment of mallet fracture with extension block technique. In spite of this, we think that one dorsal pin should be preferred to avoid additional morbidities of two dorsal pins. But reduction loss should be kept in mind in this option.

A-0200 Linburg-Comstock: Is overuse an etiologic factor?

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Objective: Linburg-Comstock anomaly is typically defined as a tenosynovial interconnection between flexor pollicis longus and flexor digitorum profundus tendon of the second finger. There are several studies stating that the current anomaly is congenital or acquired. The aim of this study is to reveal whether overuse, which is mostly reported as an acquired etiologic factor, is effective in development of the current anomaly.

Methods: Three hundred thirteen medical secretaries who work with computer keyboard at least 6 h a day were defined as study group, and 323 volunteers without jobs who necessitate continuous and repetitive hand and finger activities were defined as control group. Both study and control groups were examined by an orthopedic surgeon whether Linburg-Comstock anomaly exists. Additionally, cases with Linburg-Comstock anomaly were examined in terms of carpal tunnel syndrome symptoms, pain, paresthesia, and night symptoms at forearm or hand. Mann-Whitney *U* analysis was used for age distribution comparison and Pearson χ^2 square analysis was used for existence of Linburg-Comstock anomaly and other symptoms.

Results: There was no difference between 2 groups in terms of age distribution. There were 87 (27.8%) cases with Linburg-Comstock anomaly in the study group and 104 (32.2%) cases in the control group. The difference was not significant. Of 87 cases with the anomaly in study group, 22 (25.3%) cases had forearm pain and 5 (5.7%) cases had carpal tunnel syndrome

symptoms. Of 104 cases with the anomaly in the control group, 22 (21.2%) cases had forearm pain and 14 (13.5%) had carpal tunnel syndrome symptoms.

Conclusions: The current study reveals that overuse is not an etiologic factor in Linburg-Comstock anomaly existence and related symptoms. We think that the current anomaly develops on congenital basis rather than acquired factors. Although not an etiologic factor, overuse may aggravate preexisting symptoms.

A-0206 A retrospective 3-year study of bacteria isolated from hand infections

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Purpose: The aim of the present study is to evaluate bacterial hand infections by analyzing the frequency of isolation of gram-positive and gram-negative bacteria, assessing susceptibility rates, and determining causes and affected areas in a single hand trauma department.

Methods: All hand infections were operated in the Department of Microsurgery/Hand and Upper limb surgery at General Hospital KAT. Samples for microbiological investigation were taken from pus, inflammatory exudate, and infected tissue intraoperatively. A total of 321 positive cultures (1 per patient) were examined. Identification and susceptibility testing were performed using the Vitek 2 automated system (BioMérieux, France).

Results: A total of 321 patients (204 men and 117 women) with hand infections were operated between 2012 and 2014 in our department. The mechanisms of injury were trauma, foreign body, animal bite, spontaneous, human bite, and other causes. Infections were localized in subcutaneous tissue, tendon sheath, paronychia, joint, bone, and combined areas. Palmar area was affected in most cases.

Gram-positive bacteria were isolated in 54% of cases, and gram-negative bacteria were isolated in 45%. These included 70 coagulase-negative staphylococci, 67 *Staphylococcus aureus* isolates, 16 *Streptococcus* spp., 27 *Enterobacter* spp., 22 *Pseudomonas aeruginosa* isolates, 20 *Klebsiella* spp., 18 *Escherichia coli* isolates, 10 *Proteus* spp., and 8 *Acinetobacter baumannii* isolates. Furthermore, more than one species was isolated at 4% of infections. Species that caused polymicrobial infections were *S. aureus* with *P. aeruginosa*, *S. aureus* with *Streptococcus pyogenes*,

or different species of gram-negative bacteria, mainly *Enterobacter* spp. together with *Klebsiella* spp. Anaerobes were isolated in 1% of the cases. Susceptibility testing yielded that the majority of the bacteria tested were susceptible to most antimicrobials. Resistance rates to methicillin were at 31% for *S. aureus* isolates and 54% for coagulase-negative staphylococci. All staphylococcal isolates exhibited low levels of resistance (less than 10%) to clindamycin, rifampicin, and ciprofloxacin. All isolates were susceptible to vancomycin, linezolid, daptomycin, and tigecyclin. As for gram-negative bacteria, resistance rates were also low (<20%) for the drugs of choice with the exception of *Pseudomonas* and *Klebsiella* isolates that showed resistance to quinolones at 27% and 38%, respectively.

Conclusions: Gram-positive bacteria are the causative pathogen in the majority of hand infections followed by gram-negative bacteria. Resistance rates were low, and the percentage of Methicillin-resistant *Staphylococcus aureus* was at 31%. The identification of pathogens and the knowledge of resistance rates in hand infections are mandatory for the successful treatment and eradication of infection. Pharmaceutical treatment options are multiple up to now, despite the extended and unregulated use of antibiotics in the Greek population. The fact that the use of low-cost antibiotics is still effective in most hand infections of the Greek patients provides an excellent therapeutic tool to the armamentarium of a hand surgeon considering the local economic crisis.

A-0213 The external validation of a clinical prediction model to predict early instability in distal radius fractures

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Objective: Mackenney et al. published a prediction model to predict early loss of reduction in distal radius fractures. If the model is reliable, it could assist in decision-making regarding the treatment of choice in patients with displaced distal radius fractures. However, Mackenney et al's model was never externally validated. The aim of this study was to externally validate this model in a new population of patients with distal radius fractures.

Methods: We performed a retrospective cohort study. All consecutive adult patients with a displaced distal radius fracture between January 1, 2009, and August 4, 2014, were included. The primary outcome was early

(within 2 weeks) fracture instability. The validity of a model was assessed by comparing the observed instability with the predicted instability. To estimate the ability of the model to discriminate between patients with and without instability, we calculated the area under the receiver operating characteristics curve (AUC). The AUC ranges from 0.5 to 1, with higher score indicating better discrimination.

Results: The study group was formed by the 99 patients who had sustained a displaced (potentially unstable) fracture. In this group, early instability occurred in 61 (62%) patients. Overall, the probability of early instability according to the model ranged from 5% to 89% with a median probability of 33%. Of the three patients with a high probability of instability (>70%), one fracture was unstable. Of the four patients with a very low probability of instability (<10%), one fracture was unstable as well. The AUC of the model in our population was 0.53 (95% confidence interval: 0.41–0.64).

Conclusion: External validation of Mackenney et al's prediction rule for early instability in our population showed poor discrimination. Therefore, we must conclude that this model is not suitable for our population.

A-0214 Variation in the surgical treatment of 95,754 distal radius fractures in the Netherlands: What you get is hospital and surgeon dependent

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Purpose: Variations in medical practice have already been documented for a number of elective procedures. Generally, this variation is warranted if it is attributable to patient-related factors and unwarranted if it is attributable to factors such as physician's local beliefs and preferences. Because the evidence for the optimum treatment of patients with distal radius fractures remains inconclusive, we hypothesized that there would be a considerable variation in treatment. The aim of this study was to examine the variation in surgical treatment rates of patients with distal radius fractures across Dutch hospitals.

Methods: We obtained all reimbursement data for the treatment of distal radius fractures for 2012 and 2013 categorized by hospital. The surgical rate

across hospitals was corrected for possible explanatory variables using linear regression analyses.

Results: We analyzed a total of 95,754 reimbursements. The operative rate ranged from 0% to 23%, with a mean of 9.6%. Hospital type, the percentage of females, the percentage of patients over 65, the mean age, average socioeconomic status, and the total number of patients treated explained only 2.6% of the observed differences in the operative rate among hospitals in 2012 and 11.6% in 2013.

Conclusions: There is considerable and possibly unwarranted variation in the treatment of patients with distal radius fractures across the Netherlands which cannot be explained by hospital type and characteristics of the patient population. Our results suggest that nonscientific influences, such as surgeon's local beliefs and preferences, prevail and drive therapeutic decisions in patients with distal radius fractures.

A-0215 The content validity of the work-related questionnaire for upper extremity disorders)

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Background: Upper extremity musculoskeletal disorders are responsible for limitations in work and form a reason for a large part of the working population to report sick from work. Currently, there is lack of attention for the factor work in daily orthopedic practice. It is important to identify work-related limitations that patients experience in order to apply appropriate interventions to enhance or support work participation. Aim of this study is to develop a patient-reported outcome measure (PROM) specific for work-related limitations due to upper extremity musculoskeletal disorders and to assess its content validity.

Methods: The first version of the questionnaire was developed following the evaluation of existing PROMs and consensus within the research team. The content validity was assessed in three steps: (1) interviews with patients ($n = 14$) from the target population were held to discuss the clarity and possible adaptation of the items; (2) 48 experts from the field were approached to participate in an interview to discuss the clarity, relevance, and missing items; and (3) patients ($n = 12$) were interviewed to discuss the final version.

Results: The first version of the work-related questionnaire for upper extremity disorders (WORQ-UP) consisted of 18 items based on the criteria: exertion, dexterity, handling tools and equipment, and mobility. Patients indicated that most of the items (44%) were not easy enough to understand. Twenty-one experts participated in the interviews (physiotherapists, insurance physicians, occupational health physicians, rehabilitation physicians, and orthopedic surgeons) and adaptations were made: Items or examples were added, and items were deleted. The final version of the WORQ-UP consisted of 17 items. Patients reported all items as being easy to understand (100%).

Discussion: A PROM-specific for work-related limitations in patients with upper extremity musculoskeletal disorders was developed. The content includes four categories: exertion, dexterity, handling tools and equipment, and mobility. According to patients and experts, it has sufficient content validity.

A-0216 The work-related questionnaire for the upper extremity: Factor analysis and internal consistency

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Background: Upper extremity musculoskeletal disorders are one of the major causes for the working population to stay away from work. Up till now, little attention has been paid to the factor of work in daily orthopedic practice. The work-related questionnaire for the upper extremity (WORQ-UP) may be a useful for identifying work-related limitations in patients with upper extremity disorders in orthopedic practice. The 17 items of the WORQ-UP were retrieved based on literature and interviews with patients and clinical experts. In the present study, we tested the dimensionality of the items (factor analysis) and calculated the internal consistency.

Methods: One hundred and fifty patients from the target population (50 patients with shoulder disorders, 50 patients with elbow disorders, and 50 patients with hand-wrist disorders) filled in the WORQ-UP. Exploratory factor analysis (EFA) was performed including direct oblimin oblique rotation. After determining the number of factors, Cronbach's α (CA) was calculated for factor.

Results: Four factors with eigenvalue (EV) > 1.0 were found. The EV of the factors was, respectively, as follows: factor 1 = 5.78, factor 2 = 2.38, factor 3 = 1.81, and

factor 4 = 1.24. The factors together explained 65.9% of the variance. Factors were named exertion, dexterity, tools and equipment, and mobility. The CA for these factors was, respectively, 0.88, 0.74, 0.87, and 0.66.

Discussion: The 17 items of the WORQ-UP resemble four factors – exertion, dexterity, tools and equipment, and mobility. Each individual factor, except factor 4 (mobility), had a CA above 0.7. Based on these values, and the development of the WORQ-UP in collaboration with experts and patients from the target population, it can be concluded that the WORQ-UP has a high content validity in combination with high internal consistency.

A-0224 Ultrasound assessment of palmaris longus tendon action after Camitz tendon transfer

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Objective: Indication for simultaneous opponenplasty in severe carpal tunnel syndrome is controversial, as previous studies showed high rate of abductor pollicis brevis (APB) reinnervation after carpal tunnel release. We hypothesize that palmaris longus tendon (PL) continues to augment thumb function even after APB reinnervation.

Materials and methods: Records were reviewed for patients who had Camitz tendon transfer from September 2006 to August 2013. Electromyography was used to assess the APB muscle reinnervation. Ultrasound was used to evaluate the activity of the PL muscle during thumb opposition and abduction.

Results: Twenty-one patients were included in the study. The mean follow-up was 36.9 months (range 4–88 months). Postoperative electromyography showed 11 (52.4%) patients had good or full recovery of APB after the procedure. In this group of patients, 7 (64%) still had abundant activities of PL during opposition and abduction. There was a trend for better tripod pinch and power grip in patients with increased PL activities demonstrated by ultrasound on abduction or opposition.

Conclusion: Palmaris longus augmented the function of abductor pollicis brevis even in patients with full recovery of the muscle.

A-0229 Vascularized medial femoral condyle flap: Beyond the scaphoid nonunion

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In the treatment of bone defects and nonunion, there are cases where either the type of trauma or previous surgeries produced a poor vascular bed. In these cases, the use of vascularized bone grafts has proved to be a safe choice with faster healing time. Vascularized fibula graft is an accepted method to treat defects of more than 6 cm with structural bone graft requirement. However, in defects smaller than 6 cm, the use of vascularized bone graft is not widely accepted. The medial femoral condyle, supplied by the descending genicular artery, has proved to be a reliable source of periosteal, corticoperiosteal, osteochondral, and corticocancellous flaps. Most of the reports about this flap showed its utility in scaphoid nonunion.

Objective: To evaluate the rate and healing time and complications with the use of vascularized corticocancellous bone graft of medial femoral condyle in situations other than scaphoid nonunion.

Methods: Three men and one woman with an average age of 37 years (range 17–65) were operated on for pseudoarthrosis and acute traumatic bone defect, respectively. Nonunion included one Lisfranc joint, one diaphyseal ulna, and one clavicle. The traumatic bone defect included a partial first phalanx and first metacarpal. Two cases had been previously operated two times each. The time between the initial injury and the surgery averaged 19 months (range 0–48)

The size of osteoperiosteal flap averaged 4.2 cm (range 3.5–5cm). In three cases, arterial suture was terminolateral (to radial, ulnar and pedia) and in one case a terminoterminal suture to a branch of the toracoacromial arterial trunk. Antithrombotic prophylaxis was performed with low-molecular-weight heparin and aspirin. Bone scintigraphy for postoperative evaluation of bone perfusion was performed during the first 5 days. Consolidation was assessed using radiography and computed tomography. Complications of the procedure are described.

Results: In all cases, bone scintigraphy showed flap perfusion. Bone healing occurred in all cases at an average of 7 weeks (range 6–8). One patient had a postoperative hematoma that had to be drained. No patient had complications in the donor area.

Conclusions: This versatile vascularized flap can be crafted to requisite shapes and is useful for defects up to 5 cm not only in nonunion cases but also in acute traumatic bone defects. The consolidation was obtained in all cases, even in cases with previous surgery in an average time of 7 weeks. A refined surgical technique avoids complications in the donor site.

A-0230 Toe transfer for traumatic thumb amputations in the pediatric population

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Indications: Traumatic amputations of the thumb are fortunately rare in children compared to adults, but hand surgeons remain reticent to consider microsurgical reconstruction.

Materials and methods: Nineteen thumb amputations in 17 children (13 boys and 4 girls) between the ages of 2 and 16 years were referred for secondary reconstruction. Nine were isolated thumb amputations (R1 classification), and 10 were combined thumb and multiple finger amputations (R2–R5 classification). Two children had bilateral thumb amputations due to burns. Of the unilateral thumb amputations, eight were left thumbs and seven were right thumbs. Three thumbs were amputated just distal to the CMC joint, four through the metacarpal head or MCP joint, seven through the base of the proximal phalanx, three through the head of the proximal phalanx, and two through the base of the distal phalanx. Three children had previously undergone soft tissue coverage with a pedicled groin flap (2) and a reverse radial forearm flap (1), and two children underwent a reverse radial forearm flap simultaneously with their toe transfer.

Results: Nineteen toe-to-thumb transfers were performed, 12 second toe transfers and 7 great toe transfers (3 great toe, 2 trimmed, and 2 Morrison wraparound variations). There were no immediate postoperative reexplorations of the microsurgical anastomoses, and all toe transfers were successful. All children rapidly regained pinch and grasp function and sensibility. There were no gait problems in the donor foot/feet.

Conclusions: Microsurgical toe-to-thumb transfers are the optimal technique for posttraumatic thumb reconstruction in children for any level of amputation from just distal to the CMC joint out to the distal proximal phalanx. Second toe transfers are preferred for younger children because of better growth potential and an inconspicuous donor site, but great toe transfers become more favored for older children because of the better cosmetic appearance and for combined thumb and multiple finger amputations.

A-0231 The validity and reliability of Michigan Hand Questionnaire in patients with tendon injury

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Objectives: Michigan Hand Questionnaire (MHOQ) is a questionnaire, which is composed of 37 items and

categorized under 6 domains and shows condition of the hand as perceived by patient. In the literature, the validity of this questionnaire was studied in patients with rheumatoid arthritis, carpal tunnel syndrome, distal radius fracture, and trapeziometacarpal osteoarthritis. Validity and reliability study for MHOQ in patients with tendon injury does not exist. The aim of this study is to investigate the validity and reliability of MHOQ in patients with tendon injury for determining the level of disability related to the hand.

Methods: Fifty-three patients with flexor or extensor tendon repair participated in the study. Patients with cognitive impairment and history of upper extremity injury in previous 1 year and illiterate patients were excluded. Grip strength, Nine-Hole Peg Test (NHPT), MHOQ, and Disabilities of Arm, Shoulder and Hand Questionnaire (DASH) were assessed within postoperative seventh week. Assessments were repeated within postoperative eighth week. Validity of MHOQ was evaluated by Pearson correlation analysis with DASH scores and reliability by test-retest method.

Results: The MHOQ demonstrated good test-retest reliability ($p < 0.001$, $r: 0.813$) and moderate correlation with DASH ($p < 0.001$, $r: -.764$). Grip strength of injured hand ($p: 0.021$, $r: 0.312$) and NHPT scores ($p: 0.002$, $r: -0.417$) were correlated with MHOQ scores. The results of MHOQ, DASH, NHPT, and grip strength in the eighth week were better than the results in the seventh week ($p < 0.001$).

Conclusions: Our results demonstrated that MHOQ is valid and reliable in patients with tendon injury, and it can be used to measure outcomes after tendon injuries. MHOQ has more powerful correlations with DASH in comparison to NHPT and grip strength. Based on our results, patient-reported functional status does not necessarily match with the clinicians' objective measurements. This mismatch may be a result of psychological involvement in those patient population.

A-0235 Comparison of different splints for postoperative distal radius fractures in noninjured subjects

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Objective: To compare available wrist and forearm range of motion after the application of radial slab, ulnar-based forearm splint, volar splint, and long arm posterior mold in healthy adults and to evaluate these in terms of satisfaction.

Methods: Ten healthy subjects without previous injury to the dominant upper extremity were included

in the study. Active wrist and forearm range of motion of the dominant extremity was measured by a single examiner using a goniometer. The following splints were applied by the researcher in a randomized order: radial slab, ulnar-based forearm splint, volar splint, and long arm posterior mold. The subjects wore these for 1 h. Range of motion was again measured with each type of immobilization by the same examiner, and the subjects completed the Quick Disabilities of Arm, Shoulder and Hand (QuickDASH) questionnaire. The subjects were also asked to rate the different splints from 1 to 4, with 1 being the splint that they preferred the most. Data were subjected to analysis using SPSS version 20 through means and standard deviations or medians and range whenever applicable, pairwise comparison, and nonparametric Friedmans test.

Results: Ten adults with a mean age of 27 (range 23–32), equal gender distribution (gender ratio 1:1), and majority of whom were right handed (9:1) were included in the study. A significant difference in flexion and extension was observed in all types of splint compared to no immobilization. A significant decrease from baseline range of motion was also observed among the radial slab for radial deviation; radial slab, ulnar-based forearm splint, and long arm posterior mold for ulnar deviation; radial slab, ulnar-based forearm splint and long arm posterior mold for pronation; and long arm posterior mold for supination. There was no significant difference between mean QuickDASH scores of the radial slab, ulnar-based forearm splint, and volar splint compared to each other; however, a significant difference was found with these three when compared to the long arm posterior mold ($p = 0.039$, $p = 0.003$, and $p < 0.001$, respectively). There was a significant difference in the perception of patient ranking per splint (χ^2 with three degrees of freedom = 11.640, $p = 0.009$), with the volar splint ranking the highest.

Conclusion: The long arm posterior mold provided the overall greatest restraint to range of motion compared to the other types of splints, especially in pronation and supination. The volar splint had significantly better functional scores and subjective perception but provided the least amount of restriction. For a balance between good decrease in range of motion and better tolerance, the ulnar-based forearm splint can be used.

A-0236 Factors increasing the risk of recurrence in patients with trigger finger after steroid injection

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Objective: Corticosteroid injection is one of the first-line treatments for trigger finger, but relatively little is known about the risk factors for recurrence after the corticosteroid injection. Therefore, there has been no report to describe surgical decision criteria. We hypothesized that the recurrent trigger finger could demonstrate some characteristic findings predicting its recurrence before injection.

Methods: We conducted a retrospective review of all patients who underwent ultrasound-guided intrasheath corticosteroid injection for previously untreated trigger finger over 1-year follow-up period at our institution. A total of 40 adult patients with 50 trigger fingers were included in this study. A corticosteroid solution containing of 0.5 ml both of 5-mg triamcinolone acetonide and 1% mepivacaine was used for ultrasound-guided injection. The rate of recurrence was assessed at 1 year after ultrasound-guided intrasheath corticosteroid injection. We also evaluated the patients to determine whether preinjection factors predicted the recurrence of trigger finger. Univariate analyses and subsequent multivariate logistic regression analysis was used to assess the independent predictors of recurrence of trigger finger. The following potential predictors were analyzed before injection: sex, age, pain, snapping, PIP joint flexion contracture, synovitis and ganglion around the A1 pulley, thickness of A1 pulley, thickness of flexor digitorum tenodon, and low echoic lesion in FDS tendon. A value of $p < 0.05$ was considered statistically significant. Corticosteroid injection and ultrasonographic measurements were performed by the use of high resolution ultrasonography with a 6–14 MHz linea probe.

Results: Of 50 trigger fingers, 31 (62%) were recurrent within 1 year after the ultrasound-guided intrasheath corticosteroid injection. Logistic regression analysis confirmed that a low echoic lesion in FDS tendons was a significant risk factor (odds ratio, 5.33; 95% confidence interval, 1.14–24.89; $p = 0.03$) and a dominant hand was also a significant risk factor (odds ratio, 4.47; 95% confidence interval, 1.09–18.21; $p = 0.03$). Sex, age, pain, snapping, PIP joint flexion contracture, thickness of A1 pulley, synovitis, ganglion, and thickness of flexor digitorum tendon were not found to be associated with recurrent trigger finger.

Conclusions: Our results suggested that the patients with trigger finger who have a low echoic lesion in FDS tendon, which was identified by high resolution ultrasonography, have a high risk of experiencing recurrence within 1 year after corticosteroid injection. This characteristic ultrasonographic finding observed in FDS tendon may be useful for deciding the indication for surgical treatment of trigger finger before corticosteroid injection therapy.

A-0237 Scaphocapitate fusion in advanced Kienböck's disease: Retrospective clinical study at 4.8 years follow-up

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Objective: The treatment goal in Kienböck's disease is to preserve the integrity and allow revascularization of the lunate and preserve wrist motion while relieving patients' symptoms. In stage 3 Kienböck's disease, the lunate is often unsalvageable due to comminution and subsequent collapse. Scaphocapitate (SC) fusion aims at decompressing the lunate while restoring carpal height and maintaining wrist motion.

Material and method: We retrospectively reviewed patients with a minimal 1-year follow-up who underwent SC fusion in stage 3A and 3B Kienböck's disease. Eleven patients were reviewed clinically and radiologically. Pain, Disabilities of Arm, Shoulder and Hand (DASH), and PRWE scores, satisfaction, wrist range of motion, and grip strength were assessed independently. Preoperative and last follow-up standard films were compared for Lichtman stage, radiocarpal or midcarpal osteoarthritis, scapholunate and radioscapoid angles, the Stahl index, carpal height, ulnar carpal deviation, and ulnar variance.

Results: Seven male and four female patients were reviewed. The average follow-up was 4.85 years (1–10.55 years). The average age at the time of surgery was 30.1 years (18.5–36 years). Six patients had a radial shortening at the same time and two others had 2 and 23 years prior to SC fusion. The lunate was not explored and always left in place. Preoperative pain was 8 (6–10) and was described as constant by all patients. Visual analogue scale significantly decreased after surgery to 1.09 (0–2; $p < 0.0001$). Wrist range of motion was mildly but not significantly ($p = 0.45$) improved at follow-up. Preoperative wrist flexion was 35.5° (20°–50°) and wrist extension was 35° (20°–70°). Postoperative wrist flexion was 42.7° (10°–95°) and wrist extension was 41.4° (30°–70°). Wrist range of motion was significantly decreased in comparison to the unaffected wrist. Pronosupination was comparable to the unaffected ($p = 0.01$) side. Grip strength was significantly decreased ($p = 0.027$) with 25.8 kg in comparison to the unaffected side with 34.5 kg. Nine lunates were stage 3B and two were stage 3A. Radiographically, all SC fusions united. Ulnar variance was –1 mm on average. Three stage 3B patients improved to a stage 3A on follow-up films. Four patients with more than 4 years follow-up had radiographic dorsal radioscapoid and radial styloid

osteophyte suggesting impingement but was not clinically symptomatic. The carpal height decrease from 1.47 to 1.2 was not statistically significant ($p = 0.09$). Ulnar carpal deviation and Stahl index were unchanged. The radioscaphoid and scapholunate angles were restored to a normal range. Functional outcome was good: Average DASH was 30.45 and PRWE was 23.8.

Nine patients thought their wrist was very good or good and two that it was fair. Nine of 11 patients were employed and remained so at follow-up. Two patients changed jobs to less demanding positions.

Conclusion: SC fusion is a treatment option for advanced Kienböck's disease. Pain relief is significant. Wrist range of motion remains similar to the preoperative range. Carpal collapse does not progress, and keeping the lunate avoids ulnar translation. However, radiological progression of radioscaphoid arthritis may occur.

A-0239 Ligamentomuscular reflex patterns following stimulation of a thumb carpometacarpal ligament: An electromyographic study

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Objective: The dorsoradial (DRL) ligament is essential for CMC1 stability and is richly innervated with nerve endings and mechanoreceptors, which are known to contribute to joint proprioception. Presently, the influence of these nerve endings on the neuromuscular stability of CMC1 is not known. The purpose of our study was to examine whether a ligamentomuscular reflex pathway is present between the DRL and the muscles acting on the CMC1.

Methods: Ten healthy subjects, five women and five men (mean age 28 years; range 24–37 years), were included. Four of the primary CMC1 stabilizing muscles were investigated: musculus extensor pollicis longus (EPL), abductor pollicis longus (APL), abductor pollicis brevis (APB), and the first dorsal interosseous (DI). Needle electrodes were inserted into each

muscle, and a fine wire electrode was inserted into the DRL, with the guidance of ultrasound. The DRL was stimulated at 200 MHz with a series of four 1-ms pulsations, while electromyographic (EMG) activities in the four muscles were recorded during isometric tip pinch, key pinch, and palmar pinch, respectively. Average EMG values were rectified and divided into 20-ms time intervals and further analyzed using the Student's *t*-test to compare the prestimulus (t1) with poststimulus (t2) activity in each muscle and each position.

Results: Significant ($p < 0.05$) poststimulus changes were observed in all four muscles and positions tested. During tip pinch, we observed mass inhibition, with a decrease in all muscle amplitudes following stimulation of the DRL. In key pinch, we observed a rapid cocontraction response. Rapid inhibitory response of antagonistic musculature was observed during palmar pinch. The APL was the only muscle to react within 20 ms following stimulation.

Conclusions: We identified the presence of CMC1 ligamentomuscular reflexes. The mass inhibition of muscle activity observed during tip pinch is indicative of a protective ligamentomuscular relation that affects all four muscles studied. The cocontractions observed in all three positions promote joint stability by stiffening of the joint and thus contributing to global neuromuscular stability. The fast response in APL, coupled with its neuroanatomical proximity to the DRL, indicates a particular role in CMC1 proprioception. Consequently, proper ligamentous support and retained innervation is likely of importance for adequate joint function. Further studies investigating the role of proprioception in basal thumb osteoarthritis are warranted.

A-0240 Trapezium anatomy as a reference for optimal cup orientation in total trapeziometacarpal joint arthroplasty

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Objective: Trapeziometacarpal joint arthroplasty correct implant position is essential to minimize the risk of complications such as dislocation, component loosening, and premature wear. The first aim of this study was to evaluate the center of range of motion of the healthy trapeziometacarpal joint in abduction–adduction and flexion–extension on frontal and lateral X-rays, respectively. The second goal was to identify a radiographic landmark that has a fixed relationship with this center of motion in both planes. Such landmark could be used as a reference line for correct cup orientation during surgery. It is our

hypothesis that the proximal pole of the trapezium can be used for this.

Methods: Thirty asymptomatic patients with no history of thumb injury (11 males and 19 females) were included and invited for a radiological evaluation. Frontal and lateral radiographs of the trapeziometacarpal joint were obtained as described by Kapandji. In the frontal view, the angle was measured between the articular surface of the proximal pole of the trapezium and the longitudinal axis of the first metacarpal in maximal adduction and abduction. In the lateral view, the same angle was measured with the thumb in maximal flexion and extension. All the measurements were carried out by the two authors. Intra- and interobserver reliabilities were determined.

Results: In the frontal view, and relative to the proximal articular surface of the trapezium, the average adduction and abduction angles were 67° [range, $54\text{--}79^\circ$; standard deviation (SD), 6° ; confidence interval (CI), 2] and 110° [range, $95\text{--}129^\circ$; SD, 7° ; CI, 3], respectively. The average abduction–adduction range of motion was 42° and the bisector angle was 89° . In the lateral view, and also relative to the proximal articular surface of the trapezium, the average flexion and extension angles were 66° [range, $42\text{--}81^\circ$; SD, 11° ; CI, 4] and 100° [range, $81\text{--}114^\circ$; SD, 8° ; CI, 3], respectively. The average flexion–extension range of motion was 36° , and the bisector angle was 83° . Intraobserver and interobserver reliabilities were rated excellent for all measurements.

Conclusion: In the frontal radiographic view, the center of range of motion of the trapeziometacarpal joint approximates a right angle to the proximal pole of the trapezium. In this plane, the trapezoidal cup should be positioned parallel to the proximal articular surface of the trapezium. In the lateral view, the angle between the center of range of motion of the trapeziometacarpal joint and the proximal articular surface of the trapezium is 83° , indicating that the trapezoidal cup should be placed in 7° of flexion when a straight neck is used. Alternatively, the trapezoidal cup can be placed parallel to the proximal articular surface of the trapezium in the lateral view if combined with a prosthetic neck with 7° palmar offset. We recommend intraoperative use of fluoroscopy during trapeziometacarpal joint arthroplasty to guide cup placement using these guidelines.

A-0241 Long-term outcomes of the ARPE trapeziometacarpal joint replacement

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Objective: Arthritis of the trapeziometacarpal joint occurs commonly and can be very disabling. Numerous surgical options exist. Trapeziectomy is still considered gold standard, as it provides good pain-relief in middle-aged patients. However, it rarely restores normal thumb function, shortens the thumb, and reduces the pincer strength. TMCJ arthroplasty techniques and technology have advanced over recent years and offer patients the advantage of a more functional thumb with strength and stability. The aim of this study is to report our functional, clinical, and radiological outcomes using the uncemented hydroxyapatite-coated ARPE (Biomet) TMCJ prosthesis over 13 years.

Methods: Between 2002 and 2015, TMCJ replacements were offered to middle-aged patients, with pain, loss of function, Eaton Grade 2–4, and failure of conservative treatment. Patients with previous surgery to the thumb were excluded. All operations were performed by a single surgeon, using the ARPE prosthesis with the same postoperative rehabilitation. Independent prospective outcome data were collected for pain relief (visual analogue scale 0–10), postoperative Disabilities of Arm, Shoulder and Hand (DASH) scores, range of motion (ROM), pincer strength, clinical, and radiological complications.

Results: Forty-eight TMCJ replacements were implanted into 42 patients (33 females and 15 males), and 6 received bilateral implants on separate occasions. Mean age at the time of operation was 62 years [range 50–75 years]. Thirty-two prostheses were inserted into the dominant hand. Minimum follow-up was 2 years, mean 7.3 years, and range 2–13 years. No patients were lost to follow-up. For the surviving implants (85.4%), the mean pain score was 1.8, Kapandji opposition 8.3, key pinch 6.1 kg, and grip strength 25 kg. Mean DASH score was 22.1. Seven (14.6%) patients required revision surgery, 6 for early recurrent dislocations within 2 years and 1 for severe pain from the adjacent STT joint. Most dislocations were in male patients and dominant hand. All were revised to simple trapeziectomy. Radiologically, cup loosening was seen in 10.4%, and no stem loosening or fractures were seen. No dislocations were seen following introduction of the receptive cup 5 years ago.

Conclusions: This study demonstrates that TMCJ replacement is an effective treatment option in selected patients. It offers excellent pain relief, ROM, strength, and functional outcome scores. Dislocations were most common in male patients in manual work. Failures are easily revisable to trapeziectomy. Best outcomes were reported in female patients, implants in the nondominant hand, and patients with low functional demands.

A-0242 Reliability and construct validity of the Spanish version of the PRWE for outcomes assessment in distal radius fracture

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Background: The purpose of this study was to assess the reliability and construct validity of the Spanish version of the PRWE for outcomes assessment in distal radius fracture (DRF).

Methods: In this classic cohort study, 40 patients with DRF, treated with closed reduction and cast, completed the standard Spanish versions of the PRWE, Quick Disabilities of Arm, Shoulder and Hand (Quick-DASH), and EQ-5D at baseline, 8, 9, 12, and 13 weeks. Internal consistency reliability was assessed with the Cronbach α coefficient. Test-retest reliability was analyzed with the intraclass correlation coefficient (two-way random effect model and absolute agreement definition (ICC(2,1)) between the measures at 8 and 9 weeks and between 12 and 13 weeks. Cross-sectional precision was analyzed with the standard error of the measurement (SEM). Longitudinal precision for test-retest reliability coefficient was evaluated with the standard error of the measurement difference (SEMdiff) and the minimal detectable change at 95% confidence level (MDC95). For assessing construct validity, it was hypothesized that the PRWE would have a strong positive correlation with the QuickDASH and a moderate negative correlation with the EQ-5D Index and analyzed with the Pearson correlation coefficient (r) for variable with a normal distribution and by the Spearman correlation coefficient (ρ) for variables with nonnormal distribution.

Results: The standard Spanish version of the PRWE presented a Cronbach α of 0.96 with a SEM of 4.36. Test-retest reliability showed an ICC of 0.89 (8 and 9 weeks) and 0.92 (12 and 13 weeks) with a SRMdiff of 9.65 and 8.58 and MDC95 18.91 and 16.82, respectively. The correlation analysis between PRWE, the QuickDASH and EQ-5D Index was concordant with the a priori formulated construct hypothesis ($r = .79$ between PRWE and Quick DASH; $\rho = -0.40$ between PRWE and EQ-5D Index).

Conclusions: The standard Spanish version of the PRWE presented a high level of internal consistency,

test-retest reliability, and construct validity for outcomes assessment in DRF.

A-0247 Biomechanical analysis of the trapeziometacarpal ligaments: Implications in the arthroscopic treatment of thumb carpometacarpal instability

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Purpose: In the presence of early osteoarthritic changes in the trapeziometacarpal (TMC) joint, pain is often related to joint instability and a tendency of dorsoradial subluxation. In these instances, arthroscopy may be indicated to assess the extent of cartilage disease and the laxity of ligaments as well as to allow possible ligament thermal shrinkage.

The purposes of our study were (1) to analyze which TMC ligaments are of primary stabilizing importance and (2) to identify the best portals for an effective arthroscopic shrinkage stabilizing procedure.

Methods: (1) Eleven fresh frozen human cadaver specimens were dissected and attached to a testing jig with the thumb in neutral abduction/flexion/opposition position. The four extrinsic and five intrinsic muscle tendons acting on the TMC joint were simultaneously loaded with weights proportional to their physiologic cross-sectional area. The three groups of joint ligaments (dorsal, volar, and ulnar) were dissected. A motion-tracking device, FasTrak®, was used to study the spatial position of the base of the first metacarpal bone (MC1), before and after randomly and consecutively sectioning each group of ligaments. Statistical analyses of the MC1 translation along the transverse XY plane were performed using one-way analysis of variance and a paired t -test, with a significance level at $p < 0.05$. (2) Five other fresh frozen human cadaver specimens were dissected. All TMC joint ligaments were identified and preserved. We passed a 2-mm Kirshner wire, outside-in-outside, through the five previously described access portals, thenar (VP), 1-Radial (1R), 1-Ulnar (1U), radial palmar (RP) and dorsal distal (D2). We noticed the ligaments present and reachable around the Kirshner wire joint exit.

Results: (1) After isolated sectioning of the volar or the ulnar ligaments, the MC1 moved dorsoradially an average of 0.150 mm (standard deviation (SD): 0.072) and 0.064 mm (SD: 0.301), respectively. By contrast, the destabilization of the MC1 after sectioning of the dorsal ligaments was substantially larger (0.523 mm; SD: 0.0512; $p = 0.004$). (2) Kirshner instrumentation through the thenar portal is the only way to easily reach the altogether three dorsal ligaments.

Conclusions: The dorsal ligaments group sectioning induces the greatest dorsoradial translation of the MC1 and should, thus, be considered the primary TMC stabilizers. TMC stabilizing arthroscopic shrinkage should therefore focus on these three dorsal TMC ligaments. The thenar portal is the entrance to the straightest route to instrument those three dorsal TMC ligaments.

Clinical relevance: This study indicates that arthroscopic TMC ligament shrinkage should be performed through a volar portal to allow specific shrinkage of the three dorsal TMC ligaments.

A-0250 Anatomical study of the dorsal cutaneous branch of the ulnar nerve (DCBUN) and its clinical relevance in TFCC Repair

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Triangular fibrocartilage complex (TFCC) injuries can be seen after traumatic injuries and can cause pain on the ulnar aspect of the wrist. Treatment options have evolved over the years from open repair to arthroscopic repair. One major complication of TFCC repair is damage to the Dorsal Cutaneous Branch of the Ulnar Nerve (DCBUN) with subsequent neuroma formation. The aim of this study was to define a detailed description of the Dorsal Cutaneous Branch of the Ulnar Nerve (DCBUN) in particular in relevance to TFCC repairs. Twenty embalmed arms were dissected, and the course of the DCBUN in each arm was mapped, photographed, and measured against several bony landmarks. Using a new visualization technique CASAM, the course of the DCBUN was mapped. Furthermore, the presence of a Radio-Ulnar Communicating Branch (RCUB) was categorized. Also, retrospective cohort of 54 people who underwent TFCC repair were analyzed. There are three dorsal digital nerves (medial-, intermediate-, and lateral branch), which runs at the dorsal

ulnar aspect of the hand. The distance between the origin of the DCBUN and the ulnar styloid process was 87.5mm (55.3–110.6 mm). The distance between the ulnar styloid process and the RUCB ranges from 1.5 to 54 mm (mean 18.7 mm; standard deviation (SD) 12.5 mm). An RUCB was not present in four specimens. The third measurement between the ulnar styloid process and the lateral distal branch shows a range of –5.5 to 28.1 mm (mean 9.7 mm; SD 9.3 mm). A measurement is negative when branching of the lateral distal branch occurs proximal of the ulnar styloid process. In the group of 54 arthroscopic TFCC repairs, we found that in one patient who complained of postoperative pain and loss of sensation, the insertion site coincides with the area in which the DCBUN's end branches runs to the fingers. However, in all patients, the course of the scar was located in an area in which the DCBUN was present. No complete safe zone could be identified. At the portals location most nerves run proximal to distal, therefore it is advised to make a longitudinal incision. Second, one could argue that because of the complex anatomy, it is less harmful to damage the RCUB than the digital branches of the DCBUN, and therefore a more dorsal incision should be attempted. Although this is thought during many wrist arthroscopy and wrist surgery courses, this study visualizes the course of the nerves again highlights the importance of a proper incision technique during wrist surgery.

A-0265 Anatomic factors contributing to the vulnerability of the radial nerve at the brachium

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Objective: Radial nerve palsy is common after trauma, humeral fracture manipulation, and prolonged pressure on the nerve. The underlying mechanism is incompletely defined. The aims of this cadaveric study were to determine (1) the excursion of the radial, median, and ulnar nerves at the brachium and (2) the effects of elbow position and lateral intermuscular septum release on radial nerve excursion. We hypothesize that the radial nerve has increased vulnerability due to limited excursion and that elbow position and the lateral intermuscular septum have a significant effect on radial nerve tension.

Methods: Eight paired fresh frozen adult cadaveric upper extremity specimens were used. No donors had prior history of upper extremity surgery. A modified posterior triceps splitting approach was used to

expose the radial nerve. A medial approach was used to expose the median and ulnar nerves. The radial, median, and ulnar nerves were transected at the level of the middle point of the spiral groove to measure the in situ tension and strain. Tension was measured using two calibrated spring gauges attached to each end of the transected nerve stumps. Strain was measured after applying a 100 g load. A constant tension of 100 g was then applied to each nerve stump in line with their respective anatomic courses. Using a precision caliper, nerve excursion was determined by measuring nerve end overlap at 0°, 30°, 45°, 60°, and 90° of elbow flexion and repeated for the radial nerve after releasing the lateral intermuscular septum.

Results: Mean resting tension (the force required to approximate the transected nerve stumps to in situ position) for the radial, median, and ulnar nerves were 47.0, 71.1, and 16.3 g, respectively. Percentage of strain with 100 g load averaged 13.1%, 5.0%, and 6.8% for the radial, median, and ulnar nerves, respectively. Baseline excursion as represented by mean overlap for the radial, median, and ulnar nerves with the elbow in full extension was 8.2, 9.2, and 25.5 mm, respectively ($p < 0.001$). Radial (8.2–17.8 mm, $r = 0.521$) and median (9.2–35.9 mm, $r = 0.830$) nerve excursion positively correlated with increased elbow flexion, while ulnar nerve excursion negatively correlated with increased elbow flexion (25.5–14.5 mm, $r = -0.536$). Lateral intermuscular septum release significantly increased radial nerve excursion by 31.8% at 30°, 34.4% at 60°, and 36.0% at 90°.

Conclusions: The radial nerve has limited excursion at the brachium compared to the median and ulnar nerves. Elbow position significantly affected the amount of nerve excursion. Radial nerve excursion improves with elbow flexion and with release of the lateral intermuscular septum. Applying these measures during humeral fracture fixation may help to prevent radial nerve palsy.

A-0266 Open reduction and internal fixation of dorsal fracture dislocation of the proximal interphalangeal joint using low-profile mini-plate

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Objective: The unstable dorsal fracture dislocation of the PIP joint with articular involvement still remains a therapeutic challenge for the hand surgeons. The

authors have carried out a novel technique using low-profile mini-plate for this injury. The purpose of this presentation is to describe the surgical technique, postoperative management, and its complications.

Methods: A low-profile mini-plate (Stryker Leibinger, Freiburg, Germany) with a profile height of 0.55 mm and a 1.2 mm screw diameter was used for internal fixation.

Dorsal dislocation/subluxation of the PIP joint is reduced, and a 1.2 mm K-wire is inserted at the dorsal edge of the proximal phalangeal head percutaneously as an extension block under an image intensifier. Using a volar transverse V incision, tendon sheath is opened in a rectangular fashion, and flexor tendons are retracted. The displaced proximal fragment is reduced and temporally fixed with 0.7-mm K-wires. The depressed or impacted articular fragment is reduced intramedullarily through the fracture site. A mini-plate is cut to the appropriate length and placed over the volar fragment as a buttress passing the wires through the plate holes. Then, the 0.7-mm K-wires are exchanged for screws. Finally, the extension block is removed. Postoperative active and passive motion exercise is started in a few days. The technique was applied to 31 dorsal fracture dislocations including two pilon fractures. According to Schenck's classification, 5 fracture dislocations were Grade A, 15 Grade B, and 11 Grade C. The middle phalangeal articular involvement was averaged 52.6%. Two patients had concomitant mallet injury. The mean age was 37.1 years (range: 13–76 years). The mean periods from injury to operation was 11.9 days (range: 1–60 days). The postoperative follow-up period averaged 12.2 months (range: 6–24 months).

Results: Bony union was obtained in all cases. Active motion of the PIP joint averaged 87.4° (range: 62–104°), flexion contracture averaged 10.7° (range: 0–40°), and percentage of total active interphalangeal joint motion averaged 82.0% (range: 41.7–100%). Four patients had restricted active distal interphalangeal (DIP) joint flexion due to tendon adhesion. Two of them were resulting from the use of a relatively long plate in the early series and the other two were 1-month immobilization due to concomitant mallet finger. One patient who had a delayed lateral fracture dislocation showed residual lateral subluxation. No major complications were reported for the other 24 patients.

Conclusions: The mini-plate fixation technique offers an alternative, successful, and less difficult method. The characteristics of this technique are as follows. The reduced fragments are temporally fixed with K-wires at its optimal points, followed by exchanging for screws. The fragments can be caught rigidly between the cortex and the mini-plate used as

buttress effect, what makes possible to allow early joint motion. The factors deteriorating the functional results were a prolonged time until surgery, elderly age, and concomitant injuries.

A-0273 Minimally invasive approach for surgical treatment of unstable fractures of the proximal phalanx – Prospective, randomized and comparative study: Intramedullary screw versus lateral plate.

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Purpose: To compare functional-clinical parameters, quality of life, and return to work of patients subjected to minimally invasive surgical approach in the treatment of the fractures of the oblique and transverse proximal phalange between two relative stabilization methods: intramedullary tutor (headless compression screw) versus extramedullary tutor (lateral plate 1.5 and 2.0 mm).

Methods: Evaluating prospective and randomized 75 patients and 85 affected fingers diagnosed with fracture of the proximal transverse or short oblique phalanx, extra-articular and unstable, submitted to the surgical treatment (single surgeon) by two techniques: group A – screw (41 patients and 48 fingers) and group B – lateral plate (34 patients and 37 fingers). Both methods were applied without addressing the extensor tendon and the fracture site. The plate and screw followed the principle of relative stability, acting as internal tutors. Postoperative period was without cast and use the dual band method for immediate rehabilitation. The clinical and functional results were analyzed and the range of motion (range of motion (ROM) in degrees), pain (VAS score), quality of life (Disabilities of Arm, Shoulder and Hand (DASH) questionnaire), and return to work.

Results: The values on average were DASH = 4.73, VAS = 1.54, and ROM = 95.25% of the contralateral finger side. There was no statistically significant difference between groups. The complication rate was 9.12%. Of four patients in group A, one developed acute infection and was treated with antibiotics, two developed pain in the screw entrance area which was removed after fracture healing, and another patient developed malunion. Three patients in group B showed pain due to prominence of the plate on the finger. These were removed after fracture healing, with clinical improvement in these patients. Patients returned to work, and 69% returned to perform the same activity.

Conclusion: The minimally invasive surgical approach with relative stability are effective and safe, with few

complications. There was no significant difference between the calculated values of the clinical and functional results, complications, and rate of return to work between the groups.

A-0274 Treatment of closed mallet thumb injury

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Objective: Because of the rarity of this injury, there is no consensus regarding the recommended treatments. Although conservative treatment is often successful, retraction of the extensor pollicis tendon may lead to improper reattachment and continued deformity.

Methods: Five patients with closed mallet thumb underwent surgical treatment. There were three males and two females, aged between 40 and 54 years. The deformity was older than 10 days in four cases, that is, between 10 and 45 days. All deformity were neglected by the patients. The extensor lag at admission was between 25° and 45°. According to Doyle classification, all lesions were of type I. One patient has associated distal phalangeal tip fracture. To evaluate the postoperative functional outcome, the degrees of extension and flexion were measured using a goniometer. The Crawford's criteria were used to evaluate the functional results. Two surgical techniques were used: repair with suture anchor (two cases) and pull out suture technique (three cases) with interphalangeal joint pinning in hyperextension. The IP joint was immobilized for 6 weeks.

Results: Intraoperative tendon gap (EPL tendon retracted from its distal insertion when hyperextended IP joint) size was 0.5 to 1.2 cm (mean, 0.8 cm). The mean follow-up period was 5 months (range: 3–7 months). According to Crawford's evaluation criteria, the results obtained were considered as excellent in all cases. None of the patients demonstrated postoperative pain, pin-track or steel tread infection, or flap necrosis. Nail bed deformity was not encountered.

Conclusions: Because most closed mallet thumb injury have several amounts of retraction of EPL, conservative treatment would likely fail. Surgical treatment and early postoperative motion in mallet thumb injury provides satisfactory outcome.

A-0276 Plasma micro RNA-155 is a potential biomarker of acute rejection after hind limb transplantation in rats

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Objective: The development of immunosuppressive regimens have resulted in many cases of successful hand transplantations being performed throughout the world. However, acute and chronic rejection remains a major problem. Visual skin inspection and histological evaluations are used to assess rejection of hand transplants; however, these methods are largely subjective. Recently, microRNA has been recognized as a minimally invasive biomarker of various diseases, including acute rejection after organ transplantation. We aim to determine the potential of microRNAs as biomarkers for acute rejection in vascularized composite tissue transplantation.

Methods: Six male brown Norway rats weighting 210–290 g, whose major histocompatibility was RT1-n, were used as donors. Eleven male Lewis rats weighting 230–330 g, whose major histocompatibility was RT1-l, were used as the recipients. Bilateral hind limbs of the donor rat were amputated in the mid-thigh level and perfused with cold heparinized lactated Ringer's solution. Each harvested hind limb was simultaneously transplanted orthotopically to two recipient Lewis rats. We administered 1 mg/kg per day FK506 by intramuscular injection to the recipient rats for 7 days beginning on the day of transplantation. Plasma samples were obtained on the day before transplantation as well as 7 and 14 days post-transplantation. MicroRNAs were isolated from the plasma, reverse transcribed to complementary DNA, and measured using real-time polymerase chain reaction. MicroRNAs were analyzed using the $\Delta\Delta Ct$ method with spike-in of ath-miR159a to normalize miRNA levels. Skin biopsies were obtained from the transplanted hind limb on days 7, 10, and 14 post-transplantation and fixed with 4% paraformaldehyde. Thin sections of the skin were prepared, stained with hematoxylin and eosin, and the histologic immunoreactions assessed using a grading system for skin rejection, according to Büttemeyer.

Results: We found that plasma miR-155 was significantly upregulated at 10 and 14 days posttransplantation, compared to day 7 posttransplantation ($p = 0.040$ and $p = 0.026$, respectively). No significant changes were found in miR-146a and miR-451 expression on days 10 and 14 compared to day 7 posttransplantation. Skin biopsies on day 10 showed incomplete histological rejection classified as grade 1 or 2, whereas most skin biopsies on day 14 showed histological rejection classified as grade 3.

Conclusion: The upregulation of the plasma miR-155 is detected before the observation of complete rejection in the rat hind limb transplantation model. Plasma miR-155 represents a potential biomarker of acute rejection after vascularized composite tissue allotransplantation.

A-0277 A comparison of treatment score as reconstruction time and method of distal radius fracture malunion

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Objective: This study aims to compare and analyze the effects of surgical treatment in cases in which the displacement of the fixating material was not corrected and malunion took place.

Methods: The study was conducted from January 2010 to March 2015, and 21 patients who received surgical treatment using basal plate internal fixating material from Wonju Severance Christian hospital participated. Patients were divided into two groups – group A that received internal fixation after osteoclasis, as they received early surgery and thus showed soft callus formation and group B that received internal fixation after osteotomy as they received late surgical treatment and showed hard callus formation meaning complete enchondral ossification – and VAS scores, Mayo wrist score before and after the treatment (postsurgery, 3 months, 6 months, and 1 year, respectively), grasping power of the hand compared to the normal side, and range of motion of hand before and 1 year after the treatment were compared between the two groups.

Results: Of the 21 patients with chronic distal radius fracture (malunion), 10 patients were in group A and 11 patients were in group B. The average time to receiving surgical treatment was 7.75 weeks in group A and 23.67 weeks in group B. Both group displayed positive outcomes in VAS score after a year (both under three), and group A showed significant difference in 3-month follow-up of VAS score. The grasping power of hand were both recovered to about 80% (group A: 86%; group B: 78.3%), and there was no significant difference between the two groups. Range of motion – in terms of flexion, extension, radial side rotation and ulnar side rotation – improved in both the groups compared to pretreatment and group A showed bigger improvements than group B.

Conclusions: In conclusion, the study showed that performing earlier surgery when there is only soft callus formation to distal radius fracture malunion compared to performing late surgery when enchondral

ossification is already finished bring about statically significant differences in pain and articular range of motion.

A-0279 Transforming finger trauma care: Considering cultural preferences

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Objective: Traumatic events resulting in finger amputation or near-amputation severely impact patient health, possible future disability, and self-perception. Because beliefs about the body differ among cultures and religions, it is likely that attitudes and preferences toward amputation may differ among people of different groups. This study investigates personal attitudes and preferences regarding finger amputation.

Methods: An anonymous online (using Qualtrics) and paper survey was developed to collect nonidentifiable demographic information and explore preferences of individuals regarding hypothetical finger amputation and information-seeking behavior. Mixed-Methods analysis was conducted using descriptive statistics as well as grounded theory for qualitative analysis of free-text responses.

Results: There were 804 responses collected between May 2014 and November 2015. Respondents self-identified in various gender, age, cultural, and religious categories. When asked whether they would like replantation attempted if a finger was hypothetically amputated, 92% desired attempted replantation. Respondents also desired reattachment if the finger would take 6 months to heal (95%), it would not function (37%), it would be painful (67%), or it could not be used at work for 3 months (94%). If the finger was unable to be attached, respondents primarily preferred the hospital to dispose of the finger (76%), but others desired the finger be returned finger (20%) or some other choice (4%). Respondents also primarily identified their own beliefs or a combination of influences to their decisions about finger amputation. Finally, respondents mainly obtain information about medical treatment options from their physicians (90%) and the Internet (75%) above other sources such as family (56%), friends (41%), libraries (13%), or religious communities (5%) (multiple answers accepted).

Conclusions: This study demonstrates that the replantation of a finger should be considered based on not only medical facts but also patient wishes. From this survey, it seems that patients would prefer to have a

finger reattached even if it was painful, whereas they were less likely to desire reattachment if the finger would not function. As long as patients understand the consequences, complications and outcome results, and safety procedures are in place, options for replantation, amputation and how amputated fingers should be disposed (or, alternatively, be returned to the patient in a safe manner) should be given to patients. As patients still seek medical information from a variety of sources, but primarily from their doctors, patient education efforts regarding finger amputation options, when available, should be distributed to patients to inform their participation in their own care.

A-0284 Application of intraoperative computed tomography with an integrated navigation system in complex distal radius fractures: A comparison between free-hand and navigation techniques

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Objective: The open reduction and internal fixation (ORIF) for distal radius fractures (DRFs) remains technically difficult due to the size of the bone and its three-dimensional shape. We hypothesize that an application navigation surgery would improve accuracy, clinical, and radiographic outcomes. The purpose of this study is to investigate a navigation technique for DRFs and compare the results to the traditional technique.

Methods: We conducted a case-control study including of 26 patients undergoing ORIF for complex DRFs treated using volar locking plate with or without assistance of the surgical navigation. Thirteen patients were operated with a navigation (group N), and the other 13 patients were operated under fluoroscopy (group F). The patients in the two groups were matched by fracture type (AO classification), sex, age (<±5 years of age), and follow-up period. The operation time, clinical, and radiographic outcome data between the two techniques were analyzed.

Results: There was no difference between the two groups with respect to sex, mean age, fracture type, observation period, or surgical duration. Grip strength at the time of the final follow-up observation was significantly superior in group N than that in group F (group N:F, unaffected side ratio 85% vs. 67%, $p = 0.04$). For range of motion and Mayo wrist score, no difference was observed between the two

groups. A comparison of final radiographic evaluations revealed that group F had significantly greater ulnar variance than group N (group N:F, 1.0 mm vs. 1.6 mm, $p = 0.04$), and the postoperative loss of reduction was lower in the group N compared to group F (group N:group F, 0.5 mm vs. 1.1 mm, $p = 0.04$), and intra-articular penetration of distal screws was observed in two patients of group F.

Conclusions: In ORIF for complex DRF, the use of navigation reduced the postoperative loss of reduction, improved grip strength recovery, and lowered complication rate.

A-0285 Evaluation of postoperative radiocapitellar joint alignment in congenital radioulnar synostosis patients

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Hypothesis: No study has evaluated radiocapitellar joint alignment or proximal radioulnar joint alignment postoperatively in congenital radioulnar synostosis patients. The aim of this study was to clarify the postoperative clinical results and radiocapitellar joint alignment.

Methods: Eight forearms in seven patients (six males and one female with a mean age of 8.8 years) with congenital radioulnar synostosis, who underwent surgery with a minimum of a year and a mean of 2.1 years of follow-up, were evaluated. The surgery consisted of division of the synostosis and interposition with a pedicled vascularized adipo-fascial flap between the radius and the ulna. A corrective radial osteotomy was performed in three patients at the radial neck, which had a great angular deformity, and in one patient at the mid-diaphysis, which had a great bowing deformity. Radiocapitellar joint alignment was evaluated in a lateral view radiograph and classified into three types as anterior, intermediate, or posterior, defined by whether the radial neck and head axis were above, within, or below the capitellum. This alignment was evaluated preoperatively and at final follow-up. The active range of pronosupination was also evaluated as a clinical outcome. There was no patient who had recurrence of bony union at the divided synostosis.

Results: Preoperatively, there were five forearms of the anterior type, one intermediate type, and two of the posterior type. At final follow-up, there were two

forearms of the anterior type and six of the posterior type. Four forearms were changed into a posterior type. At the final follow-up, the active range was $37.5^\circ \pm 8^\circ$ in pronation and $20^\circ \pm 10^\circ$ in supination in the anterior type and was $41^\circ \pm 23^\circ$ in pronation and $26^\circ \pm 18^\circ$ in supination in the posterior type. There was no significant difference in pronation or supination between the types. It was more difficult to improve supination than pronation in each type.

Summary points: In this case series, it was difficult to reconstruct the proper radiocapitellar alignment. To better improve the range, especially of supination, reconstruction of the radiocapitellar joint or the proximal radioulnar joint with a more accurate corrective radial osteotomy or sigmoid notchplasty should be considered.

A-0287 Operative treatment of metacarpal and phalangeal fractures in athletes

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Objective: Evaluating the outcomes of operative treatment for metacarpal and phalangeal fractures in athletes returning early to play and discussing the more effective method that permit rapid early return to athletic activity.

Methods: We retrospectively identified a total of 105 metacarpal or phalangeal fractures in 105 athletes with conservative or operative treatment in our department. Of these, 20 athletes required an early return to sport because of a pending important game in their competition within 1 month after injury. Therefore, they underwent surgical treatment with open reduction and internal fixation of metacarpal or phalangeal fractures in an attempt to achieve an early return to their chosen sport at their usual competitive level. The patients included six rugby football players, two soccer goalkeepers, three American football players, three handball players, two baseball players, and four who participated in other sports. The clinical records of preoperative and postoperative radiographs were available for all patients, and clinical outcome was evaluated by total active motion (TAM)

Results: All athletes could attend the pending important game with returning to the prior athletic activity. The patients were followed up during mean 27 (24–43) months. At the latest follow-up examination, bone union was obtained in all cases. In cases with metacarpal and phalangeal fractures, the average TAM was 263° (range, 240 – 270°).

Conclusions: We consider that an early comeback to training and competition can be permitted exclusively for patients with metacarpal and phalangeal fractures. It is important for the attending physician to administer such treatment after obtaining informed consent and develop a trusting relationship with the patient and other related individuals while paying attention to their hope of quick recovery.

**A-0289 Enchondromas of the hand:
Treatment by curettage with or without
bone substitute transplantation**

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Objective: Although many studies have suggested that bone transplantation is not necessary in the treatment of enchondroma, many surgeons still choose to fill the cavity after curettage. The purpose of this study was to retrospectively review records of enchondroma treatment at our institution and evaluate the outcomes of simple curettage versus curettage and bone graft or bone substitute.

Methods: Of the 43 cases (47 bones) treated between February 2003 to September 2015, the 30 cases (34 bones) that had been followed up for a minimum of 6 months were included in the study. The method of treatment was simple curettage in 16 bones, curettage followed by bone substitute in 17 bones (calcium phosphate cement 8, β -TCP 9), and curettage followed by autologous bone graft in 1 bone. The following information was noted: (1) grades of new bone formation on X-rays (Hasselgren 1991 classification), (2) loss of range of motion in the digits, (3) recurrence, and (4) the timing at which cortical remodeling first became apparent on radiographs.

Results: There were no early complications such as infection or fracture in the simple curettage group. In the bone substitute group, there was one infection and one fracture. Both were β -TCP cases. In one additional case that was excluded from the study because of insufficient follow-up period, surgical site infection necessitated the removal of β -TCP. At the most recent follow-up, the X-ray classifications were as follows: grade 1 (excellent new bone formation), 20 bones; grade 2 (good new bone formation or cysts <3 mm), 9 bones; grade 3 (scanty new bone formation or cysts >3 mm), 3 bones. The three grade 3 bones had all been treated by simple curettage. There were no grade 4 bones that showed no new bone formation. Three cases had residual loss of range of motion

at last follow-up (simple curettage one bone and bone substitute two bones). Recurrence was seen in three bone substitute cases, one of which was successfully treated with a second operation. Cortical remodeling was first observed at 27–110 days after surgery. There was no significant difference in remodeling times between the transplant group (62.9 ± 2.6 days) and simple curettage group (62.8 ± 1.6 days; $p = 0.84$).

Conclusions: The use of bone substitutes is simple and requires little additional operation time. Calcium phosphate cement provides immediate mechanical stability, whereas β -TCP provides additional bone stock that eventually becomes incorporated into the native bone. These are useful materials, but as with any artificial material, the possibility of associated complications including surgical site infection should be considered. We experienced two infection cases. It has been suggested that β -TCP supports formation of new bone and helps maintain mechanical stability, but our only postoperative fracture case was a β -TCP case. The prognosis after simple curettage was satisfactory, and filling the cavity after curettage does not seem to be a necessary procedure.

**A-0294 Does TFCC tear cause problem
after fixation of distal radius fractures**

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Introduction: Distal radius fracture was associated with a high incidence of triangular fibrocartilage complex (TFCC) tear. The current postulation was that the well-vascularized peripheral TFCC tears will heal, after anatomical reduction and fixation of distal radius fractures, without concomitant repair or postoperative immobilization. This study aims to evaluate the status of TFCC after the healing of distal radius fractures with plate fixation and whether the TFCC tear will cause any symptoms and signs.

Method: Patients who were elected for the removal of implants after union of distal radius fractures were recruited from August 2013 to June 2015. Concomitant wrist arthroscopy was performed to assess the status of TFCC.

Results: Forty-two patients with 43 distal radius fractures were studied. The average period from injury to the wrist arthroscopy was 12 months. There was 16 extra-articular distal radius fractures. Fifteen patients had ulnar wrist pain and 28 were noted to have distal radioulnar joint instability on examinations. The findings of wrist arthroscopies

revealed 25 complete and 10 incomplete (with signs of healing) TFCC tears. All patients with symptoms and signs had TFCC tears, while eight patients with intact TFCC tear hand neither symptoms nor signs. Sixty percent of the TFCC tears was arisen from the sigmoid notch and 26% from fovea tears. Twenty percent of the TFCC tears were combined tears. There were no correlation between ulnar wrist pain and location of the TFCC tears. No complication was noted.

Conclusion: A large majority of TFCC tears remained to be unhealed after the union of distal radius fractures. Yet, not all TFCC tears cause signs and symptoms.

A-0297 Double-level injuries of the suprascapular nerve identified during spinal accessory nerve to suprascapular nerve transfer using a posterior approach

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Objective: The suprascapular nerve (SSN) is a priority target in reconstruction of upper brachial plexus injuries. Spinal accessory nerve (SAN) transfer onto the SSN is the preferred nerve transfer option and has traditionally been performed through an anterior approach in which the distal SSN is not routinely exposed. However, concern persists that in cases where there has been injury around the shoulder, a second-level injury to the distal SSN may be present and would explain why some nerve transfers fail.

We have recently changed to using a posterior approach in which the distal SSN is explored and aim to report our experience along with postoperative results.

Methods: Since April 2013, six transfers have been performed via a posterior approach. A review of injuries and operative findings is presented with postoperative outcomes.

Results: We found ruptures of the distal SSN at the suprascapular notch in 3 of 6 cases. In all cases, transfer was possible without need for nerve graft. One patient developed lateral winging of the scapula. No other major complications occurred. Five patients with adequate follow-up have evidence of restored SSN function with improved abduction and external rotation.

Conclusions: We found a significant incidence of SSN rupture at the suprascapular notch in patients undergoing SAN to SSN nerve transfer surgery.

These injuries would not have been detected with the traditional surgical approach and would have meant certain failure of the transfers in these cases.

A-0304 Carpal tunnel release combined with radiofrequency therapy for faster healing and reducing the pain

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Objective: Carpal tunnel syndrome has many conservative and surgical treatment methods. (1) This study presents a novel treatment combination in carpal tunnel syndrome cases as a prospective, double-blinded, randomized controlled trial.

Methods: We included 24 patients who had 'severe carpal tunnel syndrome' findings in their EMG results. We included only one hand of all patients. These 24 patients were randomly divided into two groups. First group had only conventional carpal tunnel operation. Second group was treated with the carpal tunnel operation combined with radiofrequency therapy. In this group, after releasing the median nerve, median nerve was ablated with pulse radiofrequency (routinely 20 ms current and 480 ms without current) for 360 s with an output of 45V, and the temperature at the tip of electrode was 42° from proximal part of the lesion. QuickDASH score was applied to patients preoperatively, postoperatively at third month, sixth month, and first year. The two groups were compared with QuickDASH score.

Results: Control group and radiofrequency group had statistically significant difference in third month DASH score ($p < 0.05$). Both groups had no difference in sixth- and first-year QuickDASH scoring ($p > 0.05$).

Conclusions: The results show that patient relief is significantly better in the combined therapy group in the early period. Also, less pain in the early postoperative period render possible the painless, early, and effective hand rehabilitation. So we recommend the radiofrequency combined surgery to the professional musicians or athletes who have to start to use their hand quickly and without pain.

Reference

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A-0307 To what degree do pain-coping strategies affect joint stiffness and functional outcomes in patients with hand fractures?

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Objective: Patients with hand fractures often have pain, swelling, and stiffness in the joints of the hand, which may lead them to protect their hands, resulting in more stiffness and in delayed recovery. The objective of the study is to determine whether preoperative catastrophization and anxiety in patients with hand fractures are associated with delayed functional recovery after surgical treatment for a hand fracture.

Methods: A total of 93 patients with surgically treated hand fractures were enrolled in this prospective study. Preoperative assessments measured coping strategies evaluated by measuring catastrophic thinking with the Pain Catastrophizing Scale and pain anxiety with the Pain Anxiety Symptom Scale. At 3 and 6 months postoperatively, grip strength, total active range of motion, and disability (Quick Disabilities of the Arm, Shoulder, and Hand score) were assessed. Bivariate and multivariate analyses were performed to identify patient demographic, injury, and coping skills factors that accounted for outcomes of strength, motion, and disability.

Results: Decreased grip strength was associated with catastrophic thinking ($\beta = -1.29$ [95% confidence interval, -1.67 to -0.89], partial $R^2 = 11\%$, $p < 0.001$) and anxiety ($\beta = -0.83$ [-1.16 to -0.50], partial $R^2 = 7\%$, $p = 0.007$) at 3 months, but by 6 months, only anxiety ($\beta = -0.74$ [-1.04 to -0.44], partial $R^2 = 7\%$, $p = 0.010$) remained an important factor. Decreased total active range of motion was associated with pain catastrophizing ($\beta = -0.63$ [-0.90 to -0.36], partial $R^2 = 6\%$, $p = 0.024$) and anxiety ($\beta = -0.28$ [-0.42 to -0.14], partial $R^2 = 3\%$, $p = 0.035$) at 3 months but not at 6 months. Similarly, increased disability was associated with pain catastrophizing ($\beta = 1.09$ [1.39 to 0.79], partial $R^2 = 12\%$, $p < 0.001$) and anxiety ($\beta = 0.93$ [1.21 to 0.65], partial $R^2 = 11\%$, $p = 0.001$) at 3 months; these factors failed to be associated for 6-month outcomes.

Conclusions: Preoperative poor coping skills as measured by high catastrophization and anxiety were associated with a weaker grip strength, decreased range of motion, and increased disability after

surgical treatment for a hand fracture at 3 months. However, poor coping skills did not show persistent effects beyond 6 months. More research may be needed to show interventions to improve coping skills will enhance treatment outcome in patients after acute hand fractures.

A-0309 Relationship between the chronic palmar lunate dislocation in rheumatoid disorders and Kienböck's disease: Histopathological analysis of the lunates

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Introduction: Avascular necrosis of the lunate in systemic lupus erythematosus (SLE), scleroderma and rheumatoid arthritis (RA) is not rare and is usually related to synovitis, as a result of chronic oral steroid therapy and bone infarcts. These cases are examples of nontraumatic aetiology of Kienböck's disease. Patients with chronic rheumatoid diseases frequently need to use crutches to walk because they have joint arthritis and often hip and knee arthroplasties. These cases are examples of traumatic avascular necrosis. In rheumatoid disorders in the wrists, we show ligament disruptions, lytic bone lesions, lunate flattening, instability and palmar lunate dislocation due to a destructive arthritis. Our study aimed to describe the histopathology of the lunates after removing them in the operating room in patients with rheumatoid diseases and lunate palmar dislocation.

Methods: From January 2006 to January 2015, 12 patients were operated for rheumatoid disorders, 8 for RA, 1 for SLE and 3 for psoriatic arthritis (PA). There were eight females and four males with a mean age 70 (58–83) years. Antinuclear antibodies and other relevant tests were performed. Anticardiolipin antibody, anti-double-stranded DNA and anti β 2glicoprotein I were measured by enzyme-linked immunosorbent assay. AntiSm, AntiRo, AntiLa, and Anti RNP were measured by Western blotting. A lupus anticoagulant test was performed using dilute Russell viper venom time reagent. All patients underwent magnetic resonance imaging (MRI) study. T1-weighted images were evaluated for bone necrosis of the lunate.

In the operating room, we excised whole lunates at the time of surgery. We studied the macroscopical aspect of the lunates inside and outside. The macroscopic study was carried out by visualizing the lunate aspect and areas of lunate flattening. We evaluated the size, cartilage surfaces, number of foraminas, and ligament

insertions. After that, we cut the bone and showed the bleeding bone and collapse areas. Histopathological analysis was performed with lunate sections, tinted by hematoxylin–eosin and visualized by microscope. The surgical treatment was performed to remove the palmar lunate dislocation and wrist arthrodesis with a dorsal plate (Synthes®) in seven cases and wrist arthroplasty (Universal 2®) in the other five cases.

Results: In spite of the serious ligament destruction, instability and palmar lunate dislocation, the macroscopic aspect of the lunate was good without intraosseous fractures or avascular changes. In two cases, we showed a lunate flattening associated with a hypointensity in coronal sections in the T1-weighted image in MRI. Microscopic analysis did not show avascular necrosis in any lunate in rheumatoid wrists. The correlation between MRI and the histopathology was not confirmed.

Conclusions: Neovascularization with an increased number of synovial vessels with a characteristic morphology seems to contribute to the progression of autoimmune diseases. Angiogenesis may be an important therapeutic target in PA. It is possible that patients with rheumatoid wrists have a hypervascularity and a chronic adaptation to the loss of vessels in the lunate and ligament injuries. This could avoid having Kienböck's disease in a chronic palmar lunate dislocation in rheumatoid disorders.

A-0310 Reliability of an illustrated self-administered questionnaire for upper extremity disorders in the elderly

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Objective: The Hand20 is the validated questionnaire for upper extremity disorders with explanatory illustrations. Our hypothesis was that the illustrated Hand20 would demonstrate high reliability among elderly individuals compared to the Japanese Society for Surgery of the Hand Version of Disability of the Arm, Shoulder and Hand (DASH-JSSH).

Methods: To evaluate test–retest reproducibility, a total of 542 patients (253 men and 289 women) with upper extremity disorders completed both the Hand20 and the DASH-JSSH twice, with an interval of about 11 days. They were asked to enroll in the study when their symptoms had been stable for the previous 4 weeks. Cases that had more than 10 % of responses missing were defined as inappropriate cases, which were excluded from the analysis. The

test–retest reproducibility was assessed with the intraclass correlation coefficient (ICC).

Results: The mean age of the study population was 51 ± 16 years (range 15–83). One hundred twenty one patients were more than 65 years old. Inappropriate cases in the first test were seen in 6 (1.1 %) cases and 55 (10.1 %) cases on the Hand20 and the DASH-JSSH, respectively. Inappropriate cases on the retest were seen in 1 (0.2 %) case and 41 (7.6 %) cases, respectively. ICCs for the Hand20 and the DASH-JSSH were 0.93 and 0.92, respectively. Both questionnaires met recommended reliability standards for individual-level applications, which were considered to range from a low of 0.90 to a high of 0.95. Reproducibility for the Hand20 was equivalent even in elderly patients (ICC = 0.93). However, the reproducibility for the DASH-JSSH was lower in elderly patients compared to all age-groups (ICC = 0.89).

Conclusions: With an aging society, the development of instruments to assess the health status of elderly people has become an important issue. Reliability to obtain reproducible results is essential when evaluating the results of treatment. In this study, reproducibility for the DASH-JSSH was not enough to assess individual elderly patients. In contrast, reproducibility for the Hand20 met recommended reliability standards for individual-level applications regardless of age. Furthermore, completeness of item responses for the Hand20 was significantly better than that for the DASH-JSSH. These results support our previous study in which explanatory illustrations led to less missing data and improved the reproducibility. Our result leads us to believe that illustrated self-administered questionnaire for upper extremity disorders, such as the Hand20, expand the range of application to a wider age-group.

A-0318 Functional results postarthroscopic triangular fibrocartilage complex reconstruction in chronic distal radioulnar joint instability

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Objective: Tears in the triangular fibrocartilage complex (TFCC) are often observed with ulnar wrist pain and limit wrist function in work or sport. In chronic cases, tears with degeneration of the TFCC combined with distal radioulnar joint (DRUJ) instability are difficult to treat. Consequently, this paper presents the results of arthroscopic reconstruction of the TFCC with the PL tendon.

Materials and methods: From September 1999 to September 2013, 27 adult patients, 20 males and 7

females, with chronic TFCC tears were studied. Their ages ranged from 19 to 24 years, and the mean age was 22.4 years. In our clinic, we adopted a protocol of arthroscopic TFCC reconstruction with PL tendon for all chronic TFCC injuries with DRUJ instability. Thereafter, a rehabilitation program, including wrist motion and the occupational therapy was begun. The period from the accident to the operation ranged from 14 to 28 months, with a mean of 22.6 months.

Results: All patients were found with negative, zero, or mild positive (<2 mm) ulnar variance. The results were graded using Mayo Modified Wrist Score. Eleven of the 27 patients rated their wrists as 'excellent', 15 as 'good', and 1 as 'fair'. No patients experienced wound infections or complication.

Conclusions: Arthroscopic TFCC reconstruction using PL tendon is an effective method for treating chronic TFCC tears with DRUJ instability, as suggested in this study.

A-0319 Distal radius isoelastic resurfacing prosthesis: A preliminary report

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Background: Here we present a preliminary case series of unicompartamental isoelastic resurfacing prosthesis of the distal radius to treat comminuted articular fractures of osteoporotic elderly patients.

Materials and methods: Our study included 12 patients, mean age 76 years, who presented with comminuted osteoporotic distal radius fracture. Because of the severity of injury and poor bone quality, osteosynthesis was not deemed to be a good option.

Description of Technique: The surgery was performed through a dorsal approach. The subchondral bone of the entire distal radial articular was excised, and a unicompartamental prosthesis was applied.

Results: At an average follow-up of 32 months, the pain was 2.8/10; Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) was 37.4/100; and grip strength in neutral 49.9%, in supination 59.0%, and in pronation 56.2% of the contralateral normal side. The wrist ranges of motion in flexion and extension were 56.1% and 79.3% in supination and pronation, respectively, 87.7% and 91.0% of the contralateral

normal side. Two patients experienced a complex regional pain syndrome (CRPS) type II, and these resolved spontaneously. One patient experienced distal radioulnar joint (DRUJ) stiffness, which improved after an ulna head resection. Finally, one patient required revision surgery after a secondary traumatic fracture. Radiographically, the average volar tilt was 9.8°, and the average radial inclination was 11.6°.

Conclusion: The concept of a unicompartamental isoelastic resurfacing prosthesis offers a promising option for the treatment of comminuted, osteoporotic distal radius articular fractures of elderly patients.

A-0320 Costoclavicular space could be evaluated with dynamic 3DCT after brachial plexography in thoracic outlet syndrome

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Introduction: Previously, for the detailed evaluation of patients with thoracic outlet syndrome (TOS), we performed three-dimensional computed tomography (3DCT) after brachial plexography. Recently, we focused on patients with TOS who complained of symptoms in the sitting or standing positions but not during the Wright's maneuver provocation test. Dynamic 3DCT in different positions enabled an enhanced definition of the anatomy of the brachial plexus and the dynamic assessment of the compressed brachial plexus. For further examination of TOS, this method also enabled evaluation of the relationship among the clavicle, the subclavius muscle, and brachial plexus, which is impossible with typical brachial plexography.

Purpose: The purpose of this study was to assess the feasibility of 3DCT after brachial plexography for evaluating the changes in the costoclavicular space in the supine position with or without upper limb traction for reproducing the costoclavicular relationship in the sitting and standing positions.

Materials and methods: TOS was suspected on the basis of the patient history, symptoms, neurological findings, provocation test results, and electrophysiological examination findings. Patients with other conditions associated with neuropathy (e.g. hypothyroidism and diabetes mellitus) and those with clinical findings of neuropathies, such as cervical radiculopathy and polyneuropathy, were excluded. Brachial plexography and 3DCT were performed in

15 patients (11 females and 4 males) with a mean age of 35.3 (range, 13–48) years. First brachial plexography was performed. After that, dynamic 3DCT was performed not only in the resting supine position but also in the supine position with upper limb traction for reproducing the costoclavicular relationship in the standing and sitting positions. The compressed areas surrounding the brachial plexus (interscalene space and/or space under the clavicle and/or space under the pectoralis minor muscle) containing contrast media in the plexograph and 3DCT images were assessed. In addition, special attention was paid to reconstitute the images to observe cross sections of brachial plexus in 3DCT. In these reconstituted images, we assessed the costoclavicular space (the distance between clavicle and rib), the thickness of the subclavius muscle, and the height of the contrast media around the brachial plexus. These values of the affected side and the healthy side were compared.

Results: It was possible to measure costoclavicular space and height of the contrast media around the brachial plexus using reconstituted images. The mean values of costoclavicular space at rest were 30.9 mm in healthy side and 26.9 mm in affected side, and these with limb traction were 23.0 mm and 20.5 mm, respectively. The mean values of height of the contrast media at rest were 18.6 and 17.0 mm, and these with limb traction were 14.3 and 12.0 mm. In addition, the ratio of the values of height of the contrast media to costoclavicular space with limb traction were 62.8% in healthy side and 58.8% in affected side.

Conclusion: Dynamic 3DCT after brachial plexography enabled the quantification of the narrowed costoclavicular space and diminished collections contrast media around the brachial plexus.

A-0327 Coracoid osteology, morphology, and vascularity with respect to its utility as a free vascularized bone graft for scaphoid and other small bone reconstruction

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The coracoid has been used as a pedicled bone graft in the Latarjet–Bristow procedure for shoulder stabilization. The coracoid can be removed for coracoid impingement and in anterior shoulder releases without ill effect. We investigated the potential for free vascularized transfer of the coracoid as a vascularized bone graft/flap. We also investigated the osteology, musculo-tendinous attachments and morphology of the coracoid to compare it to the scaphoid proximal pole.

Cadaver studies of 14 shoulders, in vivo dissection of 18 shoulders, radiological studies and comparative CT with three-dimensional shape matching scans were utilized to demonstrate the anatomy of the coracoid for this purpose.

The coracoid has similar size and morphology to the scaphoid proximal pole. The attachment of the conjoint tendon can replicate the scapholunate ligament. The coracoid is supplied by a previously undescribed reliable pedicle directly arising from the second part of the axillary artery. The free vascularized coracoid could be a reliable bone flap. The shape of the coracoid and its size and attachments lend it to reconstruction of the carpus.

A-0331 What is the use of 3T-MRI in chronic wrist complaints?

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Introduction: Value of noninvasive techniques in chronic wrist complaints is unclear. Prior to arthroscopy, a 3T magnetic resonance imaging (3T-MRI) is often made. By comparing 3T-MRI findings to wrist arthroscopy (golden standard), we evaluated the diagnostic value of 3T-MRI in patients with chronic wrist complaints.

Methods: We retrospectively reviewed 110 consecutive patients (111 wrists, 38 males) from January 2010 until April 2015 in our medical center. Mean age during MRI was 34.7 (13–82) years and mean time between MRI and arthroscopy was 121.3 (standard 106) days. Five diagnoses were examined: scapholunate ligament lesion (SLLL), lunotriquetral ligament lesion (LTLL), partial or total triangular fibrocartilage complex lesion (TFCCCL), ganglion, and synovitis. Results from the MRI report were compared to arthroscopic findings.

Results: With diagnosis of ganglion, the sensitivity was 81%, specificity 91%, positive predictive value (PPV) 85%, and negative predictive value (NPV) 89%. Other diagnoses had lower sensitivity: SLLL 37%, LTLL 5%, TFCCCL 36%, and synovitis 10%. Specificity was above 91% for all investigated diagnoses. PPV with SLLL was 78%, LTLL 33%, TFCCCL 100%, and synovitis 100%. NPV with SLL was 80%, LTLL 81%, TFCCCL 73%, and synovitis 17%.

Conclusions: 3T-MRI shows an acceptable result only in diagnosis of ganglion. With diagnosis of SLLL, LTLL, TFCCCL, and synovitis, MRI possesses limited value compared to arthroscopy. It might provide false assurances if no abnormalities are shown. Considering the limited value of 3T-MRI, it cannot substitute wrist arthroscopy. With chronic wrist complaints,

arthroscopy should stay the golden standard, without necessity for 3T-MRI beforehand.

A-0337 Scaphoid kinetics after excision, implantation, and stabilization with a plasty: An experimental study on cadaver

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Objective: Prosthetic replacement of the scaphoid poses unsolved problems both in material and especially regarding its stabilization in the carpus. The aim of this work is to study experimentally on cadaver the kinetics of the scaphoid after being excised, implanted, and stabilized with a flexor carpi radialis (FCR) hemitendon plasty as a possible model for stabilization of a prosthesis.

Methods: Twelve fresh cadaver specimens, including forearm, wrist, and hand without preexisting pathology, were used. Specimens were fixed vertically on a jig designed for the study. Sensors were connected to the dorsal aspect of the scaphoid, triquetrum, and capitate. The 3D changes in the alignment of carpal bones were monitored using a FASTRAK motion tracking device (Polhemus Inc., Colchester, Vermont, USA). In order to create an axial force in the carpus, five muscles were loaded in proportion to the activity observed in electromyography studies: abductor pollicis longus 9.8 Newtons (N), extensor carpi radialis longus 24.5 N, extensor carpi ulnaris 14.7 N, flexor carpi radialis 13.7 N, and flexor carpi ulnaris 21.5 N. The kinetics of the scaphoid was studied in three successive stages: (1) in the intact wrist; (2) after being excised and implanted, without stabilization; and (3) after being stabilized with an FCR hemitendon plasty. The stabilization of the implanted scaphoid was performed using a modified Brunelli plasty, in which the proximal end of the FCR hemitendon was introduced into the lunate and fixed with an interference screw. Scaphoid movement in each of the three planes, after undergoing axial load in each stage, was recorded in degrees. The data obtained were analyzed with the IBM SPSS statistics program v.22®. The Wilcoxon test for paired data was used and $p < 0.05$ was considered statistically significant.

Results: In the intact wrist, the scaphoid showed a mean supination of 0.82° [standard deviation (SD) 1.99°], a mean flexion of 5.07° (SD 3.38°), and a mean ulnar deviation of 0.89° (SD 2.25°). After being excised

and implanted without stabilization, the scaphoid showed a mean pronation of 2.23° (SD 8.83°), a mean flexion of 7.59° (SD 4.63°), and a mean ulnar deviation of 3.99° (SD 5.39°). Once stabilized with the plasty, a mean pronation of 1.71° (SD 4.47°) was observed, a mean flexion of 5.10° (SD 3.12°), and a mean radial deviation of 1.01° (SD 3.48°). Neither of these two groups showed significant differences from the intact wrist. Otherwise, regarding the deviations, significant differences were found between these two groups ($p = 0.014$).

Conclusions: The implantation of the scaphoid, unstabilized or stabilized, has not imitated the kinetics of intact wrist in our study, although the observed differences have no statistical significance between groups. The stabilization with the FCR hemitendon plasty used in this study does not seem to modify substantially the behavior of the implanted scaphoid when applying axial loads.

A-0339 Evaluating the role of ultrasound in a diagnostic and treatment pathway for suspected ulnar collateral ligament injuries of the thumb: Analysis of results in a large tertiary hand unit

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Objective: Accurate diagnosis of suspected ulnar collateral ligament (UCL) injuries is critical for determining which cases require surgery and those which can be managed conservatively. Misdiagnosis and delay in the correct treatment can lead to significant long-term morbidity. This study sets out to assess the diagnostic performance of ultrasound (US) in characterizing UCL injuries and to consider the supporting role of high-resolution US in this subgroup of hand injuries. Secondly, we were interested to note the sources of referrals and waiting times to first hand clinic appointment and US scan.

Methods: Using the radiology information system (RIS), retrospective data were collected on all US examinations of the thumb for suspected UCL injuries, from January 2010 to September 2012. Evidence from clinical examination and US were recorded. Clinical notes and operative findings for these patients from hand clinic were accessed from the online clinical portal system and in surgically explored patients, and operative findings were used as a gold standard. In patients who were conservatively managed, follow-up clinic letters documenting stability of metacarpophalangeal joint on stress testing were used as the standard. In addition to demographic details, data

on the source of referral and waiting times were collected.

Results: Forty-five patients fitted the inclusion criteria, 12 of whom received surgical intervention. Surgical exploration found that 8 patients were correctly diagnosed by US with UCL injuries (true positives). Three were incorrectly diagnosed (false positives). One patient was accurately diagnosed by ultrasound with a lax, but intact UCL was necessary for surgical repair. Thirty-three received conservative management and all achieved a satisfactory, stable outcome. One of these on MRI investigation showed the US scan had underestimated the damage (false negative). In one other case, the US scan differed markedly from clinical examination, but the diagnosis of the latter was preferred. Thus, sensitivity was 89%, specificity 92%, positive predictive value (PPV) 73%, and negative predictive value (NPV) 97%. Accuracy was 91%. In all, 56% of patients came via A&E, 40% from other hospitals, and only 4% from general practice. From A&E, average time to clinic was 12.7 days ($n = 25$). Average wait for a scan was 14.4 days ($n = 45$).

Conclusion: US is a very useful adjunct in diagnosing UCL injuries, when clinical examination can be equivocal and painful. Clearly, for those not surgically explored, we do not know whether a non-Stener lesion UCL injury was missed by US, but this is not a problem, provided conservative management is achieved and stability is maintained. US was effective in confirming those who required surgery, and judged by a satisfactory outcome, the NPV of a US scan was excellent in supporting a decision for conservative management.

In this tertiary setting, US is now becoming more commonly requested for suspected UCL injuries, referral is streamlined, and waiting time is much lower than reported for this cohort.

A-0341 Our results in 'spaghetti wrist' injuries associated with soft tissue defects

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Introduction: 'Spaghetti wrist', a term that defines complex volar wounds involving more than three major structures, is a very severe lesion and with a significant morbidity. The lesion becomes more severe in association with skin defects. This article will present the results in 49 patients operated in a 10-year period, in terms of functional recovery and socioprofessional reintegration.

Materials and methods: We analyze patients operated in a 10-year period for pure 'spaghetti wrist'

lesion or associating a skin alone or a complex soft tissue defect. The patients were analyzed with regard to the mechanism of injury, type of surgery, functional recovery, and socioprofessional reinsertion.

Results: In a 10-year period, 49 patients (35 men and 14 women), with an average age of 34, were operated for a spaghetti wrist lesion. From those, 37 presented a pure spaghetti wrist lesion and 12 also associated a soft tissue defect of more anatomical elements in 7 cases and of skin alone in 5 cases. The mechanism of injury was work related in 35 cases, traffic accidents in 2 cases, home accidents in 10 cases, and suicidal attempt in 2 cases. At least three tendons were injured in all the cases. The median nerve was injured in 19 cases, the ulnar nerve in 13 cases, and both of them in 17 cases. The radial artery was lacerated in 11 cases, the ulnar artery in 19 cases, and both of them in 7 cases. A complex soft tissue defect, including skin and tendons/arteries/nerves, was registered in seven cases and a skin defect alone in five cases.

All the cases were solved in emergency as an all-in-one procedure. A free flow through simple or composite flap was used in seven cases and a propeller perforator flap in five cases. The range of motion was very good in 31 patients (8 from those associating defects), good in 12 patients (4 from those associating defects), and fair in 6 patients. The sensory recovery was very good in only 21 patients, good in 19 patients, and only protective in 9 patients (two-point discrimination of 2–5 mm in 21 patients and of more than 6 mm for the others).

Conclusions: The outcomes after repair of both simple spaghetti wrist and associated with soft tissue defects are similar if a careful emergency all-in-one procedure is done. The overall functional outcomes after repair are generally good, allowing the socioprofessional reintegration of the patients.

A-0342 Achieving normal in finger defects coverage using mini-propeller flaps

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Purpose: Normal in finger reconstruction means to obtain both a nice cosmetic appearance and a good functional rehabilitation. The use of free flaps from the foot is a very successful method but also a very demanding microsurgical procedure. The question is why not to find a method that needs microsurgical skills only for dissection and without any microvascular suture. Koshima described the possibility of

harvesting flaps based on digital perforators located at distal interphalangeal joint. We will demonstrate that it is possible to harvest such flap also more proximal.

Methods: We will present the advantages of using these mini flaps based on perforators emerging from the digital arteries, at any level of the fingers, including the thumb. In our service we practiced 25 transposition island perforator flaps for covering tissue defects in fingers, from which 4 were for the thumb. In two cases, we used the perforator flap as a cross-finger flap to cover a defect on an adjacent finger. The transposition flaps have an oval shape and are harvested from one side of the finger, without sacrificing the digital artery. After the subfascial undermining of the flap on its entire surface and identification of the vascular pedicle represented only by the perforator, the flap can be rotated 90–180° and can cover dorsal and volar finger defects. The flap's donor site is generally directly closed; if its direct suture is not possible, a free skin graft from the forearm can be used. In the attempt to avoid this disadvantage, we developed a bilobed pedicled flap blood supplied by the same perforator vessels, which allows the donor site closure without any morbidity. This flap was used in 13 cases.

Results: These transposition flaps had an uneventful evolution, with complete integration of the flap and good quality functional recovery. In two cases, we registered a minute partial superficial necrosis, which spontaneously healed. The bilobed flaps also had an uneventful evolution. The recovery for all the patients was between 14 and 21 days.

Conclusion: We consider that the perforator island transposition flaps have the advantages of using similar tissues in reconstruction, not damaging another area, they do not require main vessels sacrifice, can be sensate, and the donor site can be generally directly closed. When the direct closure of the donor site cannot be realized, this one can be achieved using a free skin graft or the bilobed flap as a variant of the perforator flap.

A-0345 Traumatic DRUJ instability – A prospective study to address the problem efficiently

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Objective: (1) to understand the incidence, mechanism of injury, and clinical presentation of distal radioulnar joint (DRUJ) instability and (2) to devise a simple solution to treat DRUJ instability and evaluate its outcome.

Methods: Our study is a prospective cohort study taking into account 80 patients who presented themselves with wrist and forearm injuries in our orthopedic department, spanning through a timeline from September 2013 to March 2015.

DRUJ instability was looked for in these patients, and few clinical and radiological parameters were used to evaluate them. After determining the injury, closed reduction with above elbow cast application was attempted to reduce the fracture or the subluxation. A group of 34 patients had features of DRUJ instability among which 14 patients had good reduction with above elbow cast thus was left as such until it was removed after 4 weeks. Remaining 20 patients were treated surgically. All patients were followed up every 15 days, and they were evaluated comprehensively using specific parameters pertaining to DRUJ injuries at third and sixth month after the injury. At the final follow-up, two scoring systems for wrist were used to evaluate the functional and subjective outcome of the patients. The analysis of data was made on the basis of the statistical parameters such as descriptive statistics, chi-square / contingency table analysis using SPSS for Windows using latest version 20.0.

Results: Among the 80 patients, 47 patients sustained road traffic accidents among who 30 patients had DRUJ instability and only 4 patients with DRUJ instability sustained injury by other mechanisms. DRUJ Gap, DRUJ subluxation in Schecker-weighted lateral view, and Ulnar-sided pain turned to be reliable clinical parameter for evaluating DRUJ instability with *p* value of 0.001 for diagnosing DRUJ instability. Among the 34 patients with DRUJ instability, 18 patients were treated with DRUJ transfixing k wires, and they had comparatively better outcome than the rest of the 16 patients.

Conclusion: Thus, my study concludes that 70% of DRUJ instability following trauma to wrist and forearm are caused by road traffic accident, predominantly fall from a motor cycle. Early diagnosis and management using DRUJ transfixing k wires primarily gives better functional outcome.

A-0350 Long-term results of treatment of radioscaphoid arthritis and wrist by use of pirocarbon implant

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Background: Adaptive proximal scaphoid implant (APSI), maintaining carpal height and replacing an articular surface, prevents the worsening of arthritis and carpal collapse. Good tolerance of Pirocarbon and conformation of the implant give good

expectations when there are lesions of styloscapoid articulation.

Aim: In this retrospective study, the authors describe their experience with the use of a Pirocarbon implant for proximal scaphoid in styloscapoid arthritis linked to SNAC and SLAC wrist.

Materials and methods: From January 1999 to June 2015, a total of 93 wrists were treated (85 for SNAC wrist from scaphoid pseudoarthritis grades 2 and 3 and 8 for SLAC wrist from S-L lesion). All cases were evaluated pre- and postoperatively with MMWS, PRWHE, and Disabilities of the Arm, Shoulder, and Hand (DASH) scores, with an average follow-up of 84 months (minimum 6–maximum 172).

Results: All the patients reported relief from pain, small improvement in range of motion (ROM), and improvement in strength. At the follow-up, there was an average reduction in pain from 7.01 to 2.7 VAS. There was an improvement in grip and pinch force from 51% to 85% of controlateral side. Eighty-five percent of the patients were satisfied with the results and were able to return to the precedent activities. Improvement in DASH was from 89 to 29 and PRWHE from 101 to 27.8. Radiographic controls revealed 6 cases of complication with 4 cases of dislocation of the implant and no reduction in carpal height nor worsening of radiolunate angle.

Discussion and Conclusion: Replacement of proximal pole of scaphoid with APSI can restore a functional ROM free from pain in patients affected by styloscapoid arthritis, maintaining height of proximal carpal row and preventing subsequent deterioration or collapse.

A-0352 Instead of the intrafocal pinout in fractures of the distal radius About a monocentric series of 49 patients operated in 2013

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Introduction: In our department, since 2010, palmar plates were mainly used to treat distal radius fracture. In 2013, 147 patients underwent an anterior plate osteosynthesis, while 71 were treated by an intrafocal pins fixation technique. The goal of this study was to evaluate the results and the indications of intrafocal pins fixation of distal radius fracture.

Material and Methods: A monocenter retrospective study was performed in our university department. Seventy-one patients were treated by intrafocal pins fixation for a distal radius fracture. Of these 71 patients, 15 patients were excluded and 7 patients were lost for

follow-up. Finally, 49 patients were operated by intrafocal pins fixation technique and were followed. There were 30 women and 19 men, with average age of 45.4 years. Patients were divided into three groups: group A (17–50 years) 26 patients; group B (50–70 years) 15 patients; and group C (beyond 70 years) 8 patients. All fractures were dorsally displaced. All patients underwent an AP and lateral radiographic evaluation of the wrist on days 2 and 45 to measure radial deviation, distal radioulnar index, and the radial gradient.

Results: Follow-up was stopped at 1.5 months for 20 patients and at 3 months for 29 patients. Twenty-one secondary displacements were observed at follow-up, of which, 7 were in group C. There were three fixation failures, all in group C. One surgical revision was performed within 15 days after the initial surgery for a palmar displacement. The distal radioulnar index increased in the three groups.

Discussion and conclusion: In 2013, treatment by intrafocal pins fixation of distal radius fracture concerned 38% of our patients. There was a secondary displacement of the reduction in nearly 43% of cases. The most affected group was group C (beyond 70 years), where 88% displacement and 36% fixation failures were observed. On the other hand, by selecting eight patients from group A aged under 20, secondary displacement was only 12.5%. The intrafocal pins fixation technique of distal radius fracture must be limited to extra-articular fracture dorsally displaced without comminution.

A-0354 Massive coverage in upper limb defects with a new design perforator flap

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Objective: Coverage of large defects of the upper limb with multiple scars can be difficult. We present a novel design of locoregional perforator flap that successfully solves these ulcers, with no need for microsurgical anastomosis.

Methods: We present a total of five cases with upper limb defects. Eighty percent of the cases had a history of trauma or previous surgery. All cases had exposure of osteosynthesis material, joints, or neurovascular elements. All cases had particular patient-related circumstances that prevented free-flap reconstruction. Every defect was reconstructed with a single perforator bilobed island flap. The design of this flap is similar to a conventional bilobed flap, positioning the perforator located with a Doppler probe at the base of the flap, and the entire flap on the corresponding angiosome.

Some additional technical points were needed for a successful reconstruction.

Results: All flaps survived. Twenty percent of the cases suffered minor complications (lobe tip necrosis). There weren't functional limitations or sensitive deficits associated with the technique.

Conclusion: The reconstruction of complex defects is often limited by local conditions adjacent to the defect. The scars near ulcers produced by trauma or previous surgery hinder locoregional flap reconstruction. The clinical characteristics of the patients in this series (spasticity and comorbidity) did not allow microsurgical reconstruction. The reconstruction with locoregional perforator flap solves these difficulties. The bilobed design also allows to improve some problems of perforator locoregional flaps (less rotational movement, larger flap without complications of the donor site, etc.). We consider the bilobed island perforator flap a versatile and reliable option to solve complex or massive defects in patients with some types of microsurgical contraindication.

A-0357 Graded motor imagery training leads to improved pain control and hand function in patients with distal radius fractures: A randomized controlled trial

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Objective: Distal radius fractures (DRFx) are one of the most common fracture of the forearm. Immobilization period and associated soft tissue injuries increase the complication rates, leading to suboptimal functional results following DRFx. Therefore, postoperative rehabilitation period gains importance to improve functional outcome. Active treatment strategies are suggested to be more effective in reducing functional impairments encountered during recovery period. Graded motor imagery (GMI) is one of the most recent motor-cognitive approaches aiming to gradually activate cortical motor without triggering protective pain response during upper extremity movements. GMI training, which has three progressive stages (a left-right limb judgements, imagined movements of the affected limb and mirror therapy), was found to be an effective treatment approach in different conditions. The aim of this study is to determine the therapeutic effects of GMI on hand function in patients with DRFx.

Method: Thirty-six participants were allocated to either GMI group ($n = 17$) or control group ($n = 19$).

The GMI group received GMI training and traditional rehabilitation, and the control group received traditional rehabilitation alone for 2 days/week for 8 weeks. Pre- and posttreatment assessments included pain with visual analogue scale, range of motion (wrist flexion, extension, ulnar/radial deviation, supination, and pronation), and grip strength with Jamar dynamometer and upper extremity functional status with Disabilities of the Arm, Shoulder, and Hand (DASH). Within-group comparisons of treatment effects relative to baseline were analyzed with the Wilcoxon test, and between-group comparisons were performed with the Mann-Whitney U test.

Results: Intergroup comparison revealed significant improvements in pain, range of motion, and DASH scores for the GMI group than for the control group ($p < 0.05$). No significant differences were found for grip strength between the groups ($p > 0.05$).

Conclusion: GMI training in addition to traditional rehabilitation program appears to provide beneficial effects to control pain and improve upper extremity functionality in patients with DRFx. Future research is warranted to elucidate the modulation of sensory and motor recovery processing in GMI training.

A-0359 Four-corner fusion: Our experience with nonlocking plate system

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Objective: Scapholunate ligament injury or scaphoid nonunion often leads to painful wrist arthritis. Four-corner fusion (4CF) is a treatment option if the radiolunate joint is spared. We performed retrospective follow-up study of all patients operated between 2004 and 2014 using circular plate with nonlocking screws in patients affected by level II and III SLAC/SNAC wrist.

Methods: We treated 74 wrists in 70 patients (59 men) with a mean age of 55 (32–75) years in our department, due to SLAC (53) or SNAC (21) with 4CF. After 2 weeks of immobilization, all the patients had started the reeducation program. At the follow-up, we recorded complications, range of motion (ROM), pain by visual analogue scale (VAS), Mayo score, Disabilities of the Arm, Shoulder and Hand (DASH), and grip strength. Radiographs of both wrists were taken at the final follow-up. Prior to 4CF, none of the wrist showed radiolunate degeneration on standard radiographs. At follow-up, 37 demonstrated narrowing or irregular joint surfaces. Six patients were considered lost to follow-up.

Results: The mean follow-up period was 71 months (range 12–132). Three patients had perioperative complications – one injury of a. radialis and one injury of sensitive branch of n. radialis. Two patients developed midcarpal nonunion. One was asymptomatic and the second was reoperated with refixation of midcarpal joint by Herbert screws. In one case, pain lingered after 3 months, and this condition required plate removal due to a dorsal impingement. One patient had radial deviation of hand, which was corrected by carpal osteotomy. At follow-up, the Mayo score was 61.56 (preoperative 40.12), and the DASH was 20.46 points (preoperative 42.50). The average ROM in flexion–extension movements was 68%. The average grip strength was 29 kg (60% of the other limb strength).

Conclusion: 4CF gives satisfactory pain control and functional motion. The patients can expect some residual pain and reduced wrist function. The use of circular plate with nonlocking screws allows earlier rehabilitative protocol with consequent patient satisfaction as well as other techniques. Based on our experience, we think that the proper alignment and congruence of the line of fusion is essential prior to the type of used implant. We also think that there is no need for use of locking plates if this is properly achieved.

A-0364 Reconstruction following combat injuries around the wrist: The experience from the Royal Centre for Defence Medicine

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Objective: The Royal Centre for Defence Medicine (RCDM) based in the Queen Elizabeth Hospital in Birmingham provides medical support to the British armed forces on operational deployment. We describe our experience in treating complex wrist and carpal injuries in a cohort of severely wounded casualties.

Method: During the operational activities of Operation Herrick, there were 547 British casualties categorized as either seriously or very seriously injured which were transferred to the United Kingdom for further care. Following immediate stabilization in Afghanistan, casualties are transferred to the RCDM for ongoing extended resuscitation and definitive care. Of these injuries, there are a subset who had sustained severe wrist and carpal injuries.

Results: Eighteen patients with 20 severe wrist or carpal injuries were treated between 2006 and 2013. Fifteen were the result of an improved explosive device

(IED) and five from gunshot wounds. Open fractures were observed in all cases. All had varying degrees of complex soft tissue loss with 8 requiring composite flap cover. Three were associated with lower limb amputations. The injuries required a staged approach with initial debridement, the judicious use of negative pressure wound cover, and temporary stabilization with subsequent planning and staged bone and soft tissue reconstruction and cover. Only one patient had an upper limb amputation, and all others were salvaged.

Conclusion: This cohort represents a unique patient population in terms of injury mechanism, pattern, and the association with other multisystem injuries. They required a strong multidisciplinary approach to their treatment with the staged coordination of the surgical treatment of multiple complex injuries. We describe these injuries and our experience treating them.

A-0375 Reanimation of elbow flexion with phrenic nerve transfer in total plexus avulsion: Is it safe? Literature review and personal experience

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Objective: Phrenic nerve transfer (PNT) to musculocutaneous nerve (MC) is one of the available reconstructive tools in patients with total brachial plexus avulsion (TBPA). Donor site morbidity is still controversial and not fully investigated. The aim of this study is to analyze literature data concerning diaphragm dysfunction (DD) and respiratory function (RF) and to report personal experience outcomes.

Methods: A PubMed search was conducted for 'diaphragmatic paralysis brachial plexus injury', 'phrenic nerve transfer', and 'phrenic nerve function'. Fifteen adult patients with TBPA who underwent to PN transfer to MC were controlled 3 years after surgery to test and RF and DD. Diagnostic test included chest X-ray, respiratory volumes evaluation, and functional chest magnetic resonance imaging (MRI). Elbow flexion was measured using Medical Research Council (MRC) grading system.

Results: Eleven papers published between 1989 and 2015 were selected. No consensus about DD and RF was found, as highly controversial statements were reported. Diagnostic studies showed no significant respiratory dysfunction in the group of 15 controlled patients. DD was present in all controlled patients: Functional chest MRI showed an hemidiaphragmatic excursion lower than 2 cm in all patients. Biceps function recovery was grade M3 in 4 patients and M4 in 10 patients. Only one patient showed an M1 biceps.

Conclusions: PNT seems to be a safe and effective technique for restoring biceps function in adults with TBPA.

A-0376 Dimensions of the terminal phalanx and its relevance in hand surgery

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Introduction: The terminal phalanx of the fingers carries the attachment of the Flexor Digitorum Profundus (FDP) on the volar surface and the extensor on the dorsal surface. Avulsion of these tendons has traditionally been repaired with pull-through sutures. Recently, bone anchor sutures have been found to be of comparable biomechanical strength but with the added advantage of technical ease and fewer complications. However, the dimensions of the bone, at the site of insertion of the anchors, have never been studied. We measured the thickness (anteroposterior dimensions) of the terminal phalanx in 250 digits. We present our findings of the analysis. We compare these with the dimensions of the commonly used bone anchor and argue why they are not appropriate for tendon reattachment at these sites. We illustrate our argument with clinical pictures.

Methods and Results: 250 digits were analyzed on the hospital's digital X-ray system (IMPAX 6.5.3.1005, Agfa). Only digits with true lateral views were chosen. The integrated measurement device on the system was used to measure the thickness (anteroposterior dimensions) at the level of the centroid of tendon insertion. The findings were input onto a spreadsheet for analysis. The middle finger was found to have the biggest dimensions (mean of 6.4 mm and range 5.9–7.5 mm). The small finger was found to have the smallest dimensions (mean of 5.1 mm and range 4.6–5.5 mm). The index and ring finger dimensions lay in-between.

The commonly used bone anchor for tendon reattachment (Mini Mitek; DePuy Synthes) has a body measuring 1.8 × 5.4 mm. The recommended drill hole size is 2 × 9.7 mm. The opposite cortex is often breached on insertion of this anchor suture, increasing the risk of migration. We illustrate our argument with clinical pictures of such migrations. We feel that a Micro Mitek Anchor, with a drill hole size of 1.3 × 5 mm, is more appropriate at this site.

Conclusion: The dimensions of the terminal phalanx have never been studied and reported. We hope that this analysis of bone dimensions can be a useful guide to surgeons in choosing the appropriate implant for bony fixation or soft tissue reattachment.

A-0381 Ivory arthroplasty for trapeziometacarpal joint osteoarthritis: Clinical and radiological outcomes with an average of 4 years of follow-up

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Introduction: The thumb carpometacarpal (CMC) joint is a common site of osteoarthritis in the hand. A number of thumb CMC implants have been developed with an aim to improve thumb function and limit postoperative recovery time. This study sought to evaluate clinical and radiological outcomes of Ivory prosthesis with an average of 4 years of follow-up.

Method: Thirty-eight trapeziometacarpal Ivory prosthesis were performed on patients with osteoarthritis by one surgeon in our unit from 2006 to 2014 and reviewed by another surgeon. According to Dell's classification, 18 patients were diagnosed with Type 2 and 19 patients with Type 3 CMC osteoarthritis. The patients comprised 28 women and 4 men, averaging 62 years of age (range: 43–79 years). The dominant hand was involved in 50% of cases. Clinical assessments were performed on patients at their latest follow-up appointments using Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) score and the visual analogue scale (VAS). The range of motion, grip, tip pinch, and key pinch strength of the operated hand were measured and compared to the contralateral hand. Plain radiographs were used for radiological assessment to evaluate osteolysis and implant loosening. Survivorship was assessed using the Kaplan–Meier method with revision surgery as the end point.

Results: At the average follow-up time of 51 months (range: 24–106 months), the mean QuickDASH score was 11.6/100 points and the mean VAS was 0.8/10 points. Further, 97% of patients reported no pain or occasional pain. The average opposition and retropulsion Kapandji scores were 9.9/10 and 2.8/4, respectively. The mean range of motion in flexion–extension was 63° on the operated side and 66.5° on the contralateral side ($p = 0.4$). The mean grip, key pinch, and tip pinch strength were, respectively, 20, 5, and 3.5 kg in the operated thumb, and 20.6, 5.3, and 3.6 kg in the contralateral thumb ($p = 0.7$). There were 12 complications (i.e. 31%) comprising four trapezium implant loosening, two dislocations, four STT overload, and three De Quervain's tenosynovitis. A revision procedure was performed on seven patients (i.e. 18%). The survival rate was 83% and 95% confidence interval [70.7, 96.4] at 4 years. All patients reported being satisfied or very satisfied.

Conclusion: Ivory prosthesis provides satisfactory results in terms of pain relief and function. It is an appropriate option for treating advanced trapezio-metacarpal arthritis; however, the complication rate remains high.

A-0387 Using bone marrow and fat to improve nerve regeneration after autoplasty

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Objective: Recovery of large defects of nerves (over 10 cm) is currently the unresolved problem of trauma, since the time required for regeneration through a defect – place of distal suture – is overgrown with scar tissue.

Methods: The experiment was performed on 40 rabbits (4 groups of 10 rabbits). All of them underwent 1 cm nerve defect, which totaled 3/1 of the length of thigh and corresponds to nerve defects of human – more than 10 cm. Then nerve autoplasty was performed with microsurgical suturing. Group 1 was control. In group 2 was placed suture covered with autologous adipose tissue with platelet-rich plasma. In group 3 suture zone was processed by concentrated bone marrow from the proximal femur. In group 4, the zone was covered with a mixture of bone marrow and adipose tissue. After 30 days, the animals were removed from the experiment to evaluate the results of nerve recovery. To evaluate the quality of nerve restoration histological and biochemical studies of nerve tissue and muscles were held.

Results: In the first control group, the results of all parameters were similar to results of plastics in humans. Histologically, density of nerve fibers was evaluated in 1 mm^3 . In the part of nerve plastic, nerve fibers per 1 mm^3 (in intact nerve: 9601.0 ± 285.5) was 1501.0 ± 121.1 in the first group, 3029.0 ± 206.8 in the second group, 3245.4 ± 200.5 in the third group and 3786.3 ± 210.7 in the fourth group. In control group and in group where transplantation of adipose tissue was performed, sprouting of nerve fibers was not found in the distal fragment; in Group 3, sprouting of nerve fibers was noted and its density was 851.9 ± 54.3 and in group 4 it was even higher – 906.0 ± 54.4 . Protein level was significantly lower in the experimental group than in the control group: in control – 3.77 ± 0.38 ; in group 2 – 2.98 ± 0.22 ; in group 3 – 3.03 ± 0.33 ; and in group 4 – 2.88 ± 0.46 ; rate of intact nerve was $1.99 \pm 0.09 \text{ mg/ml}$. The level of catalase in was as follows: group 1 – 30.33 ± 2.79 ; group 2 – 18.65 ± 1.82 ; group 3 – 22.38 ± 1.13 ; and group 4 – 22.84 ± 1.75 ;

rate of intact nerve was 14.66 ± 0.31 . We performed histological examination to investigate thickness of muscle fibers to determine the level of muscle dystrophy. In intact muscle it was 1484.9 ± 150.8 in the first group, 539.4 ± 37.3 in group 2, 638.5 ± 59.9 in group 3, 559.6 ± 62.0 in group 4 – $966.8 \pm 108.8 \mu^2$.

Conclusions: Significantly better recovery rates of nerve were observed in groups where autoplasty was combined with biotechnology. Best restoration was held in the group which combined bone marrow and adipose tissue. Sprouting of nerve fibers through distal suture was observed only in groups where autoplasty combined with the use of bone marrow, so this technology not only improves quality but also increases the rate of nerve regeneration. In addition, in fourth group there was the lowest level of hypotrophy of muscles.

A-0393 Osteoarthritis in the hand: A comparison between the prevalence and digit involvement patterns in the Western and Asian populations

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Objective: Osteoarthritis (OA) is a chronic, debilitating disease that frequently involves joints of the hands. The aim of this study was to quantify and compare the prevalence of OA between Western and Asian populations, with particular focus on joint-specific prevalence and involvement pattern of hand OA.

Methods: X-ray radiographs from 186 consecutive elderly patients at Khoo Teck Puat Hospital Singapore and 50 consecutive elderly patients at St John's Hospital, Livingston, UK, were retrospectively reviewed. The presence of radiologic osteoarthritic changes via the criteria of Kellgren and Lawrence (K-L), as well as Eaton and Littler (E-L) radiological staging for the first carpometacarpal joint, were recorded. Presence of OA was defined as a K-L score of greater than 2 (presence of osteophytes). Details of patient age, sex, ethnicity, and comorbidities were recorded from patient notes. Exclusion criteria included all patients below the age of 60 years and those with incomplete radiographs of the hand where X-ray images are taken of specific fingers or joints only. Basic descriptive statistics were employed for the purpose of epidemiological analysis.

Results: The prevalence of hand OA in the Singaporean population was higher than that of the British population, with 117 (63%) people showing signs of radiographic OA of at least one hand joint in the

Singaporean population and 25 (50%) in the British population. The mean age of patients evaluated was 73 years and 5 months, with the female gender representing over 60% of both study populations. Radiographs evaluated an equal proportion of consecutive left- and right-handed radiographs. In the Singapore population, presence of OA was highest in those of Indian ethnicity (91%). In the British population, presence of OA was higher in those who were of White Scottish ethnicity (60%) and had two or more comorbidities (74%).

The index and middle finger distal interphalangeal joints (DIPJs) and the first carpometacarpal joint (CMCJ) were the most common joints to develop radiologic OA changes among the British population, in contrast to the first CMCJ (33%) and the thumb interphalangeal joint (47%) in the Singaporean population.

Conclusion: This study suggests a higher prevalence of hand OA in the Asian population, with differing joint-specific prevalence and involvement in terms of radiologic OA compared to a Western British population. It also advocates the inclusion of thumb IPJ and CMCJ, along with the second, third, and fifth DIPJ in the assessment of radiologic hand OA. Such differences are most likely due to cultural, genetic, and environmental factors and highlight the need for further in-depth research worldwide for hand OA with regard to various ethnicities.

A-0394 Diffuse osteomyelitis of the radius with large bone defect: Free fibula versus the membrane-induced technique

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In Type 4 osteomyelitis, segmental bone resection and reconstruction is one of the recommended treatment and sometimes the only option. Literature about the treatment of severe osteomyelitis in the radius is poor. In the last 10 years, we found 1 paper with 11 cases treated with resection and reconstruction with the Ilizarov external fixator, showing 90% of major complications, and 6 other cases in 6 different papers treated with free fibula or free flaps.

We present six cases of diffuse osteomyelitis to the radius with bone destruction. There were six men at a mean age of 49 years (31–64). Three cases were chronic osteomyelitis caused by *Staphylococcus aureus*, one case of acute osteomyelitis caused by *S. aureus*, and two cases caused by *Mycobacterium tuberculosis*. In four cases, the carpus was also affected and the segmental defect to be reconstructed ranged from 7 to 21 cm.

Three patients had the radius reconstructed with a free osteocutaneous fibula. Because of poor donor vessels, three patients had the radius reconstructed with the membrane-induced technique described by Masquelet. All patients healed from both groups eventually healed from infection and consolidate.

In the free fibula group, we observed no complications and the radius consolidated in 3 months. Patients needed an average of 1.5 operations to heal. We did not record any donor site morbidity.

In the Masquelet group, two patients in group needed a realignment of the cemented spacer and two patients had an initial resorption of the graft and needed a new conventional corticocancellous bone graft. Consolidation was observed at an average of 8 months, and the patients needed an average of 3.3 operations to heal. We observed one case of abdominal hernia at the donor site.

For diffuse osteomyelitis of the radius with bone destruction, our first choice is to reconstruct the radius with a free fibula, unless contraindicated. In four cases, involvement of the carpus segmental defect ranged from 7 to 21 cm.

A-0395 The possible influence of Dupuytren's disease on the recovery of knee mobility after total knee replacement

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Objective: There is growing evidence that Dupuytren's disease (DD) might be a manifestation of a more systemic tendency for fibrosis (fibrosis diathesis). We evaluated the possible association role of Dupuytren's chords or nodules and the recovery of motion after total knee arthroplasty as well as frozen shoulder syndrome.

Methods: Patients who underwent a total knee arthroplasty for primary gonarthrosis at more than 50 years of age were examined 1 year postoperatively. The range of motion (ROM) of the knee was measured and compared to the ROM at 6 weeks, mentioned in the patient's chart. Additional measures and procedures to gain motion postoperatively were also recorded as well as risk factors for postoperative stiffness. Palmar cords, nodules, or finger contractures were recorded, and risk factors associated with increased severity and risk of recurrence of Dupuytren's contracture were retrieved. Frozen shoulder syndrome was diagnosed by anamnesis of shoulder pain and clinical examination. Student *t* test was used to evaluate statistically significant differences between continuous

variables, and χ^2 testing was used to evaluate distribution of nominal variables between the two groups.

Results: We included 61 patients with a mean age of 71.7 years (± 9.2). There were 13 men and 48 women (79%). Twenty-five (41%) patients showed clinical signs of DD, and the non-DD consisted of 36 (59%) patients. The difference in ROM between the two groups was not significant at 6 weeks after surgery ($p = 0.8198$) nor at 12 months after surgery ($p = 0.1489$). When comparing the need for additional procedures, we found that in the non-DD group, only one patient had additional physiotherapy for an extension deficit during the rehabilitation, and no patients underwent a manipulation under anesthesia (MUA). In the DD group, however, two patients underwent MUA and two patients had additional physiotherapy compared to the normal protocol. In both the groups, 6 patients met our criteria of frozen shoulder, which meant 32% in the DD group and 16% in the non-DD group. This difference was also significant ($p = 0.0446$)

Conclusions: Although we were unable to detect a significant difference in the ROM between patients with and without signs of DD, significantly more patients in the DD group needed additional physiotherapy or MUA to achieve the same ROM compared to the non-DD patients. This might indicate a possible connection between DD and postoperative stiffness of the knee. This would mean that by examining the hand for DD, patients with more difficulty to regain ROM postoperatively could be identified. This would enable the surgeon to adapt the postoperative rehabilitation protocol for these patients.

Another interesting finding is the significantly higher prevalence of frozen shoulder syndrome in patients diagnosed with DD. This is yet another argument in support of the supposed influence of fibrosis diathesis on joint stiffness.

A-0401 Angiotomographic study of the circumflex lateral femoral circumflex artery system applied to the anterolateral thigh flap

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Objective: This study's goal is to identify the lateral femoral circumflex artery system and its anatomic variations through computerized angiotomography and classify it. We also aim to establish differences

between genders and differentiate sides in the same patient.

Methods: Inferior limb angiotomographies of 181 thighs were used. Images were reconstructed in three-dimensional models from axial cuts. The irrigation pattern was classified according to findings described in Lakhiani et al's paper.

Results: Classic anatomy was the main finding. Types 6 and 12 were not found in the researched population. In 41 thighs, the irrigation pattern did not match any type described previously by Lakhiani et al.

Conclusion: Lakhiani's type 1 was the most frequent, and 10 new types were described. There was no gender difference and correlation between arterial irrigation from both thighs in the same individual.

A-0402 Anatomical study of distal radius and comparison with volar locking plates

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Objective: To evaluate, by analyzing distal human cadaveric radii, volar cortical angle (VCA), the variation in the lateral and intermediate columns, the shape and pattern of the watershed line (WL) of the distal radius, and its correlation with locking volar plates available.

Methods: Twenty-seven human cadaveric radii of department of morphology of the institution, and nine locking volar plates of six different companies were analyzed. With the aid of calipers, metallic contour gauge, and AutoCad 2015® software, the VCA was measured from the lateral and intermediate columns and their repectives on the plates as well as comparing the relief of distal third and plates.

Results: Volar cortical angle varied between columns of the distal radius extremity, and the average in the lateral side column was 153.40° and 146.06° in the intermediate. Four of the nine plates used in this study showed no variation in its volar angulation. In the WL analysis, we compared the standard format found on pieces and its equivalent on the plates and divided into four types: biconvex, convex, ulnar convex, and plain. Of 27 radii, 13 showed convex pattern and 12 had biconvex, while most of the plates (7 of the 9 analyzed) were biconvex drawing.

Conclusion: There was no congruence between the plates and the anatomy of the radii, given that all plates showed volar cortical angle greater than the average found in the anatomical pieces. The Synthes® plate had the best anatomical fit.

A-0406 Ultrasonographic Examination of the Anatomical Variation in de Quervain's Disease

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Objectives: The purpose of this study was to address usefulness of ultrasonography in determining the presence of intracompartmental septum and aberrant slips of APL in de Quervain's disease and analyze the reliability of examination.

Methods: Between March 2014 and October 2015, a total 26 patients (28 wrists) with clinical diagnosis of de Quervain's disease, preoperative examination using ultrasonography, and surgical release of first extensor retinaculum were included. Transverse scan with high-frequency 16.0 MHz linear transducer was performed by one musculoskeletal radiologist and one hand surgeon at three sites: between 1 and 2 cm proximal to radial styloid process, between 1 cm proximal to radial styloid and tip of styloid process, and between 1 and 2 cm distal to radial styloid process. The presence of intracompartmental septum and the shape of the groove for extensor pollicis brevis (EPB) were evaluated at proximal two sites, and aberrant slips of APL were assessed at the distal site. Surgical findings were used as the reference standard, and reliability was analyzed using intraclass correlation coefficient (ICC).

Results: An intracompartmental septum was present in 24 (85.7%) cases and absent in 4 cases. Incomplete septum was present in 7 (29.2%) of 24 cases. Ultrasound was accurate in diagnosing a septum in 23 cases with 1 case that was not visualized due to an incomplete septum. In determining the presence of an intracompartmental septum, the sensitivity of the ultrasonographic examination was 95.8% [95% confidence interval (CI), 78.9%~99.9%], the specificity was 100% [95% CI, 39.8%~100%], the positive predictive value (PPV) was 100% [95% CI, 85.2%~100%], and the negative predictive value (NPV) was 80% [95% CI, 28.4%~99.5%]. The groove for EPB was found in 24 cases during ultrasonographic examination, and the groove was shallow in 16 cases and deep in 8 cases. Almost patients with the groove for EPB had intracompartmental septum. However, there was no septum in one case of shallow groove and incomplete septum in one case of no groove.

Aberrant slips of APL were found in 25 (89.3%) cases. Ultrasound was accurate in determining the aberrant slips of APL in 23 cases, with complete assessment of number of slips in 19 (76%) cases. In prediction of the aberrant slips of APL, the sensitivity of ultrasonographic examination was 92% [95% CI, 74%~99%], the specificity was 66.7% [95% CI, 9.5%~99.2%], the PPV was 95.8% [95% CI, 78.9%~99.9%], and the NPV was 50% [95% CI, 6.8%~93.2%].

The ICC for intraobserver reliability was 0.94 ($p < 0.001$) and 0.75 ($p = 0.002$) for the intracompartmental septum, 0.86 ($p < 0.001$) and 0.83 ($p = 0.015$) for the shape of groove for EPB, and 0.75 ($p = 0.002$) and 0.55 ($p = 0.065$) for the aberrant slips of APL in the hand surgeon and the musculoskeletal radiologist, respectively. The ICC for interobserver reliability was 0.75 ($p = 0.002$) for the septum, 0.75 ($p = 0.003$) for the shape of groove for EPB, and 0.65 ($p = 0.029$) for the aberrant slips of APL.

Conclusions: Ultrasonography was useful to determine the presence of intracompartmental septum and the aberrant slips of APL. Further study is needed to improve the interobserver reliability of the examination.

A-0412 Ultrasonographic evaluation of the flexor tendons in function of volar plate positioning and pronator quadratus repair on cadaveric models

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Flexor tendon injury is a potential complication after volar plating of distal radius fracture due to the friction of the flexor tendons and the prominence of the volar plate. The flexor pollicis longus (FPL) tendon is most at risk.

To assess the risk of flexor tendon injury, we evaluated with ultrasonography in 17 cadaveric hands (12 males and 5 females; mean age 77.1 years with range of 45–94 years) the distance between the FPL and the most volar prominence. If direct friction between the FPL and the prominence occurred, possible bulging of the FPL tendon over the prominence was also measured. This assessment was performed with and without the pronator quadratus (PQ) muscle sectioned. This was repeated with a volar plate (volar plate 2.4 double column plate; Synthes) fixed proximal to the watershed line, with a volar plate fixed distal to the watershed line, and an LCP volar rim distal

radius plate (Synthes) and a low-profile volar hook plate contouring the volar rim. Statistic analysis was performed with paired *t* test ($p < 0.05$).

Mean distance from the FPL to the volar prominence (volar rim) decreased statistically significantly when PQ was sectioned (0.3 mm) versus an intact PQ (1.5 mm). Besides, mean distance also decreased statistically significantly when a volar plate was fixed, even proximal to the watershed line with an intact PQ (0.4 mm) compared to no plate placed. Mean distance decreased statistically significantly when the volar plate was placed distal to the watershed line (-0.2 mm) versus proximal to the watershed line. Frequently (53%) bulging of the FPL over the prominence of the plate occurred when volar plate was placed distal to the watershed line. When volar plate was placed proximal to the watershed line, mean distance also decreased statistically significantly when the PQ was sectioned (0.1 mm) vs an intact PQ. Identical result was obtained when volar plate was placed distal to the watershed line, since mean distance also statistically significantly decreased when the PQ was sectioned (-0.5 mm) versus an intact PQ. FPL bulging incidence increased to 76%. Finally, mean distance did not differ statistically significantly ($p > 0.05$) when volar rim plate was fixed contouring the volar rim (-0.1 mm range 0) versus a plate distal to the watershed line, although statistically significant increase was measured when volar rim plate was placed with PQ repaired versus sectioned (-0.4 mm).

Ultrasonography is a possible technique to evaluate possible friction between the flexor tendons and the volar plate prominence. Our results suggest the importance of correct positioning of the volar plate proximal to the watershed line and the repairing of the pronator quadratus to increase the distance from the flexor pollicis longus tendon to the volar prominence. Direct friction or bulging of the flexor tendons occur frequently when plates are placed distal to the watershed line. Clinical studying with ultrasonography is necessary to correspond these flexor tendon friction or bulging reported on ultrasonography with clinical symptoms of flexor tendinopathy and to view the sustainability of pronator quadratus repair over time.

A-0414 Joint reconstruction with free vascularized osteochondral transplantation

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Purpose: To introduce a reconstructive method in major joint defect of upper extremity with free vascularized bone and joint transplantation.

Materials and methods: We studied 16 cases of joint reconstruction with free vascularized fibular head or metatarsal joints. Affected joints were 12 wrists, 3 shoulders, and 1 elbow joint. Average age of the patients was 12.3 years (range: 3–34). Average follow-up period was 6.3 years (range 1–16 years). The etiologies of the joint defect were seven traumatic, three infection sequel, three congenital, and three tumorous conditions. Donor bone and cartilage of this transplantation surgery were 15 fibular head with metaphysis and 1 case of double metatarsal joints transplanted to the elbow joint. We evaluate the joint conditions and fate of the transplanted osteochondral parts during follow-up period with serial radiographic study and functional evaluation of the joints.

Results: Transplanted bony portion united to recipient bone within 5 months in all cases (average 4.8 months, range: 3.2–8.3 months). The articular cartilage of the donor bone survived with expectable outcome in 13 cases, and maintained continuous growth potent was observed in children in both volume and length of the bone and cartilage. Adoptive changes in the transplanted osteochondral part were observed in 13 cases. In the case of elbow reconstruction with double metatarsal joints, transplantation had persistent lateral instability and weakness of joint power was revealed.

Conclusion: Free vascularized osteochondral transplantation to the defective joint portion in major joints in upper extremity can utilize as one of the most challenging methods in profound joint lesions that has no effective solutions with conventional modalities. The proximal osteochondral part of the fibula can serve as a very effective donor in this procedure. Free vascularized metatarsal joint transplantation to the elbow joint could not give sufficient stability although double metatarsal joints were transplanted.

A-0424 Trapeziectomy with ligament reconstruction and tendon interposition using the FCR tendon versus using an allograft: A randomized controlled trial

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Objective: Trapeziectomy with ligament reconstruction and tendon interposition (LRTI) is usually performed using the flexor carpi radialis (FCR) or abductor pollicis longus (APL) tendon as interpositional material. An alternative to secure the tendons is

to use an allograft (GraftJacket, Wright Medical Technology, Inc., Arlington, TN) as suspension–interpositional material. There are a few studies investigating the use of GraftJacket for treating trapeziometacarpal osteoarthritis (TMC-OA) with promising results. However, there is no evidence which method is superior regarding the outcome. The objective of this study was to compare the use of the FCR-tendon for trapeziectomy with LRTI versus using a GraftJacket.

Methods: Sixty patients with TMC-OA scheduled for trapeziectomy with LRTI were randomized into two groups: In group A, the FCR-tendon was used as suspension–interpositional material, whereas a GraftJacket was used in group B. The surgical technique was chosen according to a modified Weilby's technique. In the GraftJacket group, the free allograft was sutured to the FCR tendon as close to its insertion on the second metacarpal base as possible and then used as the FCR tendon strip. All patients were assessed prior to and 6 months after the surgery. They filled out the Michigan Hand Outcomes Questionnaire (MHQ). Furthermore, key pinch and grip strength were assessed.

Results: Group A (FCR tendon) included 29 patients, whereas 31 patients were randomized to group B (GraftJacket). Patients in both groups showed significantly improved MHQ scores after 6 months compared to baseline (group A: 51 at baseline to 83 at 6 months, $p \leq 0.001$; group B: 53–76, $p \leq 0.001$). Furthermore, grip strength improved from 19.3 to 22.0 kg in group A ($p = 0.05$) and from 19.5 to 21.4 kg in group B ($p = 0.05$). No relevant change in key pinch strength was observed in both the groups ($p > 0.05$). The between-group comparison showed no statistical significant differences for all variables neither at baseline nor at 6 months ($p > 0.05$).

Conclusions: Our results indicate similar outcomes for using the FCR tendon or a GraftJacket for trapeziectomy with LRTI. Therefore, the GraftJacket seems to be an interesting alternative if the use of autologous tendon is contraindicated. However, the cost aspects have also to be considered and analyzed in further studies.

A-0458 Silicone arthroplasty versus screw arthrodesis in distal interphalangeal joint osteoarthritis

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Objective: Arthrodesis is widely accepted as the standard treatment in osteoarthritis of the distal interphalangeal joint (DIP). Functional deficits have been

rated as minor; however, some patients do complain about impaired fine motor skills. The hypothetical advantages of an arthroplasty include preservation of joint function and avoidance of the potentially disturbing approach at the fingertip when using a screw. The aim of the study was to evaluate the subjective functional difference between screw arthrodesis and silicone arthroplasty of the DIP.

Methods: Patients with primary osteoarthritis of the DIP seeking operative treatment were enrolled. Based on the radiographic and clinical findings, the surgeon proposed either a silicone arthroplasty using a Swanson implant or a lag screw arthrodesis. Contraindications for arthroplasty included deficient bone stock, gross deformity, and instability. Before surgery and at 3, 6, and 12 months postsurgery, patients rated their pain during daily activities and completed the Michigan Hand Questionnaire (MHQ) and the Disabilities of the Arm, Shoulder and Hand Outcome Questionnaire (DASH). Additionally, the range of motion (ROM) was measured in the arthroplasty group. Standard anterior–posterior and lateral radiographs were taken.

Results: We included 45 patients (37 females and 8 males; 70 DIP joints) with a mean (standard deviation [SD]) age of 65 (9) years. Fifty-six screw arthrodeses and 14 silicone arthroplasties were performed. Patients reported a 1-year mean (SD) pain level of 3.9 (3.5) in the arthroplasty and 2.9 (3.0) in the arthrodesis group, respectively, both with a significant improvement compared to preoperative ($p \leq 0.05$).

One year after surgery, both groups showed improved scores for the MHQ (arthroplasty: 56 at baseline to 75 at 12 months, $p = 0.028$; arthrodesis: 57 at baseline to 70 at 12 months, $p = 0.000$) and DASH (arthroplasty: 34 at baseline to 19 at 12 months, $p = 0.091$; arthrodesis: 35 at baseline to 29 at 12 months, $p = 0.002$) compared to preoperative. The mean change in score from final follow-up to baseline between groups was slightly higher for the MHQ ($p = 0.187$) and significantly higher for the DASH ($p = 0.048$) in the arthroplasty than in the arthrodesis group. The active ROM showed no significant difference 1 year after surgery in the arthroplasty group, and the mean extension lag was 10°. One screw failure and one nonunion were observed in the arthrodesis group.

Conclusion: Our results indicate similar subjective outcomes for arthroplasty and arthrodesis. Patients treated with an arthroplasty showed good active motion and high overall satisfaction. The small number of patients considered eligible for arthroplasty reflects a limited role in the treatment of DIP osteoarthritis; however, in selected patients with good osseous and ligamentous prerequisites, it is an interesting alternative to joint fusion.

A-0464 Walant and ultrasound-guided surgery: A new fast track treatment of carpal tunnel syndrome

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Carpal tunnel syndrome is commonly treated by a mini-open or endoscopic procedure. It has been demonstrated that an ultrasound guidance permits assessment of a precise anatomical diagnosis in of the carpal tunnel, avoiding nervous lesions and controlling the complete release of the median nerve.

The aim of this study is to evaluate the feasibility and the advantages of a wide awake technique and thus to validate an original ultra fast track procedure for patients who suffer carpal tunnel syndrome.

In a prospective study, 350 people (55 men and 295 women, with a mean age of 62 years) were treated between June 2014 and June 2015 with an ultrasound-guided percutaneous procedure by 2 surgeons. All patients had a clinical examination and a conduction study. The procedure has been performed for all patients with a modified wide awake protocol of anesthesia (local anesthesia with epinephrine, associated with a median nerve blockade at the wrist) and without tourniquet named WALANT (Wide Awake Local Anesthesia with No Tourniquet). None received a sedation. The carpal release was performed with a Kemis® knife (NewClip Technics™, France). The progression of the knife was controlled with the high-frequency ultrasound probe (6–15 MHz). A picture of the knife through the retinaculum was taken as evidence of the complete release. All patients go directly to the nursing ward and are allowed to leave this unit after 15 min. Time to leave the unit of hand surgery was noted.

Results: All patients have had a good clinical result. None of them complained of any pain during the procedure. There was no nervous injury. All the clinical parameters were same compared to traditional carpal tunnel release. None of the patients complained about reflex sympathetic dysrophy. The mean duration time to leave was 32 min (15–68).

In conclusion, the study emphasizes that ultrasound-guided carpal tunnel release is a safe method. Moreover, this surgery may be done without tourniquet and with a limited anesthesia. Patients had an immediate functional recovery of the hand which allowed to spend a very short time in the day surgery ward. Further study could be assessed to point out the possibility to drastically reduce the cost of the carpal tunnel syndrome with the use of an ultra fast-track procedure allowed by ultrasound-guided surgery with wide awake plus approach.

A-0467 A novel laser-activated biopolymer adhesive film for sutureless epitendinous repairs: An ex vivo comparison on porcine deep flexor tendons

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Purpose: Laser-activated biopolymer adhesives have recently emerged as an alternative for joining of tissues in fields of reconstructive surgery. This study investigates the use of a novel adhesive biopolymer foil for the use of tendon repairs.

Methods: In an ex vivo laboratory experiment, porcine deep flexor tendons were repaired by either (1) simple circumferential suture epitendinous repair + Adelaide core repair or (2) sutureless biopolymer adhesive epitendinous repair + Adelaide core repair. Polymer samples of 2.5 × 2.5 cm were adhered to porcine tendons by laser activation from an infrared diode laser (GaAlAs diode).

Tensile testing was conducted using an Instron-5543 (Canton, USA) biomechanical testing machine. Tendons were gripped in pneumatic clamps with 4-cm spacing before being separated at a constant distraction rate. Tensile testing analyzed total tensile strength, maximum load, and load at clinical failure (2 mm gapping force).

Results: Sutureless biopolymer-supported Adelaide repairs provided similar maximum load to failure stability when compared to conventional circumferential suture-supported Adelaide repairs. Sutureless biopolymer-supported Adelaide repairs showed greater average loads at clinical failure (2-mm gapping force) when compared to conventional circumferential suture-supported Adelaide repairs.

Conclusion: Laser-activated biopolymer films could present a potent alternative for conventional-sutured circumferential tendon repairs in the future.

A-0468 Hyperselective neurectomy in the treatment of upper limb spasticity: A prospective study

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Objective: Selective neurectomy ('hyponeurotization') advocated by Brunelli since 1983 has not gained much popularity in the treatment of the spastic upper limb, with a general perception that recurrence

is frequent. In light of our recent anatomic studies involving 96 cadaver dissections, new guidelines have been described, and we have conducted a prospective study in order to reevaluate the results of this treatment.

Methods: A prospective study has been performed over a 2-year period on 20 spastic patients undergoing 22 selective neurectomies. Indication of this technique was muscle spasticity, exclusive of muscle contracture. Patient selection was based on repeated clinical examination and the results of preoperative botulinum toxin injections.

Hyperselective neurectomy (HSN) consisted in individualizing each motor branch for the target muscle(s) at the neuromuscular junction. Preoperative nerve stimulation was used in all cases. Then at least two-third of each of these motor branches was resected.

Pre- and postoperative assessment was based on spontaneous limb position, active and passive motion, and muscle strength (MRC scale). Spasticity was evaluated with the modified Ashworth and the Tardieu scales. Functional results were evaluated with the House score and an ADL questionnaire. Patient satisfaction was rated according to the visual analogue scale.

Results: Twenty spastic patients were enrolled in this study (22 surgeries). The etiology of spasticity included nine cerebral palsies, eight strokes, two head injuries, one surgery for intracranial tumor. The average age at surgery was 33 years old (12–59). All patients had previous botulinum toxin injections (1–12).

HSN involved 63 muscles (11 biceps, 11 brachialis, 4 brachioradialis, 10 FCR, 8 FCU, 5 PL, 7 pronator teres, 2 teres minor, 2 supraspinatus and 2 infraspinatus, 1 pectoralis major), amounting to 2.9 neurectomies per surgery. Associated procedures were performed simultaneously in 11 cases, 24 muscle lengthening, 1 first web opening, and 1 interosseous membrane liberation.

Complications involved one hematoma in a patient treated with Coumadin, and one bilateral failure of the procedure (shoulder), probably due to a technical error.

After a mean follow-up of 10 months (1.5–20), spontaneous position, which was recorded for the elbows, improved from 97° to 40°, active motion of the involved joints improved by 19.4°, and passive motion by 15°. Spasticity decreased from 1.9 to 0.4 on Ashworth scale and from 45.6 to 8.5 on Tardieu scale (V1–V3). Loss of strength was minimal, from 4.1 to 3.8. The house functional score increased from 2 to 3.1. Patient satisfaction averaged 6.9 of 10. In the six cases with a follow-up longer than 12 months (average 17.5 months), results have remained stable over time.

Conclusions: Although spasticity is difficult to evaluate, our results have been promising, showing effective reduction in spasticity and improved motion, with minimal loss of strength, and some functional gain. These results have remained stable over time in the middle term.

**A-0469 Dupuytren's contracture
Tubiana's grades 3 and 4 treatment with
mini-invasive techniques in two steps:
Progressive Distraction with dorsal
external fixator and collagenase injection**

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Summary: It is possible to downgrade Dupuytren's disease (DD/contracture) stage 3–4 (Tubiana) using a percutaneous transarticular external fixator via dorsal approach. This can be followed by a minimally invasive collagenase injection, without surgical approaches, few risks, and excellent results.

Materials and methods: From August 2014 till December 2015, we performed 15 implantations of external fixator 'mini-FLO®' (CITIEFFE®) in 12 patients affected by DD: 7 in stage 4 and 8 in stage 3. In seven cases, it was interested the V ray, in six the IV ray, and in two cases the III ray. The implanted device is a transarticular monoaxial articulated external fixator with a dorsal mounting. It requires two self-drilling pins for each flexed bone segment, applied with percutaneous transtendon approach in local anesthesia. All the patients were trained to begin the distraction acting autonomously on the device. During the follow-up correction grade, skin conditions, pain, tolerance, and possible adverse reactions have been monitored. In the end of the treatment, the external fixator was removed nonoperatively. In every case, a collagenase injection was performed, followed by a treatment with a thermoplastic dynamic dorsal splint.

Results: The average duration of treatment with external fixator was 19 days (15–22), with an excellent patient compliance. All patients have been treated in the second step with an injection of *Clostridium histolyticum* collagenase, obtaining a further correction and avoiding any damage to soft tissues.

Discussion: The treatment of DD advanced stages remains nowadays a hard challenge even for the most skilled surgeon. The treatment protocol we improved has been giving satisfying preliminary results both

for patients and for surgeons. The dorsal articulated external fixator allowed a progressive, painless, and controlled correction, tolerated by patients, effective, and with undoubted advantages. A regression of 2 or 3 stages of the disease was observed in every patient. The second step with collagenase injection allowed an additional improvement in the results with a non-operative, modern, and safe technique even in the most severe cases. It must be remarked that the progressive opening obtained using the external fixator could be performed, where needed, with any other secondary technique. Due to limited sample extension and short follow-up, it is not possible to draw significant statistical evidence about recurrence rate. The two-step method permits to treat the most advanced grades of DD, with a percutaneous and minimally invasive technique, totally covered by Italian Nation Health Service. The achieved results drive a valid noninvasive option to traditional riskier techniques associated with a high complications rate.

A-0470 Has the mode of operative treatment an effect on the incidence of CRPS in distal radius fracture

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Background: Fractures of the distal radius may cause complex regional pain syndrome in 1%–37% of cases. Factors common to those who develop CRPS include onset at third to fourth week postcast removal, female gender, tight casts, and repeated reductions without sufficient analgesia.

Methods: A retrospective review of distal radius type CRPS patients who were eligible for inclusion through applying the criteria of Veldman and Gorise (4 of 5 of the following present at the wrist/hand/fingers), and they occurred (or increased) after activity: (1) unexplained diffuse pain, not in normal relation to the stage of fracture treatment; (2) difference in skin color relative to the other hand and wrist; (3) diffuse edema; (4) limited active range of motion of the wrist and fingers, unrelated to the stage of fracture treatment; and (5) difference in skin temperature relative to the other hand and wrist.

Results: Eighty patients were initially described as having CRPS in distal radius fractures based on a review of charts from 2005 to 2015. Of these patients, 35 were excluded as they either did not meet the eligibility of Veldman/Gorise (28) or went on to have an alternative explanation for their symptoms at a time in the future (7). Forty-five patients were remaining.

Three groups existed: conservative management with cast, K wiring, and open reduction internal fixation. Fractures were classified according to the AO classification. There was a trend toward a higher incidence of CRPS in patients who underwent K wiring. CRPS was more common in the more severe fracture types and in females. The average time of onset was in keeping with international norms. The diagnosis of CRPS increased from 2005 to 2015; however, this was not statistically significant.

Conclusion: CRPS should remain a diagnosis of exclusion. There was an overdiagnosis in our series whereby the criteria were not fulfilled. There was a trend toward an increase in CRPS in patients treated with K wiring over open reduction internal fixation. At-risk groups included females aged 45–60. Early identification can limit the morbidity associated with CRPS through early physiotherapy. It is important to keep the diagnosis under review, as an alternative pathology may be emerging as was found in this series.

A-0472 Radioulnar immobilization in DRUJ instability post distal radius fractures

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Objective: Our objective is to evaluate the results in the treatment of clinical acute distal radius ulna joint (DRUJ) instability associated with distal radius fractures (DRF) treated by open reduction and internal fixation (ORIF) and pronation-supination blocking for DRUJ unstable patients.

Methods: This study is a case series of 20 patients with distal radius fracture and associated DRUJ instability assessed by intraoperative positive ballottement wrist test after reduction and stabilization of the DRF by a volar plating system. The patient population was in average 43 years of age and receiving Workers Compensation. The forearms remained in neutral rotation and fixed with a radioulnar Kirschner wire for 4 weeks having an average follow-up time of 5 years and 4 months. Patients were clinically assessed for DRUJ stability; visual analogue scale (VAS; for pain and level of patient satisfaction), grip and pinch strength, Quick Disability of the Arm, Shoulder and Hand (Quick DASH) score, and magnetic resonance imaging of the wrist (MRI) were also evaluated postoperatively.

Results: Eighty-five percent of the patients had a postintervention clinically stable DRUJ (median of 53.5 months); 73.3% of patients showed healing of the triangular fibrocartilage complex (TFCC) on

magnetic resonance imaging. The average VAS of pain and satisfaction were 2.35 and 8.35, respectively. The grip strength and pinch strength were 75.86% and 86.91%, respectively. The average of Quick DASH score at the end of the follow-up was 23.75. No secondary TFCC repair was performed in clinically DRUJ stable patients.

Conclusions: In acute DRUJ instability secondary to distal radius fractures, intraoperative pronation-supination blocking was associated with stable DRUJ in most cases after 4 weeks of immobilization of the DRUJ with radioulnar Kirshner wires. The TFCC repair was not performed subsequently on DRUJ clinically stable patients. Further studies of higher evidence level are recommended.

A-0474 3D printed replica of distal radius fractures

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Introduction: Three-dimensional (3D) printing, also known as additive manufacturing or ‘rapid prototyping’, is a low-cost technology that uses a 3D computer representation to create solid objects from a feed-stock material. In this study, we present our initial experience preparing and using 3D printed models of the bony anatomy of distal radius fractures, and we describe a way to qualitatively quantify their effect on surgical planning and patient information.

Materials and methods: From November 2014 to November 2015, 30 patients affected with a distal radius fracture eligible for surgery were enrolled. After the computed tomography scan to study the fracture pattern, the 3D Reconstruction of the radius was exported to STL file which is widely used for rapid prototyping. The 1:1 realistic replica of the fractured bone was evaluated by the surgeons for surgical planning and was used to illustrate fracture morphology and surgical technique to the patient. A simple questionnaire was used to obtain feedback.

Results: Patients reported an enthusiastic general appreciation about the use of this new technology in our hospitals. There was a substantial improvement in comprehension of the fracture before and after seeing the 3D printed models. While surgical planning was not changed after checking the 3D printed models, the plates selected during preoperative planning fitted perfectly during the operation.

Conclusions: A 1:1 3D printed model of articular radius fractures provides an additional tactile and visual experience, increasing the appreciation of articular surface gaps of ≥ 2 mm with severe displacement of bony fragments. These models are important for patient communication to complete the surgical consent and could be used to reduce costs of surgery.

A-0479 How to prevent iatrogenic Extensor pollicis longus tendon rupture in distal radius fractures treated by volar plate

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Objective: Rupture of extensor pollicis longus (EPL) tendon can occur after distal radius fractures (DRFs) as a consequence of attrition on bone fragments but also for iatrogenic factors such as drilling or dorsal screw protrusion of a volar plate. We aimed at finding effective strategies to prevent iatrogenic lesions of EPL tendon when treating DRFs with volar LCP plates.

Methods: We reviewed the clinical records of all the patients who underwent volar plating of DRFs at our institution from January 2005 to August 2015 in order to detect and analyze any case of EPL tendon rupture. All available patients were evaluated by an interview at the time of this study. For the patients treated after January 2010, we adopted the following strategy for preventing EPL tendon rupture: (1) preoperatively, accurate clinical and radiographic evaluation of Lister tubercle zone for planning an additional dorsal approach to explore the third extensor compartment in suspect cases; (2) intraoperatively, cautious drilling of the dorsal bone cortex and fluoroscopic control of screw length and location in different views (obliques, facet views, and axial); and (3) postoperatively, close clinical monitoring for detecting early tendon ruptures during the first months; the patients were also advised to pay specific attention to pain or swelling at the dorsal side of the wrist for detection of delayed ruptures. Ultrasound examination was performed when partial/complete rupture or irritation of the tendon was suspected. We compared the incidence of EPL lesions in two groups of patients: group A including the patients treated before January 2010 (i.e. without prevention strategy), and group B after January 2010.

Results: A total of 614 wrists in 612 patients underwent volar plating for DRFs: Group A included 151 patients with 151 wrists and group B 463 patients with 465 wrists. Of the 612 patients, 530 (86.6%) were available for the interview: 128 (84.8%) of 151 in group A with a follow-up of 63–127 months, and 402 (86.8%) of 463 in group B with a follow-up of 3–62 months. In group A, six complete EPL tendon ruptures and two partial lesion at risk of rupture were detected (6.3%); no tendon ruptures or lesions were detected in group B. The complete ruptures were treated with tendon transfer from the second finger, while the partial lesions (one caused by a prominent screw and one by a bone fragment) were explored and treated with hardware removal and tenolysis. All the EPL tendon lesions occurred in young patients (mean age of 32 years) and within 1 year after surgery.

Conclusions: Plating of DRFs has become one of the most common procedure performed by orthopedic surgeons, and it is necessary to highlight the potential risks related to this operation. In the authors' experience, some simple and reproducible actions aimed at preventing early iatrogenic EPL tendon ruptures proved to be effective. The adoption of this strategy, which implies the patient's awareness and compliance, is therefore advisable for reducing the risk of this complication and for allowing a more prompt recognition and treatment in case it occurs.

A-0483 Morphological type of the lunate seems to affect surgical outcome of the distal radius fracture

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Objective: Previous literature described that the wrist with type II lunate might be stiffer than the wrist with type I lunate. The aim of current study is to compare surgical result of the distal radius fracture treated with volar locking plate (VLP) between two groups divided by the type of lunate. The hypothesis is that the wrist with type II lunate might have worse surgical outcome of distal radius fracture.

Methods: From June 2013 to July 2014, sixty-seven patients with surgically treated distal radius fracture using VLP were included in the current study. All subjects were performed computed tomography (CT) preoperatively. Classification of the lunate type is analyzed with simple radiograph and CT scans by

two independent observers. Type I is defined as the lunate with no articulation with the hamate, and type II is defined as the lunate with accessory articulation with the hamate. The surgical outcome of the distal radius fracture is assessed with the Disabilities of the Arm, Shoulder and Hand score and the modified Mayo Wrist Score at final follow-up. Range of motion (ROM) of the wrist joint and grip strength were also measured at final follow-up and recorded with the proportion to the contralateral side. Interobserver measurement reliability was analyzed with the Cohen's κ value. Diagnostic value of simple radiograph to identify the type II lunate was calculated based on CT image as the reference standard. All the subjects were divided into two groups according to the type of lunate, and the two groups were compared. Multiple logistic regression analysis was done to find predictors of worse surgical outcome of the distal radius fracture.

Results: Mean age of the subjects was 53.66 (17–74) years. Mean follow-up was 14.54 (12–52) months. The proportion of the type II lunate was 43.4% (95% confidence interval = 32.1–55.2). Both CT and simple radiographs have high interobserver measurement reliability (Cohen's κ = 0.88 and 0.81, respectively). Simple radiograph has high diagnostic value in identifying type II lunate (sensitivity = 82.8% and specificity = 97.4%). The mean flexion of the wrist joint was significantly lower in the group with type II lunate (96.4% vs. 86.7%, p = 0.002). The mean extension of the wrist joint was also significantly lower in the group with type II lunate (94.8% vs. 88.9%, p = 0.028). In multiple logistic regression analysis, the predictors of worse flexion of the wrist joint were the type II lunate (odds ratio = 6.156, p = 0.010) and abnormal volar tilt angle at final follow-up (odds ratio = 5.494, p = 0.027).

Conclusions: The wrist joint with the type II lunate shows significantly lower wrist joint ROM compared to the wrist with the type I lunate after surgical treatment of the distal radius fracture using VLP. Patients with the type II lunate on their preoperative images should be concerned about their postoperative ROM of the wrist joint.

A-0484 The risk factor for refracture following implant removal of pediatric diaphyseal forearm fracture

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Objective: The risk factors for refracture following implant removal in pediatric patients who underwent surgery for diaphyseal forearm fracture has not been clarified. The aim of this study is to detect risk factors for that unfavorable complication.

Methods: From January 2008 to September 2014, a total of 47 pediatric patients who underwent surgery for diaphyseal forearm fracture in our institution were included. We retrospectively corrected data of patient's characteristics and surgical outcome from stored records. Patients were divided into two groups according to the surgical procedure (Group C: closed reduction and percutaneous pinning, $n = 27$ vs. Group P: plate fixation, $n = 20$). We performed univariate analysis between two groups about clinical factors and surgical outcome. Moreover, we stratified those two groups according to the incidence of refracture and compared each group by the clinical factors including X-ray findings in order to find risk factors for surgical outcome.

Results: In patient's background, 47 cases were boys and 4 cases were girls. Twenty-seven cases were categorized into Group C and 20 cases were in Group P. Average age at the time of injury was 8.0 years for Group C and 12.5 for Group P. All implants were removed after initial surgery and average term from the time of initial surgery to removal was 27 days in Group C and 213 in Group P. Average observational term was 202 days for Group C and 315 for Group P. Refracture cases were five (18.5%) in Group C and two (10%) cases in Group P. When stratified by the incidence of refractures in each group, Group C demonstrated higher age at the time of initial operation (refracture: 9.2 years vs. nonrefracture: 7.7) compared to Group P (refracture: 13.0 years vs. nonrefracture: 12.4). However, that difference was not statistically significant (Group C: $p = 0.27$, Group P: $p = 0.51$). Although X-ray findings (location of fracture, bone type, and pattern of fracture) were not related to refracture ($p = 0.79, 0.72, \text{ and } 0.43$), all types of initial fractures were transverse fracture.

Conclusion: Transverse fracture and percutaneous pinning for older pediatric patients may become a risk factor for refracture after surgery.

A-0486 Percutaneous screw fixation of non- or minimally displaced scaphoid fractures: Results of 90 cases

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Non- or minimally displaced scaphoid fractures (types A2, B1, and B2 according to Herbert) are the most common fracture of the carpalia. They are generally treated with 8–12 weeks of cast immobilization with 88–95% union rate. To avoid prolonged period of immobilization, the surgical technique of percutaneous screw fixation is becoming more popular. Several studies suggest earlier return to work and sports after surgery and even shorter healing time. However, the preferred treatment is still debated. Most of the studies introduce a small number of patients (22–60) or a short follow-up period. We introduce our results of percutaneous screw fixation in 90 cases and discuss clinical outcome, pseudarthrosis ratio, and complications. In the period 2005–2013, we treated 103 patients with an acute, monolateral non- or minimally displaced scaphoid fracture by percutaneous screw fixation using a double-threaded screw. Fractures were assessed by X-ray and computed tomography scan and classified as type A2, B1, and B2 (Herbert) and as non-/minimally displaced. A guidewire was inserted along the longitudinal axis of the scaphoid and a double-threaded screw was inserted via small skin incision along the guidewire. Immobilization with short thumb-spica cast for 2 weeks followed. Ninety patients (87% of total) were present at follow-up 6 and 12 weeks postoperatively for clinical examination and radiographic study to evaluate fracture union. Long-term follow-up at least 12 months postoperatively was possible for 56 patients. Mean follow-up time was 40.6 months (12–84). The check included clinical examination, X-ray in four projections, DASH score, VAS for pain and function, and Mayo wrist score. Seven (7.7%) of 90 patients developed pseudarthrosis – 2 of them were active smokers, 2 began with sports and heavy manual work directly after removing the cast 2 weeks postoperatively, and in the last 3 cases we couldn't identify a particular risk factor. One patient needed a revision surgery due to a too long screw within the first 2 weeks postoperatively. No cases of postoperative infection, CRPS, screw dislocation, or radial dysesthesia could be reported. In 56 patients, 40.6 months (12–84) postoperative follow-up was possible. The clinical examination showed an ROM of the operated wrist of 66–0–71° and of the not injured of 68–0–74°. The DASH gave a mean score of 4.8 points (0–31.6), the VAS for pain 7.8 points (0–45), and for function 90.5 (55–100). Results using the Mayo wrist score gave an excellent score for 40 patients, good for 12 patients, satisfactory for 3 patients, poor for 1 patient. In this study, we review a higher number

of patients than introduced in the literature so far. We report very good results with healing rate similar to conservative treatment and a very low risk of complications – no postoperative infections, CRPS, or dysesthesia and only one case of a screw overlength. Patients benefit from shorter immobilization, earlier return to work, and sports and are highly satisfied. We consider this technique as a good and safe alternative to conservative treatment, especially for active, young patients.

A-0487 Surgeon volume and outcomes following Dupuytren's disease surgery

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Objective: The relation between the surgeon's volume of operations and outcome has been demonstrated for various surgical procedures. However, the relative impact of this surgeon's volume on outcome in Dupuytren's disease surgery remains uncertain and was the objective of this study.

Methods: Using data from a quality-of-care registry used by a consortium of six hand surgery practice sites in the Netherlands, we assessed the outcomes of 590 patients who underwent limited fasciectomy or percutaneous needle aponeurotomy between 2011 and 2014 by every surgeon of 17 hand surgeons. Using multivariable regression models that accounted for patient, treatment, and disease-specific characteristics, we examined the impact of surgeon volume on the degree of residual contracture and adverse events assessed between 6 and 12 weeks postoperatively.

Results: The average total residual contracture (active extension deficit summed over the MP, PIP and DIP joint) was 24°, which corresponds to a post-procedure improvement of 65%. Of all patients, 47% experienced at least one adverse event of which neuropraxia, scar-related sequelae, and wound healing problems were the three most common.

Surgeon volume was inversely related to the degree of residual contracture ($p = 0.001$) and the risk of an adverse event ($p = 0.001$). Each 10 additional procedures on an annual basis corresponded to a 0.9° less residual contracture and a 1.3% lower risk of adverse events at follow-up.

Conclusions: Surgeons within this population of specialized hand surgeons (all have passed the FESSH exam) who perform Dupuytren's disease surgery frequently achieve relatively small but significantly better outcomes in terms of contracture correction and adverse events.

A-0491 Modified minimal invasive extensor carpi radialis longus tenodesis for scapholunate dissociation: A prospective study

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Scapholunate dissociation is the most common form of carpal instability. However, there is no gold standard for operative treatment. In this prospective observational study including 54 patients, a modified minimal invasive dynamic extensor carpi radialis longus tenodesis is described, which is characterized by a smaller approach and application of a cannulated screw and washer for tendon fixation. Quick Disability of the Arm, Shoulder and Hand (Quick-DASH) results, postoperative satisfaction, and the onset of postoperative complications are analyzed. A median Quick-DASH of 54.6 was observed preoperatively which significantly decreased to a median of 28.4 after the procedure. Of 46 followed up patients, 31 (67.4%) reported that they were satisfied with the surgical treatment's outcome. Thirty-seven (80.4%) patients would recommend the procedure to a friend. There was no association of severity of symptoms and comorbidities with outcome. The presented method is as successful as other described techniques. It is less invasive, thus more patient friendly without harming feasibility of future salvage options.

A-0492 Age-related pathological alterations in the viscoelastic properties of denervated muscles in children with OBPP: A quantitative analysis of the deltoid muscle with Myometer

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Objective: Obstetrical brachial plexus palsy (OBPP) is a complex nerve injury of overstretched brachial plexus during delivery. Abnormalities in muscle properties are a common feature following OBPP, leading to variety of musculoskeletal problems and poor motor control. Many studies demonstrated histomorphological alterations in denervated muscles; however, no investigations of viscoelastic properties of denervated muscle have been performed in patients with OBPP. Viscoelastic properties of a muscle in terms of tone, stiffness, and elasticity are the passive properties, which play important role in muscle function. Examining the mechanical properties of denervated muscle is important in monitoring the pathologic processes of muscles for determining optimal time of muscle response to therapeutic interventions and for assessing the effects of these interventions. The purpose of this study was to investigate the pathological changes in viscoelastic properties of the denervated deltoid muscle in terms of tone, elasticity, and stiffness across different age-groups.

Methods: Sixty-one (42 boys and 19 girls) children with upper trunk (C5–C6) injury (Narakas type 2 injury) aged between 1 and 36 months were enrolled to the study. Children were classified into three groups according to their ages to examine the progression of changes in viscoelastic properties over time: 1–5 months, 6–24 months, and 25–36 months. Viscoelastic properties of the involved and healthy deltoid muscles were analyzed with using Myoton-3 device (Müomeetria AS, Tallinn, Estonia), which is a valid and reliable handheld device for measuring viscoelastic properties of muscles by recording the damped mechanical oscillations. The center part of the deltoid muscle was measured 10 times with the interval of 1 s between measurements in 90° shoulder abduction position by the physiotherapist, and the average of the measurements were used for statistical analysis.

Results: Muscle tone was lower ($p = 0.028$) at the involved side than the healthy side in children aged between 1 and 5 months ($n = 13$). Muscle tone ($p = 0.018$) and stiffness ($p = 0.036$) values were higher than healthy side in the children aged between 6 and 24 months ($n = 37$). There was no difference in the viscoelastic muscle properties of the involved and the healthy side in children aged between 25 and 36 months ($n = 11$).

Conclusions: Viscoelastic properties of the denervated muscle demonstrated different characteristics by age-groups. Changes in muscle tone and stiffness were significant until 2 years of age. Various underlying

mechanisms could be considered for these changes. Decrease in deltoid muscle tone in the first 5 months of age may be due to ongoing denervation process. However, after 5 months, higher values in muscle tone and stiffness may be a result of the increased fibrous tissue content and adipose tissue infiltration during the reinnervation process. Alteration trend in the viscoelastic properties in the first 24 months might be a clue for the importance of early physiotherapy interventions addressing muscle tissue. Future studies are warranted to monitor the effects of different treatment interventions in using this measurement method, which is easy to administer in clinical settings.

A-0494 Which joint fragment is mostly related to the surgical outcome of the distal radius fracture? An analysis using postoperative computed tomography

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Objective: Accurate reduction in intra-articular surface is known to be an important factor in the surgical treatment of distal radius fracture. We evaluated the fragment-specific articular surface reduction with computed tomography (CT) and determined which joint fragment is mostly related to the outcome of distal radius fracture surgically treated with volar locking plate (VLP).

Methods: Between May 2012 and February 2014, a total 124 patients with surgically treated distal radius fracture using VLP were eligible for the current study. A total of 71 patients had met the inclusion and exclusion criteria and permitted to participate in the current study, and their wrist was evaluated with CT at final follow-up. To evaluate the fragment-specific articular surface reduction, the articular surface was divided into six specific fragments: scaphoid facet, volar lunate facet, dorsal lunate facet, central portion, dorsal rim, and volar rim. The articular surface mismatch within each specific fragment were evaluated with three-grade ordinal scale; 'no mismatch', 'mismatch less than 2 mm', and 'mismatch more than 2 mm'. To evaluate the alignment of the distal radius, simple radiograph taken at final follow-up were examined. For clinical evaluation, the Disability of the Arm, Shoulder and Hand (DASH) and modified Mayo wrist score (MMWS) were completed at final follow-up. Subjects were divided into

two groups according to final DASH and MMWS score and compared. Correlation analysis between several parameters and DASH and MMWS were performed. Multiple logistic regression analysis was performed to evaluate cause-effect relationship between surgical outcome and various parameters and to control confounding effect of each parameter.

Results: Mean follow-up period was 13.9 (range: 12–52) months. Mismatch of the volar lunate facet and the dorsal lunate facet was significantly greater in the group with worse DASH score ($p = 0.019, 0.023$). Variables that showed significant correlation with DASH score were radial inclination, the volar lunate facet, the dorsal lunate facet, and central depression. The mismatch of dorsal lunate facet showed strongest correlation with MMWS (spearman's $\rho = -0.511, p < 0.001$). Articular surface mismatch at dorsal lunate facet, central depression, and volar rim were significantly greater in the group with worse MMWS score ($p < 0.001, 0.036, \text{ and } 0.042$). Variables that showed significant correlation with MMWS were the articular surface mismatch at scaphoid facet and dorsal lunate facet and the central portion. The mismatch of dorsal lunate facet also showed strongest correlation with MMWS (spearman's $\rho = -0.502, p < 0.001$). The result of multiple logistic regression analysis showed that the mismatch of the dorsal lunate facet has significantly high odds ratio of having worse result of MMWS.

Conclusions: The degree of articular surface mismatch within dorsal lunate facet seems to be mostly related to the surgical outcome of the distal radius fracture. With the case involved the dorsal lunate facet, surgeons should be cautious about its reduction during surgery using VLP.

A-0496 Outcomes of tendon grafts in spontaneous flexor tendon rupture

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Objective: Spontaneous flexor tendon ruptures are rare and the cause is not clear. The treatment options such as tendon transfer, tendon graft, and tenodesis have been reported, but it is unknown which method can be best for spontaneous flexor tendon rupture. We report the outcomes of tendon grafts using palmaris longus in spontaneous flexor tendon ruptures.

Methods: From June 2006 to October 2014, twelve patients with closed flexor tendon ruptures were treated surgically and were reviewed retrospectively. We enrolled patients with a diagnosis of closed flexor

tendon rupture. We excluded (1) patients who could not be followed up for more than 12 months, (2) patients who had associated disease that could cause tendon rupture, and (3) patients who did not agree to enroll in this study. Finally, 10 patients were enrolled in this study. The patients were assessed at a mean of 20.5 months (range 12–54). The active ranges of motion of affected fingers were measured with a goniometer and the Disability of the Arm, Shoulder and Hand (DASH) scores were assessed by physician assistants. There were nine men and one woman with a mean age of 65 years (range 44–74) at the time of surgery.

Results: According to Strickland and Glogovac's criteria, seven fingers were excellent and five fingers were good. No finger was rated as fair or poor. The DASH scores were 15.6 points preoperatively to 6.2 points at the final follow-up. There was no complication of treatment.

Conclusion: This study suggests that tendon grafts for treatment of spontaneous flexor tendon ruptures are useful to recover the function of ruptured flexor tendon.

A-0497 A new method to control tendon tension in the transfer of extensor indicis proprius to extensor pollicis longus rupture

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This study evaluated the outcomes of extensor indicis proprius (EIP) transfer based on varying degrees of thumb extension after EIP transfer and elongation of the EIP. A total of 24 cases with extensor pollicis longus (EPL) ruptures who underwent EIP to EPL transfer were analyzed prospectively. The EIP transfer was performed with neutral wrist positioning. In group I (12 cases), EIP and EPL were sutured on the thumb in neutral state at interphalangeal joint, and the mean EIP elongation of this group measured 0.2 cm (range: -0.5 to 0.5 cm). In group II (12 cases), EIP and EPL were sutured on the thumb in full extension state at interphalangeal joint, and the mean EIP elongation measured 0.7 cm (range: 0.5–1.5 cm). The mean follow-up period was 13.5 months. The 2 groups were compared based on thumb motion, grip strength, pinch power, and the Disabilities of the Arm, Shoulder, and Hand questionnaire score. Extension of the thumb at the interphalangeal joint was -5.2° in group I and 7.2° in group II, demonstrating statistically significant differences. No significant differences were

found between the two groups in other parameters. In EIP transfer, thumb in extension after transfer and EIP elongation is recommended for restoring thumb extension at the interphalangeal joint.

A-0498 The study for normal scapholunate interval measured with plain radiograph in the wrist of healthy Korean men

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Objective: The scapholunate (SL) interosseous ligament is the critical stabilizer of a delicately balanced system of intercarpal ligament and most commonly encountered ligament lesion causing carpal instability. When the initial radiographies suspect the carpal instability, additional dynamic stress views are recommended. Many different dynamic stress views for the diagnosis of SL instability have been described in the literature. Several studies have reported that SL interval more than 3 mm demonstrates SL instability. However, there have been few reports about radiographic evaluation of SL interval in healthy wrist. The purpose of this study is to measure the SL interval at several radiographic dynamic stress views in healthy Korean men and determine which view is the most useful for the radiographic diagnosis of SL instability.

Methods: From January to October 2014, this study is based on the analysis of 56 healthy wrists (30 men, mean age 33.1 [range 28–54] years) without any pain, discomfort, or history of trauma and surgery of wrist. Seventeen (1 static and 16 dynamic stress) radiographic views were taken on all wrists using portable C-arm. In order to characterize the best dynamic stress view, we studied additional parameters, including varied ulnar deviation and degree of obliquity. SL intervals were measured in all radiographic views using a previously presented method with PACS and X-ray ruler. We analyzed mean values and standard deviations.

Results: The posteroanterior (PA) ulnar deviation (UD) view resulted in the widest SL interval (mean 2.14 mm), and the anteroposterior clenched fist in 10° of UD with 2.3 metacarpal heads flat on cassette view resulted in the narrowest SL gaps (mean 1.57 mm). PA clenched fist radial deviation (RD) view resulted in the lowest standard deviation (0.4 mm). There was no significant difference between dominant and non-dominant hands statistically.

Conclusion: The mean values of SL interval measured with various radiologic views were lesser than the value of previous diagnostic consideration in SL

instability. These values might assist clinicians and be used as protocols for the diagnosis of dynamic SL instability and dissociation. PA clenched fist RD view was thought to be the reproducible view (standard deviation 0.4 mm). For assessing the injury of SL ligament, we recommend PA clenched fist RD view.

A-0500 Gorham's disease of the forearm

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Objective: Gorham's disease is an extremely rare disorder of the musculoskeletal system of unknown etiology in which the normal bone is affected by an aggressively expanding vascular tissue that causes massive osteolysis, transforming the bone into fibrous tissue. When the forearm is affected, pronosupination is lost and elbow or hand function can be severely impaired. The initial and systemic treatments, out of the scope of this presentation, are provided in order to stop the bone destruction. When the osteolysis is stopped reconstruction is required. At this point, we have to stress that there are scarce recommendations for treatment once the process is arrested: Epyphysiodesis of the unaffected bone or one-bone forearm reconstruction are the preferred options, whereas conventional bone grafting may not be advisable. We present our experience and strategy in the reconstruction of Gorham's disease of the forearm with a vascularized fibula flap.

Methods: Three patients presented to our clinic at the ages of 7, 10, and 10 with a previous diagnosis of Gorham's disease of the forearm (one right radius and two left ulnae), and two of them had previously been treated. Surgical technique consisted of (1) radical debridement of all the diseased tissue; (2) reconstruction with a free fibula flap, either as intercalated graft or on-top plasty; and (3) additional soft tissue procedures (interosseous membrane reconstruction). Postoperative growth was closely monitored, and distraction osteogenesis of the vascularized graft was done in two cases to obtain the normal length of the reconstructed bone and to align proximal radio-ulnar joint.

Results: All patients achieved consolidation and gained near-normal length of the bone after secondary procedures. Hand and elbow function were normal in all patients. Pronosupination was restored to some degree with all patients achieving an active range of motion of over 90°. No complications were observed.

Conclusions: Gorham's disease of the forearm reconstructed with a free fibula flap is a reliable treatment

to restore forearm length, hand and elbow function, and a good range of motion.

A-0510 1,2 Intercompartmental supraretinacular artery (1,2 ICSRA) vascularized graft used in scaphoid nonunion revealed with magnetic resonance angiogram (MRA)

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Objective: Whenever the subject is about the role of vascularized autograft in scaphoid nonunions, there is a vivacious debate. Scrutinizers of the technique pose concern for pedicle perfusion and revascularization. The purpose of this study was to confirm whether the 1,2 intercompartmental supraretinacular artery (1,2 ICSRA) that was transferred with the bone graft was still patent or thrombosis had occurred.

Methods: A magnetic resonance imaging (MRI) angiography was performed in 14 patients who were treated for scaphoid nonunion. In the index procedure, they underwent a vascularized bone graft interposition. The 1,2 ICSRA was identified and dissected along with corticocancellous bone graft from the radius. The edges of the nonunion were cleaned until bleeding bone was encountered. A K-wire was inserted from the distal pole to lunate to stabilize the graft. Data were obtained and analyzed from the radiographs, and we assessed the pre- and postoperative range of motion, grip strength, visual analog scale pain score, as well as the Mayo and Disabilities of the Arm, Shoulder, and Hand (DASH) functional scores. Magnetic resonance angiogram (MRA) using a 3T (tesla) MRI scanner was the method of choice to reveal pedicle perfusion and scaphoid revascularization.

Results: Follow-up ranged from 2 to 11 years. All scaphoid nonunions united after an average of 9 weeks. There was major improvement in pain which was evaluated with a visual analogue scale (from 6.1 to 0.8). There was also significant improvement in both Mayo and DASH functional scores (from 64 to 85 for Mayo and from 40 to 9 for DASH). The range of motion remained unchanged and grip strength trended toward minor improvement. The carpal height was preserved, and the dorsal intercalated

segmental instability was corrected. MRA showed dye intake in the previous nonunion area in all 14 patients, but the pedicle was revealed in 13 of the 14 scaphoids. The course of the pedicle was confirmed in three levels (coronal, axial, and sagittal) and also using three-dimensional multiplanar reconstruction view.

Conclusions: The results of this procedure are very encouraging provided that the technique is carefully performed and the pedicle is intact and patent. Vascularized bone graft from 1,2 ICSRA is a biological solution that enhances reperfusion in the avascular area of scaphoid nonunions, whereas years after, the pedicle is still there functioning as an extranutrient vessel.

A-0514 The accuracy and precision of radiostereometric Analysis in shoulder, elbow, wrist and trapeziometacarpal joint arthroplasty: A systematic review of the literature

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Introduction: Radiostereometric analysis (RSA) is an accurate method to measure early migration of orthopedic hip and knee implants. For the shoulder, elbow, wrist, and hand joints, several implant designs have been developed in the last decades. RSA of these joints is scarce and has several challenges, since the size of the surrounding bone is limited. The relation between early migration and future aseptic loosening as described for hip and knee prostheses has not been proven for prostheses of the upper limb. Therefore, we performed a systematic review of the literature to investigate the relation between early migration and future loosening of the implants of these joints. Furthermore, we wanted to assess the feasibility and precision of RSA in the hand, wrist, elbow, and shoulder.

Methods: Embase, Medline, Cochrane, Web of Science, Scopus, Cinahl, and Google Scholar were searched for relevant studies up to April 2015. Selection of suitable studies was performed by two authors independently. Quality assessment was performed by two authors using the MINORS score and the Downs and Black checklist. Quality of RSA was scored

scored using 11 items from a standard RSA protocol. Data were extracted using a standardized template including the following topics: (1) study information; (2) study design; (3) joint and prosthesis data; (4) RSA details and migration data; and (5) relation between early migration and future loosening.

Results: The literature search resulted in 612 articles. After correction of duplicates and screening of titles and abstracts, 35 studies remained. Assessment of the full text resulted in the inclusion of 20 articles (13 shoulder, 4 elbow, and 3 trapeziometacarpal joint). Mean precision of translation measurement was 0.35 mm for the shoulder, 0.22 mm for the elbow, and 0.93 mm for the TMC joint. Mean precision of rotation measurement was 1.72° for the shoulder, 0.64° for the elbow, and 88.25° for the TMC joint. One study investigated the relation between early migration and future loosening for elbow prostheses, with a mean follow-up time of 8.2 years. No relation could be demonstrated in this study.

Discussion: Radiostereometric analysis of shoulder, elbow, and TMC-joint prostheses is feasible. Precision of the technique in the shoulder, elbow, and TMC joint is less compared to RSA of total hip and knee prostheses. However, it is still the useful and the best available method to determine early migration. Precision of rotation measurement is poor, especially in the TMC joint. This could be due to the limited size of surrounding bone and overprojection of the beads by the prosthesis. No relation between early migration and future loosening has been proven for prostheses of the upper limb. Further research is required to assess this relation.

A-0517 Formative hand surgery: Combined use of microsurgery and external fixator

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Purpose: Reliable initial treatment with a view toward two-stage reconstruction and a treatment plan centered on postoperative rehabilitation are important to improving the function of replanted fingers and reconstructed hand after severe trauma. In order to acquire better joint function, it is logical to start using an adjustable external fixator that allows range of motion (ROM) exercise while exerting traction on the finger joint before bone union. We use a compass PIP joint hinge external fixator (CPJH) or an Ilizarov Mini

external fixator (IM) and have obtained consistent results in regard to release of the above-described contractures around the first interdigital space and PIP joints. Moreover, since we have performed bone lengthening and bone transfer with the IM to treat lost fingers, we will report our experience thus far.

Subjects and Methods: There are three groups of subjects: (1) a group (13 fingers) with replanted fingers who wore a CPJH or IM for the purpose of traction of a proximal interphalangeal (PIP) or metacarpophalangeal (MP) joint and ROM exercise (CPJH 7 and IM 6); (2) a group (12 hands) in which contracture with the first interdigital space was released with an IM; and (3) a group composed of 9 fingers in whom lengthening and reconstruction of the proximal phalanx was performed. In Group 1, depending on the type of the fracture, we attempted to maintain reduction during the initial treatment by using the IM, to which we had added new parts. Later, we inserted wire and rearranged the fixator in the form of a hinge and performed posttreatment by applying traction to the joint. In Group 2, it was possible to attach the external fixator by a method that for the first time enabled opening between the first interdigital space in two directions. In Group 3, as a rule, we started bone lengthening on postoperative day 7. As a rule we lengthened the bone at a rate of 0.5 mm/day.

Results: (1) TAM was 55%, and the mean score according to the new criteria for evaluation of the function of amputated and reattached fingers of the Japanese Society for Surgery of the Hand was 66 points. (2) The mean follow-up period was 11 months. The preoperative passive distance between the thumb and the index finger was 41% in radial abduction and 33% in palmar abduction. Postoperatively, in radial abduction, the passive distance between the thumb and the index finger was 91%, while in palmar abduction the passive distance between the thumb and the index finger was 92%. (3) The total amount of lengthening was 15–35 mm. There were also cases in which sensory reconstruction was performed by adding a sensory flaps.

Discussion: We think that they are also useful for reconstructing missing fingers and that 'formative hand surgery' centered on soft tissue and bone lengthening with an external fixator is an effective solution to the treatment of various deformities and losses after hand trauma.

A-0524 Reliability of 3D measurement of the upper extremity

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Objective: Assessment of changes in the volume of the extremities is important in observation of swelling after trauma, in infection, or lymphedema. Up to date, the most common techniques are water displacement and tape measurements. Therefore, the aim of the study was to determine the reliability of three-dimensional (3D) surface scans in the upper extremity in comparison to the tape measurement.

Methods: We measured the particular upper extremity repetitively 3 times by 3D-Scan and by tape measurement by means of three investigators. A total of 10 healthy subjects were examined.

Results: There was a significant lower difference in the three scans of a particular extremity inside the scans of one investigator ($23.05 \text{ cm}^3 \pm 6.1$) and in the different investigators scanning one particular extremity ($26.37 \text{ cm}^3 \pm 6.9$) in comparison to the tape technique. ($p < 0.05$, SEM)

Conclusion: The reliability of 3D surface scans in the upper extremity is significantly higher as in the common tape measurement standard.

A-0525 Metacarpal fragility fractures: Cross-sectional study on epidemiology and predictive value of further fragility fractures

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Objective: To identify metacarpal fractures associated with osteoporosis and describe the characteristics including mechanism of injury, associated factors, and management. This has not been previously described in the literature.

Method: We retrospectively analyzed our Fragility Fracture Database from January 2008 till October 2015. All patients who had sustained metacarpal fractures with DEXA scan/ X-ray-proven osteopenia/osteoporosis were included in our study. Patients with pathological fractures, infections, and reflex sympathetic dystrophy and younger patients with metacarpal injuries due to attributable trauma without evidence of osteoporosis were excluded. We analyzed the age and sex distribution, ethnic background, association with smoking, fracture pattern, mechanism of injury, family history, previous fractures, and refracture rate. All patients were assessed in the fracture clinic/accident and emergency and referred to Osteoporosis Clinic for follow-up. Further

mobilization after conservative treatment was done by the physiotherapists and hand therapy.

Results: A total of 46 patients over this period were included in our study. The male-female ratio was 12:34, respectively. In all, 4% (2 patients) were less than 60 years old, 37% (17 patients) were between 60 and 75 years old, and 59% (27 patients) were over 75 years old. Of our patients, 91% (42 of 46) were non-smokers. In all, 71% (33 of 46) were Caucasian with the rest being Afro-Caribbean, Asian, and mixed ethnic backgrounds; 84% (39 of 46) patients had falls in the previous year with 21% (10 of 46) patients having sustained a fracture. Eleven percent (5 of 46) had a family history of osteoporosis. All the included patients had DEXA scan with 39% (18 of 46) with osteopenia and 30% (14 of 46) with osteoporosis. Nineteen percent (9 of 46) were proven on X-rays, and the results of four patients were not available in the system. The fifth metacarpal was most involved with 58% (27 of 46), with 44% (12 of the 27) involving the base. Four patients had fractures of the fourth, one patient of the third, two patients of the second, and four patients of the first metacarpal, respectively. The remainder of the patients (17%) had a combination of metacarpal fractures, with the majority involving the fifth metacarpal. Of the patients, 89% had falls from standing height, trivial direct injuries, and minor assault, while 6% sustained moderate energy injury (fall while running) and 5% were unable to recollect the mechanism of the injury. Of the patients, 97% were treated conservatively with plasters and splints as appropriate, and mobilization was supervised by physios at the hospital and the community. Further follow-up was continued at the GP practice. Six (13%) patients sustained a fracture at a future point in time after their metacarpal injury while under follow-up.

Conclusion: Elderly population are at a higher risk to sustain fracture. We noted a high number of patients within this group who had a fall in the previous year, with 21% sustaining a fracture. Our study defines the patient groups at risk, fracture characteristics, and it is important to recognize the vulnerability of this cohort group to reinjury (13%) as demonstrated in our study.

A-0527 Arthroscopically assisted four-corner fusion

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Objective: Four-corner fusion (4CF) is an accepted and effective procedure for managing several degenerative disorders of the wrist. This procedure consists in the excision of the entire scaphoid in association

with midcarpal fusion of the remaining carpal bones (lunate, triquetrum, capitate, and hamate), and it is generally performed through an open approach.

The combination of a minimal volar approach, for scaphoid excision, with arthroscopic preparation of midcarpal joint surfaces plus bone graft placing and percutaneous fixation techniques can, potentially, generate the best possible functional outcome by minimizing the effect of extra-articular adhesion related to open surgery. The purpose of this retrospective study is to present the arthroscopically assisted 4CF performed in our practice and to evaluate the clinical and radiographic results.

Methods: Eleven patients underwent scaphoidectomy and 4CF. In each case, the scaphoidectomy was performed through a minimal volar approach, and the midcarpal joint surfaces were denuded through dry arthroscopy. The regular midcarpal portals were used. The bone graft was prepared from the excised scaphoid, and it was placed in the midcarpal space using a 3.4-mm burr cannula. The fixation was achieved using headless cannulated compression screws. In the postoperative period, patients were put in a splint for 2 weeks. Range of motion exercises began 2 weeks after surgery. Functional outcomes were assessed by objective and subjective measures: range of motion, grip strength, Quick Disabilities of the Arm, Shoulder and Hand (Quick DASH) score, visual analogue scale (VAS) of pain, satisfaction, and return to work. The X-rays were evaluated for union. The mean follow-up was of 20 months.

Results: Mean surgery time was 2 h. There was no need for conversion to the classic open procedure in any patient. The average flexion was 44° (range, 30°–70°) and extension was 39° (range, 10°–50°). Grip strength averaged 23 kg (62% of the other hand). Terminal to terminal pinch averaged 5.8 kg and terminal to lateral pinch was 7.3 kg (89% and 88% of the other hand, respectively). The mean Quick DASH score was improved postoperatively from 40 to 10. Mean VAS postoperative pain rating was 2 compared to 7, measured preoperatively. All the patients were satisfied and were able to return to their previous activities. Fusion was achieved in every patient, confirmed by X-rays taken at 10 months postoperatively. We had a surgery-related complication, a second-degree burn related to the use of the burr, which resolved with dressings, and there was breakage of a screw in two patients, but in both cases fusion was achieved.

Conclusions: Although technically demanding, in our opinion, the arthroscopically assisted 4CF seems a valid alternative to the classic 4CF procedure. The preliminary results seem promising, but longer follow-up is needed to confirm the benefits of this technique.

A-0529 Reconstruction of soft tissue defect after severe finger trauma using free tissue transfer using short pedicle

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Introduction: In case of reconstruction of fingers of the hand, which are exposed parts of the body, it is necessary to choose a surgical procedure from the cosmetic as well as functional points of view. Defects of the palmar soft tissues in the distal parts of the fingers caused by fingertip amputation would have a conspicuous functional as well as esthetic impact. I have been performing reconstruction for such severe injuries using wraparound flaps (WAFs) that include the second toes, hemipulp flaps, venous flaps (VFs), and dorsal ulnar artery perforator flaps (DUAPFs) and report the clinical outcomes, together with some discussion.

Subjects and Methods: The subjects of this series were 37 fingers, belonging to 32 men and 5 women ranging in age from 19 to 62 years, who sustained complete or incomplete amputations and crush injuries. WAFs were used for 19 fingers, hemipulp flaps for 7 fingers, and in all of these cases, both the donor sites and the recipient sites were reconstructed using short pedicles, paying attention to the esthetic appearance. DUAPFs were used for five fingertips and VFs for six fingertips, especially targeting reconstruction of the palmar soft tissues at the distal parts of the fingers. The sites for harvesting of the VFs were the forearms in four cases and the dorsum of the foot in two cases. Artery–vein–artery (A–V–A) VFs, for cases requiring concurrent reconstruction of tissues and blood flow of the digital arteries using VFs, in which the outflow and inflow vessels are digital arteries, were used for two fingers, and the artery–vein–vein (A–V–V) VFs, in which the inflow vessels are digital arteries and outflow vessels are dorsal digital veins, were used for four fingers.

Results: All of the WAF and dorsal ulnar artery flaps survived, and superficial layer necrosis was observed in two cases in which VFs were used. In one of the cases in which a WAF was used, the nail became thin as compared with that on the healthy side. In all of the cases in which circulation reconstruction was performed concurrently with replantation, the flaps survived. Pinching was possible in all cases in which WAFs were used. Reconstruction of the fingertips with VFs was performed in six cases, of which five showed nail regeneration. In some cases in which

a WAF was used, partial nail transfer was also performed, taking into consideration the cosmetic appearance of the toe.

Discussion: Our results suggested that WAFs were superior for the reconstruction of fingertips, from the points of view of both cosmetic appearance and functionality. For those patients who do not desire to undergo tissue transplantation from the toes, reconstruction using VFs, which can be performed under conduction anesthesia, or using DUAPFs, whose harvesting area is small, is also useful. In cases where hemipulp flaps with short pedicles are used for the thumb, the flaps were harvested under combined conduction and local anesthesia in some cases, and use of such flaps is a good method taking into consideration the cosmetic appearance, harvesting area, and so on

A-0530 Occult die-punch injuries of the distal radius causing ulnar abutment syndrome: Our experience

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Objective: Ulnar abutment syndrome is one of the commonest causes of ulnar-sided wrist pain. This is usually associated with positive ulnar variance due to a congenitally long ulna, functionally long ulna, and radial shortening due distal radial malunion or pediatric distal radius growth arrest. However, in several patients who had developed ulnar abutment after an apparently soft tissue wrist injury, on closer examination and advanced imaging, we found an occult volar tilted die-punch injury of the lunate fossa of the distal radius causing an alteration in the sigmoid notch resulting in subluxation of the lunate and the ulnar abutment. This is often missed due to the difficulty in visualizing the injury on plain radiographs.

Method: We present a case series of six patients in our practice over the past 3 years, with this injury pattern who presented acutely or as a delayed presentation. Following their initial clinical assessment, imaging including computed tomography (CT)/magnetic resonance imaging (MRI) was done to assess the anatomy. All our patients with this suspected injury underwent wrist arthroscopic evaluation where we noted a die-punch injury of the lunate fossa with classical ulnar abutment with TFCC perforation, reciprocal lunate wear, and very marked lunate slope with injury to the scapholunate ligament. We proceeded to perform a wafer procedure with debridement of the TFCC. If symptoms of ulnar abutment remained post-operatively, we proceeded to corrective osteotomy of

the distal radius to achieve restoration of the normal anatomic parameters.

Results: Following the interventions, all patients were reviewed in our clinic and followed up for 12 months. We followed a protocol of early mobilization with referral to our Hand Therapy services. Regular assessments of their hand function was charted and documented. Objective and subjective assessment tools were used to evaluate the postoperative recovery including Mini-Disability of the Arm, Shoulder and Hand, PRWE, and active range of motion. Overall, we noted good improvement with pain and hand function.

Conclusion: In patients with posttraumatic ulnar abutment syndrome, a careful evaluation of the X-rays and, if necessary, CT /MRI scans need to be done to exclude an occult die-punch injury. Although the standard treatment for ulnar abutment syndrome is an ulnar shortening or a wafer procedure, if debridement of the TFCC does not work, a different approach may be needed since the primary problem is abnormality of the sigmoid notch.

A-0534 Accuracy of evaluating an ulnar styloid base fracture in distal radius fracture by simple radiograph

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Purpose: It remains uncertain whether to fix or not an ulnar styloid fracture accompanied by distal radius fracture. Fixation should be required in cases of the fracture involving a fovea of ulnar head, an attachment site of deep triangular fibrocartilage. We analyzed patients with ulnar styloid fracture accompanied by distal radius fracture using simple radiograph and three-dimensional computed tomography (3D CT) scan images, respectively, and compared accuracy of evaluation for the types of ulnar styloid fractures, which might designate the treatment methods

Materials and methods: We retrospectively reviewed 168 patients who underwent surgery for distal radius fracture in our hospital from January 2005 to March 2015 and evaluated whether ulnar styloid base was involved or not using simple radiographs and 3D CT scan images. And we analyzed the accuracy of evaluation by simple radiographs compared to the findings of 3D CT scan images. To avoid the effect of memory, evaluation using 3D CT scan images were performed in randomized order 2 weeks after initial simple radiograph evaluation.

Results: On simple X-ray, 64 (38%) cases had ulnar styloid base fractures; however, 21 cases revealed nonbase fractures by 3D CT scan images, and 7 of 104 cases, on simple radiographs, were determined as nonbase fracture by simple radiographs and were diagnosed as base fractures by 3D CT ones. Based on findings of 3D CT scan images, the accuracy of simple radiograph evaluation for types of ulnar styloid fractures was 83% with 86% sensitivity and 82 % specificity. The positive predictive value was 67% and the negative predictive value was 93%.

Conclusion: Accuracy of evaluating an ulnar styloid base fracture in distal radius fracture by simple radiograph, when compared with 3D CT, was 83%; therefore, we recommend that 3D CT scan image-based evaluation should be performed in case of unclear involvement sites so as to determine whether to fix it or not.

A-0537 Modified Bunnell two-strand pullout technique versus the transosseous Teo technique for repair of distal profundus tendon injuries: A biomechanical comparison in human cadaveric hands

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Background: Surgical repair by fixation into the phalanx is the usual method in the treatment of lesions of the deep flexor tendon in zone 1 of the hand. A wide variety of techniques have been described for the repair, including the Bunnell pullout technique and its modifications, by fixation with one or two suture anchor and combinations of transosseous and anchor sutures. In vitro cyclic testing and a load to failure test were used to compare the repair of a flexor digitorum profundus tendon using the transosseous technique of Teo or a modified Bunnell two-strand pullout technique using a braided polyester suture.

Methods: Thirty-six fresh frozen cadaveric fingers were randomly divided into two repair groups and a control group: A transosseous technique of Teo with 3-0 braided polyester suture or a modified Bunnell technique with a 3-0 braided polyester suture and a control group with the flexor intact. After repair, the samples and the control group were loaded cyclically from 2 to 15 N at 25 mm/min, for a total of 500 cycles. Gap formation at the tendon–bone interface

and grip-to-grip distance were assessed every 100 cycles. Specimens were tested to failure at the end of 500 cycles. Load displacement graphs were generated to calculate repair displacement, force to 1, 2, and 3 mm of displacement, displacement under 20 N, yield force, time to yield, displacement to yield, ultimate force, time to ultimate force, displacement to ultimate force, total displacement, total time, and stiffness.

Results: The transosseous technique of Teo showed a significantly lower displacement: 9.33 mm (DE 1.76) after 500 cyclic loading compared to modified Bunnell technique: 13.81 mm (DE 2.08). The Teo technique showed approximately 30% less gap at the tendon–bone interface and grip-to-grip distance every 100 cycles than the modified Bunnell technique. The Teo technique needed a 30% more power to cause a 1, 2, or 3 mm of gap than the modified Bunnell technique. The Teo technique showed a significantly lower failure load: 75.5 N (DE 12.5) than did the modified Bunnell technique: 57.3 N (DE 5.4).

Conclusion: We have found statistically significant biomechanical differences in failure loads and displacements between the two repair techniques after rupture of the profundus flexor tendon. The transosseous technique of Teo suffers less gap formation when subjected to cyclic loading, has more resistance to failure when subjected to maximum load, and resists overtraining distance of 1, 2, and 3 mm than the modified Bunnell two-strand pullout technique.

Study design: Controlled laboratory study.

A-0540 Predicting outcome after surgery for carpometacarpal osteoarthritis: A prospective study

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Objective: Research on carpometacarpal (CMC) osteoarthritis (OA) is primarily focused on comparing surgical outcome of different techniques in case series or comparative studies. Nearly all studies do not demonstrate significant differences in outcome between surgical techniques. However, it has been reported that a relatively large part of treated patients have significant residual pain and functional

limitations or even deterioration of their initial complaints. Overall outcome may also be improved by selecting 'the right patients' for surgical treatment. Therefore, the aim of this study is to (1) describe the outcome of widely used techniques for CMC OA in a large, multicenter cohort and (2) identify predictive factors of poor surgical outcome, defined in terms of pain, complications, hand function, and patient satisfaction to predict possible failure after surgical treatment.

Methods: We included 668 patients in a multicenter, prospective study in the Netherlands between 2011 and 2015, who were surgically treated for CMC OA with trapeziectomy with LRTI. Outcome parameters, registered preoperatively, 3 months, and 12 months after surgery included pain (VAS), function (Michigan Hand Questionnaire), complications, and satisfaction with the hand. Postoperative outcomes were compared to baseline levels. Multiple imputation was performed after missing value analysis. Baseline pain, function and strength, sociodemographics, and hand surgical history were analyzed as possible predictors of outcome after surgery by multivariate regression analysis.

Results: For all measurements, outcomes improved significantly after surgery, with effect sizes over 0.8 for pain, total MHQ-score, and patient satisfaction outcomes. However, we found a residual rest pain of 19 (VAS 0-100) after 1 year. In total, there were 327 complications in 229 patients, of which 43% required no or conservative treatment. Univariate analysis showed that only a few of the baseline variables correlated with postoperative outcome measurements at 12 months. These associated variables were combined with predictors selected from literature and were considered in multivariable analyses. For pain and the number of complications, the multivariable regression models could only explain 2% of the variance in the model. For self-reported satisfaction of the hand, this was only 5%. For the MHQ score, the multivariable regression analysis could explain 17% of the variance in the model, with a history of De Quervain tendinitis, smoking, lower baseline MHQ total score, and increased preoperative pain, independent predicting a worse postoperative MHQ-score.

Conclusion: After surgical treatment for CMC OA, improvements in pain, strength, and function in our study are highly significant and clinically relevant. Despite the large overall improvement, we found significant percentages of patients with unfavorable outcomes (residual pain and functional deficits) in this large cohort, which is also in line with present literature. Based on this study, we conclude that we cannot predict which patients will have bad surgical results after surgical treatment for thumb CMC OA, despite

our relatively large sample of baseline characteristics and large cohort. Our study suggests that we need to look beyond the commonly evaluated predictive factors (age, gender, baseline functional scores, etc.) and treatment algorithms to improve outcome of all patients with CMC OA.

A-0543 Post-procedure care following needle aponeurotomy for Dupuytren's contracture: A survey of current splinting practice in Europe and North America

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Objective: Needle aponeurotomy (NA), or percutaneous needle fasciotomy, is an accepted treatment for Dupuytren's contracture. The role of splinting after NA is controversial, and there is no reliable evidence available on which to base practice. The aim of this study was to identify current splinting practice among Hand Surgeons in Europe and North America. **Methods:** A web-based survey was conducted over a 6-week period. Members of BSSH, the Dupuytren Foundation, and European surgeons with an interest in Dupuytren's surgery were invited to participate. Respondents were asked about their own surgical experience and case load, the circumstances in which splints would be provided post-procedure and what splinting regimes were commonly used.

Results: One hundred seventy-one respondents performed NA; 98% of respondents practiced in Europe or North America with 58% coming from Europe; 56% had more than 5 years of experience in NA, and 47% were performing at least once a week; 70% of surgeons referred for splinting post-procedure. Within this subset, there was little agreement of the circumstances in which splinting would be appropriate (i.e. joint(s) involved, extent of correction achieved or extent of cord division achieved). When each of these factors were asked about in turn, between 62% and 70% of respondents from this subset answered that they always referred for splinting, with different respondents referring in different circumstances. There was no agreement regarding factors that would make splinting more likely (such as previous recurrence or rapid progression of deformity). Some consensus on splint type was found with volar-based hand splints (65%) being selected most commonly followed by volar-based digit splints (32%), although splint type often followed therapist preference (38%). Most surgeons preferred the splint to be worn for 1-3 months (54%) at night only (61%). Of the 30% who didn't refer for splinting, lack of evidence was cited by 65% and poor patient compliance by 26%.

Conclusions: Our study demonstrates marked variations in current practice. There is some consensus regarding splint type, duration and wear regime. The decision to use post-operative splinting at all remains controversial. There is no level 1 evidence to guide practice. A multi-centre clinical trial is planned.

A-0544 The use of the corticoperiosteal flap for difficult nonunions of the upper limb

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Objective: Bone flaps have been successfully applied for the reconstruction of bone defects. Their use is widely accepted for the treatment of nonunions with long bone defects. However, their use for small defects is less popular. This study aimed to evaluate the medium to long-term results with the vascularized corticoperiosteal flap from the medial femoral condyle in the persistent nonunions of the upper extremities.

Methods: Forty patients (35 males and 5 females) with persistent nonunion were evaluated from October 2007 to June 2015. Average age was 42 years (range of 26–63). Average size defect was 2.73 cm (± 1.085 cm, range of 0.6–5.0). Every patient was treated one time at least (1–3). Bones involved were 17 ulna, 4 radius, 4 humerus, 3 scaphoid, 2 metacarpal, 9 phalanges, and 1 clavicle. Rigid internal fixation was obtained and the corticoperiosteal flap was dissected according to Sakai-Doi technique. Additionally, time of consolidation, postoperative complications, and final outcome were recorded.

Results: Average follow up was 23 months (4–96). Bone union was obtained in every case. Clinical evidence of consolidation was observed as soon as 3–5 months postoperatively, although radiologic evidence of bone union took more than 6–10 months in some cases. With protected rehabilitation, all patients regained a functional range of motion and rejoined work. Donor-site complications were few and transient (paraesthesia along the saphenous territory, seroma, suture intolerance, and painful squatting). No femoral fracture or knee instability was encountered.

Conclusions: Although most nonunions can be successfully treated by rigid fixation and nonvascularized bone grafting, the corticoperiosteal flap from the medial femoral condyle is an excellent alternative for difficult and persistent nonunions of the upper limb. We believe that this flap deserves a role when dealing

with difficult nonunions, as it affords healing in a single stage with minimal morbidity.

A-0546 Treatment of distal radius fractures in Norway – Data from the Norwegian Patient Registry from 2009 to 2014

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Objective: National incidence rates or data describing treatment practice of distal radius fractures in Norway are lacking. An analysis of the incidence of distal radius fractures in adults and treatment practice at a national and regional level is therefore conducted.

Methods: We used data from the Norwegian Patient Registry, which included every patient visiting public hospitals and private hospitals with reimbursement agreement. Data identifying patients over 18 years of age with a distal radius fracture (ICD-10 code S52.5 or S52.6) and the treatment given for the period 2009–2014 were used. Operative treatment of distal radius fractures was defined by the NCSP procedure codes NCJ45, NCJ47, NCJ55, NCJ57 or NCJ65. Conservative treatment was defined as a distal radius fracture without an operative procedure code. The results are presented as age- and gender-adjusted rates per 100,000 inhabitants for specified regions. Each residential area consisted of the municipalities served by the 21 Norwegian Hospital Trusts (HTs).

Results: The number of distal radius fractures in Norway has been around 12,500 annually (245 per 100,000 inhabitants) with the distribution 3/4 females and 1/4 males. Average age is 63.5 years for females and 50.1 years for males. At a national level, 28% of the patients are treated operatively. The operative rate has remained unchanged over the period. However, large variations are seen between the different HTs with regard to operative rates. In between the HTs, there have been changes over the period 2009–2014. While the treatment rates for distal radius fractures varies with only 1/4 between the HTs, the variation in operative rates is threefold. At a national level, the use of different operative techniques has changed considerably in the period. The use of plates has increases from 53% in 2009 to 81% in 2014, with eight- to ninefold variation between the different HTs. In the same 6-year period, a reduced use of both percutaneous pinning and external fixation is seen, also here with striking variations.

Conclusion: This study demonstrates stable incidence of distal radius fractures over the last 6 years in Norway. However, there is great variation of operative rates between the various HTs. The use of plates has varied considerably between the different HTs in the period. The variation in use of the other operative methods is also pronounced. Without known variation in morbidity, such practice variation is considered inexplicable and may thus be an indication that operative treatment for distal radius fracture is not equally distributed across the population. Such variation in operative treatment between residential areas can most likely be attributed to variations in practice variation between professionals. An important addressee to work with practice variation is the hand- and orthopaedic societies. Treatment guidelines for distal radius fractures based on scientific evidence could harmonize practice and thus make health services more equal distributed.

A-0547 Outcome of proximal pole scaphoid nonunion treated with antegrade headless compression screw and bone graft

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Introduction: Scaphoid fractures accounts for approximately 15% of all fractures of hand and wrist. Proximal pole fractures represent 10–20% of scaphoid fractures. Non-operative treatment shows high incidence of non-union and avascular necrosis. Surgical intervention with bone graft is associated with better outcome.

Objective: The aim of this study was to evaluate the radiological and functional outcome of management of proximal pole scaphoid non-union.

Methods: We included 35 patients presented/referred to our hospital from 2008 to 2015 with proximal pole scaphoid non-union. We treated all patients with same technique. We used compression screw fixation with bone graft except one which was dealt with k-wire and bone graft. Thirty three patients had bone graft from distal radius and two from iliac crest. Post-operatively patients were treated in plaster for 6–8 weeks followed by splint for another 4–6 weeks. All patients underwent hand physiotherapy commencing at 6–8 weeks. All the patients were analysed at the final follow-up using Disabilities of the Arm, Shoulder and Hand score and X-rays.

Results: Of the 35 patients, all the patients underwent surgery with bone graft. Mean age of the patients was 28 years (20–61) and M:F ratio 11:1. We lost three patients (9%) to follow-up. At a mean follow up of 24 weeks (16–32), 23 patients (66%)

achieved radiological union. All patients but three (91%) achieved good functional outcome at mean follow up of 52 weeks (32–74).

Conclusion: A good functional outcome can be achieved with surgical fixation and bone graft in proximal pole scaphoid fractures non-union. Pre op fragmentation of proximal pole dictates the type of fixation (screw or k-wire or no fixation). In our experience, there was no difference in outcome whether graft was taken from distal radius or iliac crest, although later is associated with increased morbidity.

A-0554 Treatment of metacarpal fractures by means of a photodynamic polymer (IlluminOss®)

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Introduction: Displaced metacarpal fractures are usually treated surgically. Conventional methods such as bouquet pinning of metacarpal neck fractures or plate fixation of comminuted shaft fractures may have implant-associated complications necessitating early implant removal. Photodynamic resins, cured by administration of light at a certain wavelength, have been widely used in dentistry ever since the 1990s and are now available for fracture treatment. The advantage of this technique lies in a more rigid internal fixation than, for example, bouquet pinning and avoids removal of the implant. This study presents first results with this type of osteosynthesis.

Materials and methods: From December 2014 until August 2015, 17 patients with 20 displaced metacarpal fractures leading to malrotation were included and treated via intramedullary osteosynthesis using a photodynamic resin (IlluminOss®). There were 4 times fractures of the 4th metacarpal, once of the 3rd metacarpal and 15 times of the 5th metacarpal bone. There were 14 subcapital neck and 6 diaphyseal fractures. After osteosynthesis, assisted active motion was started on the first day postoperatively. Patients received an Edinburgh splint for 10 days and a metacarpal brace allowing free active motion until 6 weeks postoperatively. All patients with a minimum follow up of 12 weeks were included. Patients were clinically and radiologically examined after 6 and 12 weeks.

Results: Average time to treatment was 6 days (0–17). Mean duration of surgery was 80.1 min (40–120). Fifteen patients (18 fractures) were included in the follow up. The average range of motion at 6 weeks after surgery was for flexion/extension mcp 67-0-4, pip 91-4-0, and dip 70-0-0 improving over time to mcp

83-0-5, pip 94-3-0, and dip 78-0-1 after 12 weeks. In all fractures, bony healing was observed radiologically after 6 weeks. In four cases of comminuted subcapital fractures, mild shortening of 2–3 mm was seen without functional impairment. In one case of a severely comminuted fracture, a secondary dislocation occurred resulting in implant removal and reosteosynthesis with plate fixation and bone graft. No loosening of the implant or implant-related infection was observed.

Conclusions: Intramedullary fracture stabilization using a photodynamic polymer (IlluminOss®) is a safe option for treatment of displaced metacarpal fractures. Due to the intramedullary implantation and stable fixation, surrounding soft tissues are preserved allowing early mobilization. In contrast to conventional bouquet pinning, no implant removal is necessary.

A-0558 Splinting after fasciectomy: A systematic review of the evidence

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Objective: This systematic review identifies and appraises available evidence regarding the effectiveness of post-surgical splinting following Dupuytren's Disease. The review provides a useful synthesis of evidence which may guide evidence-based clinical decisions.

Methods: In September 2015, a systematic literature search for randomized clinical trials, since 2008 was conducted in the Cochrane Library, Medline, Cinahl, Embase, PEDro and OTSeeker databases. The retrieved abstract and titles were screened. Methodological quality of included randomized trials was assessed using the Risk of Bias Tool. A meta-analysis was conducted for patient-rated outcomes and active range of motion. For rating the quality of evidence, the grades of recommendation assessment, development and evaluation (GRADE) was used. The study protocol was prospectively registered onto the International Prospective Register of Systematic Reviews.

Results: Three articles met a minimum set standard and a total of 254 patients are included in the studies. All patients have undergone fasciectomy or dermo-fasciectomy. Post-surgery all patients had standard hand therapy and patients in the intervention groups wore a night extension splint. Using GRADE on both the primary patient-rated outcomes and the secondary outcomes active range of motion, the studies are downgraded for risk of bias but are not downgraded for indirectness, inconsistency or imprecision. The studies provide moderate quality.

Conclusion: Moderate quality evidence is found and shows that the use of a night extension splint in combination with standard hand therapy has no greater effect on the patient-rated outcomes or active range of motion than standard hand therapy alone after Dupuytren's fasciectomy. The results indicate that the practice for routinely providing every patient with a night extension splint post-surgery has to change.

A-0559 Bioengineering and regenerative surgery: What is new for reconstruction of complex lacks of the upper extremity and of the hand

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Background: Soft tissue deficiencies represent a challenge for the plastic surgeon when associated with exposed tendon and absent paratenon which make it difficult select the proper procedure due to tendon adhesions, poor range of motion (ROM), poor cosmesis and donor-site morbidity. The Integra Bilayer Matrix Wound Dressing (Integra Lifesciences, Plainsboro, NJ, USA) is a skin substitute already used in reconstructive surgery, including the incidental coverage of tendons. Integra dressing's post-operative functionality of the tendons, anyway, has not been well documented. We present our results on the Integra use for soft tissue reconstruction overlying tendons with loss of paratenon in the upper extremity soft tissue defects.

Materials and methods: We reconstructed 52 patients (45 men and 7 women) with exposed tendons due to trauma ($n = 47$), cancer excision ($n = 2$) or chronic wounds ($n = 3$) using the Integra dressing. Results obtained in a prospective manner including age, gender, wound location, wound size, time to final closure, operative time, follow-up length, split-thickness skin graft percentage taking and active post-operative ROM. Medline engine was used for a literature research of current surgical techniques for the treatment of exposed tendons and the results compared with our results.

Results: All patients healed with an average split-thickness skin graft take rate of 92.5% (SD 6.1; range 80–100%). The 42 patients not lost to follow-up achieved an average ROM of 91.2% (SD 6.5; range 80–100%).

Conclusions: The Integra dressing offers an ideal, efficient operative technique with minimal morbidity, assuring good morpho-functional results. Thus, the Integra dressing may offer an alternative, valid option

for immediate tendon coverage in the upper extremities reconstruction.

A-0560 Preliminary outcomes of distal radius fractures treated with PEEK volar locking plates

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Introduction: Volar plates have emerged as a popular method of treatment for internal fixation of displaced distal radius fractures. The radiolucency of the PEEK volar locking plate allows for the observation of bone details and facilitates preoperative reduction and radiographic follow-ups. The purpose of this study was to evaluate the clinical and radiological outcomes of this plate for displaced distal radius fractures.

Methods: Over a minimum 6-month follow-up period, 33 consecutive distal radius fractures were prospectively reviewed. The patients comprised 23 women and 10 men with an average age of 53 years (range 17–81 years). According to the AO fracture classification, 21 patients were type A, 1 patient was type B, and 11 patients were type C. The dominant hand was involved in 39% of cases ($n = 13$). The surgical procedure and postoperative rehabilitation were uniformly performed in all patients. The functional assessment was evaluated using the patient rated wrist evaluation (PRWE). The range of motion and grip strength of the operated wrist were measured and compared to the contralateral wrist. Volar tilt, radial inclination, and ulnar variance were measured using standard radiographs.

Results: At the minimum follow-up time of 6 months, the mean PRWE was 10.7 points. Comparing the operated and contralateral wrist, the mean range of motion in flexion–extension was 144.7° and 150.5° ($p = 0.34$), in prono-supination was 161.3° and 163° ($p = 0.54$), and in radial and ulnar inclination was 49° and 52° ($p = 0.44$), respectively. The grip strength was 98.8% for the contralateral side if the operated side was dominant and 82.4% if it was non-dominant. Comparing the operated wrist to the contralateral wrist, the mean volar tilt was 7.7° and 9° ($p = 0.09$), the mean radial inclination was 21° and 21° ($p = 0.99$), and the mean ulnar variance was -1.35 mm and -1.56 mm ($p = 0.6$), respectively. There were four complications (i.e. 12%) comprising two cases of Complex Regional Pain Syndrome, one case of frozen shoulder and one case of De Quervain's tenosynovitis; however, each complication had a favorable evolution with conservative treatment. There was no material-related complication.

Conclusion: The PEEK volar locking plate was shown to be a safe and effective treatment for distal radius fractures. It restored and maintained acceptable reduction and had a complication rate comparable to standard volar locking plates after a minimum of 6 months of follow-up.

A-0566 Think twice before re-manipulating distal metaphyseal forearm fractures

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Objective: Treatment of displaced pediatric distal forearm fractures is not always successful. Reoccurrence of angular deformity is a frequent complication. No consensus exists when to perform secondary manipulations. The purpose of this study was to analyse the long-term outcome of re-angulated pediatric forearm fractures to determine if re-manipulations can be avoided.

Methods: Children who underwent closed reduction for distal forearm fractures and presented with re-angulation at follow-up were included in this retrospective cohort study. We compared those that were re-manipulated to those managed conservatively. Re-angulation was defined as $\geq 15^\circ$ of angulation on either the AP or lateral view. Children were reviewed after 1–8 years post-injury. Outcome measures were residual angulation on radiographs, active range of motion, grip strength, Visual Analogue Scales (satisfaction, cosmetics, and pain), and the ABILHANDS-Kids questionnaire.

Results: Sixty-six children (mean age of 9.6 years) were included. Twenty-four fractures were re-manipulated and 42 fractures had been left to heal in angulated position. At time of re-angulation, children <12 years in the conservative group had similar angulations to those re-manipulated. Children ≥ 12 years in the re-manipulation group had significantly greater angulations than children in the conservative group. At final follow-up, after a mean of 4.0 years, near anatomical alignment was seen on radiographs in all patients. Functional outcome was predominantly excellent. There was no significant difference in functional, subjective, or radiological outcomes between treatment groups.

Conclusion: Re-manipulation of distal forearm fractures in children <12 years did not improve outcomes, deeming re-manipulations unnecessary. Children ≥ 12 years in the conservative group achieved satisfactory outcomes despite re-angulations exceeding

current guidelines. Based on observed remodelling, we now accept up to 30° angulation in children <9 years; 25° angulation in children aged 9–12; and 20° angulation in children ≥12 years, when re-angulation occurs. We conclude that clinicians should be more reluctant to perform re-manipulations.

A-0568 Corrective osteotomies for pediatric malunited forearm fractures: Who are the winners? A meta-analysis of individual participant data

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Objective: Malunions following forearm fractures in children occasionally cause functional impairment, for which corrective osteotomy can be an option to restore anatomy and increase range of motion. However, it is uncertain what functional gain can be expected for each individual patient. The aim of this study was to assess determinants of superior functional outcome after corrective osteotomy for pediatric malunited forearm fractures. This will aid surgeons in their decision-making whether or not to operate: Who are the winners?

Methods: We performed a meta-analysis of individual participant data according to the PRISMA-IPD meta-analysis statement. We searched multiple databases for prospective and retrospective cohort studies evaluating outcomes after corrective osteotomy. Eligible studies contained participants who underwent corrective osteotomy for pediatric malunited forearm fractures causing restricted pro-supination. Our primary outcome was gain in pro-supination. We analysed the following variables: age at trauma, time until osteotomy, single or both-bone fracture, malunion level, angular deformity, and use of 3-D computer-assisted techniques. After identifying optimal subgroup cutoff points via weighted Youden index, analysis of variance and multivariate regression were performed.

Results: Individual participant data of eleven cohort studies were included, concerning 87 participants. Corrective osteotomy provided a mean gain in pro-supination of 72° (±38°), from 68° preoperatively to 140° after a mean follow-up of 31 months (±28). Significantly greater gain in pro-supination was observed given: time until osteotomy <1 year (91° vs. 57°), angular deformity >22° (93° vs. 58°), and malunion

in the middle third (78° vs. 61°). Multivariate regression analysis revealed that time until osteotomy and level of malunion were independently associated with greater functional gain.

Conclusion: Based on this meta-analysis, better functional results can be expected after corrective osteotomy in a patient with a functionally limiting pediatric malunited forearm fracture, if corrective osteotomy is performed within 1 year after trauma and if the malunion is located in the middle third.

A-0569 The impact of diameter modification of human epineural sheath conduits using tissue adhesive on the recovery of 20-mm sciatic nerve gap in athymic nude rat model: A preliminary report

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Objective: Although nerve autograft is a gold standard for peripheral nerve repair, it has its limitations; thus, nerve allografts offer a boundless source of neural tissue (e.g. Epineurium), which can be modified to the recipient's injured nerve diameter to support nerve recovery. This study assessed the effects of human Epineural Sheath Conduit (hESC) adjusted with tissue adhesive on the regenerative potential of 20-mm long nerve defect in a nude rat model.

Methods: The size ratio between a human and a rat sciatic nerve is 10:1. Restoration of 20 mm of nude rat sciatic nerve defect, with epineural conduit created from human sciatic nerve and filled with saline, was tested in the nude rat experimental model – Group 1: autograft control ($n = 6$); Group 2: mismatched size diameter hESC ($n = 5$); Group 3: matched diameter hESC ($n = 6$); and Group 4: hESC with diameter adjusted with tissue adhesive ($n = 5$). The conduits were prepared by dissecting the epineurium from the fascicles of the sciatic nerve (Group 2) or its 1–2-mm diameter branches (Group 3). Group 4 was first dissected, followed by adjusting the diameter of the lumen of the conduit using Histoacryl Tissue Adhesive (n-Butyl-2 Cyanoacrylate). Following resection of 20 mm of sciatic nerve, epineural conduits were connected to the proximal and distal nerve stumps using 10-0 nylon sutures. Clinical assessment for weight loss, limb autocannibalization, hindlimb pressure sores, or signs of foreign body response (inflammation and edema) was conducted daily. Functional tests of toe-spread and pinprick analyses were performed at 1, 3, 6, 9, and 12 weeks after repair. At 12 weeks, nerve samples were harvested for toluidine

blue staining and for the presence of GFAP, NGF, S-100, and laminin B by immunostaining. Muscle denervation atrophy was determined using gastrocnemius muscle index (GMI) measurements.

Results: Daily clinical assessment confirmed that there were no signs of animal discomfort or foreign body reaction. At the end of follow up, Group 1 had the best functional recovery, followed by Groups 3, 4, and 2 (pinprick 3.0 vs. 2.0 vs. 1.6 vs. 1.0; toe-spread 1.83 vs. 1.0 vs. 0.8 vs. 0.4, respectively). Similarly, GMI was the highest for Group 1 (0.347) followed by Group 3 (0.274), Group 4 (0.261), and Group 2 (0.193). The macroscopic evaluation confirmed the preservation of shape and integrity of the human conduit. In addition, the nerve conduits showed good vascularization without tissue adhesion or local signs of inflammation in all groups. Toluidine blue and immunofluorescent staining results are currently under evaluation.

Conclusions: We established the feasibility of hESC creation and adjustment of nerve diameter discrepancy using tissue adhesive (*n*-butyl-2 cyanoacrylate). hESC adjusted with tissue adhesive (Group 4) showed sensory and motor recovery comparable to results achieved with matched diameter hESC repair (Group 3). Our new hESC offers a novel potential alternative to autograft nerve repair.

A-0572 The effect of intermittent pneumatic compression in occupational therapy following Dupuytren's fasciectomy – A prospective randomized controlled trial

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Introduction: Post-surgical rehabilitation after fasciectomy for Dupuytren's disease (DD) can include intermittent pneumatic compression (IPC). To our knowledge, no studies have been published whether IPC have an impact on patients' self-perceived performance of daily living with respect to edema, active range of motion (AROM), pain, and wound healing.

Methods: A prospective randomized controlled trial was conducted to evaluate the effect of IPC on patients' self-perception of performance in everyday living, edema, AROM, pain, and wound healing in rehabilitation compared with rehabilitation without IPC following Dupuytren's fasciectomy. Fifty-six patients were allocated to an intervention group or a control group. The primary outcome was patients' self-perception of performance in everyday living using the Canadian Occupational Performance Measure (COPM). Secondary outcomes were edema, active range of motion, self-reported pain, and time of wound healing. Measures were taken presurgery

and 3–5 days post-surgery and once a week until 6 weeks post-surgery and again 6 months post-surgery.

Results – preliminary: No statistically significant between-group difference for COPM scores was observed at 6 weeks (performance: adjusted mean difference -0.52 , 95%CI -0.78 to 0.67 , $p = 0.889$ and satisfaction: adjusted mean difference 0.02 , 95%CI -0.51 to 0.55 , $p = 0.947$) or at 6 months follow-up (performance: adjusted mean difference 0.57 , 95%CI -0.12 to 1.27 , $p = 0.107$ and satisfaction: adjusted mean difference 0.77 , 95%CI -0.02 to 1.55 , $p = 0.055$). For the secondary outcome, pulpa volar distance at 6 weeks and total active extension at 6 month, the between-group difference was significantly better in the IPC group.

Conclusions – preliminary: The use of IPC in combination with rehabilitation has no greater effect on patients' self-perceived performance of daily living than rehabilitation only following fasciectomy for DD. Even though the intervention group showed a significantly larger increase in ROM the differences were small and without clinical importance.

A-0573 Wide awake sonographically assisted percutaneous trigger finger release: A prospective study of 99 digits

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WALANT (wide awake local anesthesia no tourniquet) technique for percutaneous trigger finger release has become increasingly popular. The aim of this prospective study about 99 fingers is evaluate the feasibility and outcome of this technique and to propose a classification of the results. Eighty-nine patients has been operated under local anesthesia, with a simple 19G needle ultrasonographically with a high-frequency probe and at the end of the procedure, an intrasheath steroid injection. According to Quinell classification, 68 fingers (including the thumb) were classified as type 3 and 31 type 4. Criterias of exclusion were children, Quinell 1 and 2, and diabetes/rheumatoid diseases, or history/trauma/surgery of the flexor tendon. Pain was evaluated with the visual analogic scale (VAS: 0 if no pain to 10 if extremely intense). At 1-month follow-up, the results were noted as excellent, adverse event, complication and failure. There was no lost sight patients. The mean VAS was 1.45 (extreme 0–5). Eighty-seven fingers presented an excellent result. Twelve fingers had an adverse event (3 with a Dupuytren's brid on the scar, 3 with a slight swelling of the digit, 1 with a transitory

paresthesia of the fingertip, and 5 with a small lack of flexion of the digit). No one had a complication (no sign of infection, no tendon rupture, and no nervous section) or a failure, that is, with recurrence of the triggering.

The WALANT technique with ultrasonography allows the surgeon to perform an effective, painless percutaneous trigger finger release safely and quickly.

A-0577 Sirolimus-loaded in situ forming implants for regional immunosuppression in vascularized composite allotransplantation

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Objective: Vascularized composite allotransplantation (VCA), such as hand and face transplantation, is an emerging field in reconstructive transplantation. Since these are rather life enhancing than life saving procedures, the risks and benefits have to be carefully assessed. In order to reduce systemic side effects of immunosuppression, regional administration of drugs to the allograft, leading to high local drug levels, has been proposed in VCA.

Sirolimus (SIR) may promote regulatory T cell differentiation, which can contribute to peripheral tolerance. The aim of this study was to develop a SIR-loaded in situ forming implant (ISFI) for long-term regional release of SIR directly into the graft and to evaluate the release kinetics and allograft survival.

Methods: (1) In vitro, SIR-loaded ISFI (PLGA and *N*-methyl-2-pyrrolidone) were injected into a release medium and stored under horizontal shaking in an incubator at 37°C. Aliquots were taken at regular intervals and analyzed via high-performance liquid chromatography. (2) In vivo, naïve Lewis rats received subcutaneous injections of ISFI loaded with 5 mg of SIR ($n = 2$). SIR blood levels were monitored routinely by liquid chromatography/mass spectrometry. (3) Rats underwent hind limb allotransplantation (Brown Norway to Lewis) after an induction therapy with antilymphocyte serum

(day -4 and +1) followed by 7 days of tacrolimus (0.5 mg/kg/day intraperitoneally) and were assigned to three groups: control ($n = 9$), ISFI injection of SIR 5 mg into the transplanted hind limb (ISFI-ipsi, $n = 6$), or the contralateral hind limb (ISFI-contra, $n = 3$). Analysis of peripheral blood was performed using flow cytometry.

Results: (1) Repeated in vitro analysis shows a continuous, slow release of SIR over 2 weeks after a small initial burst release. (2) In vivo, SIR levels showed a burst release within the first 24 h, fell below the therapeutic window after 2 weeks and demonstrated a continuous release over >45 days. (3) Five milligrams of SIR suppressed rejection after a single injection on POD 7 for >100 days in 83.33% of ISFI-ipsi. ISFI-contra showed a survival of 68.5, controls of 29 days. ISFI-contra showed a trend toward higher levels of chimerism and T-reg count than ISFI-ipsi.

Conclusion: One time application of ISFI shows feasibility to suppress rejection for >100 days under subtherapeutic systemic levels, while fulfilling the requirements of biocompatibility and prolonged release over >2 weeks. Regional application of ISFI may reduce overall systemic toxicity and adverse effects in VCA.

A-0582 Results of 253 Rubis II reverse trapeziometacarpal prostheses at 10 years follow-up

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The objective was to assess the clinical and radiological results of the Rubis II trapeziometacarpal reverse prosthesis, at a mean follow-up of 10 years. Between 1997 and 2008, 253 prostheses have been implanted in 199 patients among whom 115 were reviewed. Mean 10-year survival was 89%. Patients were mainly young retired (mean age 61 years). At last follow-up, 69% of prostheses were painless while others were responsible for moderate and intermittent pain. Satisfaction rate was 98%. Mean opposition was 9.3 and mean QuickDASH was 29.8. Wrist, key, and tip pinch strengths were comparable to the non-operated side. One loosening (1%) and 10 dislocations (9.5%) were observed, mostly caused by trauma (90%), leading to a surgical revision for 11 thumbs. This study confirms the good clinical results of the Rubis II prosthesis that are maintained in the medium and long term and represents a useful alternative to trapeziectomy for selected patients.

A-0586 Medium-term results of free vascularized scaphoid reconstruction with a femoral condyle graft

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Purpose: In complicated scaphoid pathologies, reconstruction using free vascularized medial femoral condyle grafting is our preferred approach. Analysis of our medium-term results is necessary to reevaluate the significance of this technique and to present the clinical and radiological findings.

Materials and methods: Based on our first results in 2011, we plan a retrospective study of 39 patients treated with a free corticocancellous medial femoral condyle graft between September 2008 and December 2010. The indications were long-standing non unions, avascularity of the proximal pole, extensive humpback deformity, or multiple previous operations. Clinical and radiological reexamination including a Disabilities of the Arm, Shoulder and Hand (DASH) score and a modified Mayo Wrist Score will be performed again after a mean follow-up time of 65 months.

Results: In the previous study 2011, we found 63% of 49 patients radiologically definitely healed. Clinical results were good. The mean DASH score was 20, the mean modified Mayo Wrist Score 74 points. Specific complications were ossification of the pedicle in four cases, loosening of the screw in three cases and one femoral fracture after heavy trauma. Main complications were nonunion in eight cases and osteoarthritis in four cases requiring a four corner fusion in four of these cases. New research will show us, if and to what extent clinical and radiological results will deteriorate in the course of time.

Conclusions: First medium-term results of free vascularized reconstruction of the scaphoid using a corticocancellous medial femoral condyle graft show that this technique seems to be a valuable tool in difficult scaphoid pathology. Successful results require a perfect planning and performance of all aspects of this operation. Nevertheless failures cannot be avoided completely. Medium-term results will show us, if this demanding technique leads to clinical significant complications in the course of time or to long-lasting successful results, so that we will be able to better judge the true value of this procedure.

A-0589 Hand infections in patients with human immunodeficiency virus

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Introduction: Human immunodeficiency virus (HIV) is common in South Africa, affecting approximately 1 in 10 people in the general population. Currently, the literature is deficient in providing evidence for a relationship between HIV infection, CD4 count, and the ability to clear sepsis.

Methods: We conducted a prospective cohort study of 213 patients with hand infections seen during a 3-month period. Mechanism of injury, microbiological culture and sensitivities, and comorbidities including HIV, diabetes, and substance abuse were recorded. The severity of infection in terms number of procedures, length of hospital stay, functional deficit, and need for ablation was recorded. Significance testing with the Fisher's exact test was conducted.

Results: Thirteen patients had incomplete records, declined HIV testing, or defaulted follow-up. The prevalence of HIV in the study group was 24%, and 75% of these patients were previously undiagnosed. Staph aureus was the offending organism in the majority of cases, however, diabetics and patients with HIV showed an increased propensity for other organisms. Flucloxacillin provided inadequate cover in 40% of patients with HIV or diabetes. The majority of patients with hand infections were management successfully with a single procedure as outpatients, however, patients with diabetes, bite injuries, and HIV positive patients with a CD4 count <150 had an increased risk of multiple surgeries, prolonged hospital stay, functional deficit, and ablation.

Conclusion: HIV is two to four times more prevalent in patients with hand infections and often diagnosed for the first time in the hand unit. Hand infections in patients with no comorbidities can be successfully managed in an outpatient setting with a single procedure and flucloxacillin. Bite injuries and hand infections in patients with diabetes or HIV positive patients with a CD4 count <150 require more aggressive surgery, inpatient care, broad spectrum antibiotics, and are at higher risk of ablation.

A-0590 Comparison of outcomes from mixed nerve reconstructions in the upper extremity with processed nerve allografts and nerve autograft from a National Registry Study

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Objective: Historically, the standard for mixed nerve gap repairs has been the nerve autograft. Processed

nerve allografts (PNAs; Avance® Nerve Graft, AxoGen Inc.), commercially available since 2007, have been established as a viable alternative for the reconstruction of peripheral nerve injuries as previously reported in a national registry. To evaluate for potential variations in recovery to the historical standard, controls were added to the registry at select participating centers. Here, we report our findings on the functional outcomes of mixed nerve repairs utilizing either PNA or nerve autograft for gaps up to 70 mm.

Methods: The RANGER registry is an active database designed to continuously monitor and collect injury, repair, safety, and outcomes data for PNAs and includes a contemporary control to allow for comparison of recovery outcomes to other repair modalities. The current database was queried for subjects presenting with upper extremity mixed nerve gap injuries up to 70 mm repaired with either PNA or nerve autograft at participating centers. Identified subjects reporting quantitative outcomes with a minimum of 9 months follow-up were included in this data set. Subject demographics and repair characteristics and recovery of function were compared. Meaningful recovery was based on the last reported follow-up visit with quantitative functional outcomes data. To be consistent with much of the relevant literature, we considered scores of S3/M3 (MRCC scale) or greater as indicative of meaningful recovery. For mixed nerve repairs providing both a sensory and motor MRCC score, the higher of the two was used as the indicator of the level of recovery.

Results: Twenty-one subjects with 23 injuries were included. The groups consisted of PNA ($n = 14$) and nerve autograft ($n = 9$). Subject demographics, medical history, and concomitant injuries were comparable between treatment groups, however, the PNA group reported a higher incidence of high-energy traumatic injuries. There were 12 median, 9 ulnar, and 2 radial nerve repairs. Repair techniques varied between the groups. The PNA repairs included size-matched fascicular or caliber-matched epineural repairs while all the nerve autografts used a multi-stranded cabled repair approach. The average nerve gap between the groups varied at 30 ± 14 mm and 44 ± 11 mm for PNA and nerve autograft, respectively. Available quantitative data reported meaningful recovery in 86% in PNA group as compared to 89% for nerve autograft. Return of sensory and motor function were reported at higher levels (\geq S3+/M4) in both groups. There were no reported adverse events related to the treatment groups.

Conclusions: Outcomes from this analysis demonstrate that PNAs can successfully be used to repair mixed nerve injuries for return of sensory and motor function. Reported levels of meaningful recovery for

PNAs were comparable to nerve autograft. These outcomes were comparable to those reported in historical literature. The registry remains ongoing, expansion from participating sites will allow for further comparisons to study controls.

A-0592 Characterization of processed human nerve allograft with an organotypic neurite outgrowth measurement

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Introduction: Material biological activity (bioactivity) provides implantable products with the ability to support a specific biological effect after implantation and is an important design consideration, especially in peripheral nerve repair products. Bioactivity of peripheral nerve implants allows for axonal and Schwann cell migration, which is necessary for functional recovery. Passivation of bioactivity may be achieved by chemical alteration of the implant substrate, independent of structural alterations, through use of chemical cross-linking agents such as formaldehyde. Organotypic culture-based assays with early postnatal rat dorsal root ganglia (DRG) provide an assessment of bioactivity through neurite outgrowth measurement in three-dimensional physical constructs of the nerve graft.

Methods: Processed nerve grafts were brought to equilibration in culture media (Standard group). Bioactivity passivation was performed by exposing the nerve graft to formaldehyde solution, multiple saline washes, and culture media equilibration (ChemP group). A DRG from a Sprague Dawley rat pup aged p3–p7 was placed on the end of each nerve graft (both groups), secured with a thin film of collagen gel, and cultured for 7 days. Longitudinal histological sections of the cultured grafts were prepared for immunohistological staining with β III-tubulin for axons or S100 for Schwann cells. Histology slides were imaged to measure the neurite or Schwann cell outgrowth length and the intra-fascicular or extra-fascicular outgrowth of the neurite. The maximum outgrowth was determined by averaging the three longest neurites in each sample, with group comparisons for treatment effects.

Results: The Standard group average maximum neurite outgrowth was 2498 μ m, while the ChemP group had less extensive outgrowth at 732 μ m average maximum neurite outgrowth into nerve grafts. Similar Schwann cell outgrowth patterns were noted in S100-stained slides. The Standard group exhibited 96% intra-fascicular extension of the longest neurites, whereas the ChemP group exhibited 42% intra-fascicular extension.

Conclusions: A three-dimensional organotypic assay can assess bioactivity of peripheral nerve repair implants. Under standard conditions, high levels of neurite outgrowth were observed in processed human nerve allografts, demonstrating quantifiable bioactivity. The nerve structure was unaltered by formaldehyde treatment of the ChemP group, when compared to the Standard group. Exposure of the processed human nerve allograft to formaldehyde resulted in bioactivity passivation, observed in both the maximum neurite outgrowth and fraction of intra-fascicular growth. This methodology can readily assess the bioactivity of peripheral nerve implants and provides a novel approach for measuring adjunctive regenerative therapies with peripheral nerve scaffolds.

A-0593 Obesity is associated with increased postoperative complications after operative management of distal radius fractures

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Objective: Given the increasing prevalence of obesity, it is of utmost importance to anticipate and counsel on possible complications following fixation of distal radius fractures (DRFs). This study elucidates the possible complications of common DRF fixation methods.

Methods: All data were derived from a publicly available, subscription database of patients, the Pearl-Diver Patient Records Database which is searched utilizing ICD-9 codes. The database was queried for open reduction and internal fixation of distal radius fractures using CPT codes 25607, 25608, and 25609. Patients in each operative group were then divided into nonobese (body mass index (BMI) < 30 kg/m²), obese (BMI 30–40 kg/m²), and morbidly obese (BMI > 40 kg/m²) cohorts using ICD-9 codes for obesity, morbid obesity, and BMI. Basic demographics and comorbidities were then queried for the selected patients.

Results: One hundred forty-three thousand three hundred thirty-eight unique patients (143,338) who underwent operative management of distal radius fractures were identified from 2005 to 2012. The obese and morbidly obese cohorts had significantly higher rates of most assessed medical comorbidities compared to nonobese patients. Specifically, morbidly obese patients had significantly higher rates of postoperative carpal tunnel syndrome (odds ratio [OR] 1.4, $p < 0.0001$), carpal tunnel release (OR 1.5,

$p < 0.0001$), infection (OR 4.1, $p < 0.0001$), tendon rupture (OR 1.9, $p = 0.012$), wrist/hand osteoarthritis (OR 1.6, $p < 0.0001$), venous thromboembolism (OR 2.1, $p < 0.0001$), and medical complications (OR 1.9, $p < 0.0001$) compared to nonobese patients. Compared to obese patients, morbidly obese patients had significantly higher rates of infection (OR 1.9, $p < 0.0001$), venous thromboembolism (OR 1.2, $p = 0.036$), and medical complications (OR 1.3, $p < 0.0001$). Obese patients had significantly higher rates of postoperative carpal tunnel syndrome (OR 1.4, $p < 0.0001$), carpal tunnel release (OR 1.3, $p = 0.001$), infection (OR 2.1, $p < 0.0001$), tendon rupture (OR 1.4, $p = 0.157$), wrist/hand osteoarthritis (OR 1.2, $p = 0.041$), venous thromboembolism (OR 1.7, $p < 0.0001$), and medical complications (OR 1.4, $p < 0.0001$) compared to non-obese patients.

Conclusions: The obese or morbidly obese is more likely to have suffered a complication from operative treatment of their DRF when compared to their non-obese counterparts.

A-0594 Outcome assessment by gap length of digital nerve gap reconstructions with processed nerve allografts and manufactured tube conduits from a National Registry Study

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Objective: Processed nerve allograft (PNA) and manufactured tube conduit both offer convenient nerve gap repair options during hand surgery. Despite the common nature of the injury, no consensus exists as to the optimal treatment for digital gaps across 20 mm in length. To evaluate for potential variations in recovery with these repair methods, a national registry was queried and analyzed to determine the differences in outcomes of digital nerve repairs at increasing gap lengths.

Methods: The RANGER registry is an active database designed to continuously monitor and collect injury, repair, safety and outcomes data for PNA (Avance® Nerve Graft, AxoGen, Inc.), and includes a contemporary control to allow for comparisons of recovery outcomes to tube conduits. The database was queried for digital nerve injuries with gaps up to 20 mm with a minimum of 6 months follow-up. Complex mechanisms of injury such as amputations, gunshot, and avulsions injuries were excluded from the data

set. The data set was stratified into two gap length groups, gaps ≤ 10 mm and 11–20 mm. Comparisons of meaningful recovery outcomes were completed by repair method between and across the gap length groups. Meaningful recovery was defined as $\geq S3$ with higher thresholds of recovery defined at S3+ or greater. Statistical significance between treatment groups was evaluated using Fisher's exact test; $p < 0.05$ was considered significant.

Results: There were 38 subjects and 63 nerve injuries included in the data set. The ≤ 10 mm gap group consisted of 20 PNA and 8 conduit repairs. The 11–20-mm gap group consisted of 20 PNA and 15 conduit repairs. Subject, medical history, and concomitant injuries were comparable between treatment groups. Most of the repairs were conducted acutely, within 20 days of the original injury. No adverse events directly attributed to either type of repair were reported. Overall, PNA repairs resulted in a significantly higher rate of meaningful recovery compared to conduit repairs (90% vs. 48%, Fisher's exact test $p < 0.001$). In the ≤ 10 mm gap group, PNA and conduit reported 100% and 75% meaningful recovery, respectively, with no revisions. In the 11–20-mm gap length group, PNA and conduit reported 80% and 33% recovery, respectively ($p < 0.0132$), with four revisions reported in the conduit group.

Conclusions: Repair with PNA resulted in better recovery of sensory function compared to the manufactured conduit group, especially for gaps in the range of 11–20 mm. There were no reported adverse events. Comparisons within the conduit group reported a statistically significant difference by gap length with ≤ 10 mm repairs reporting more consistent levels of recovery as compared to poorer levels of recovery seen in the 11–20-mm subgroup. The registry is currently ongoing, additional data collected will allow for further comparisons of PNA to conduit.

A-0597 Efficacy of extracorporeal shock wave therapy as a novel conservative therapy for Kienböck disease

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Hypothesis: We have been applying extracorporeal shock wave therapy (ESWT) to Kienböck disease (KD) and have been observing a favorable outcome since

2011. Our hypothesis is that ESWT is effective and safe for the treatment of KD.

Methods: Fourteen wrists in 14 patients with KD were prospectively evaluated for a minimum of 6 months and a mean of 19 months of follow-up. Nine males and five females with a mean age of 65 were recruited for the study. According to Lichtman's classification, three wrists were classified as grade 2, six wrists were classified as grade 3a, and five wrists were classified as 3b. ESWT was applied to the patients who had no improvement with splint therapy for 1 month. Using Dornier Epos® (Dornier, Germany), ESW was applied to the lunate 5000 times once per month and repeated for three consecutive months. We evaluated using the visual analog scale (VAS) at rest and on exertion, used Quick Disabilities of the Arm, Shoulder and Hand (DASH), and monitored arc of motion of wrist, grip strength, and Mayo wrist score at initial visit and final follow-up. Comparisons were performed using a Wilcoxon signed-rank test. Magnetic resonance image (MRI) was also evaluated before and at 6 months after ESWT.

Results: Before ESWT, VAS was 18 ± 11 at rest and 51 ± 22 on exertion, QuickDASH was 34 ± 18 , the arc of wrist was $89 \pm 35^\circ$, grip strength was $69 \pm 24\%$ at the contralateral side, and Mayo wrist score was 73 ± 25 . After ESWT, VAS was 15 ± 10 at rest and 21 ± 17 on exertion, QuickDASH was 10 ± 13 , the arc of wrist was $127 \pm 40^\circ$, grip strength was $84 \pm 29\%$ at the contralateral side, and Mayo wrist score was 87 ± 23 . All items except VAS at rest improved significantly following ESWT. However, there was no wrist in which signal intensity improved in the T1-weighted image by MRI. There was no patient whose symptoms deteriorated or had other symptoms after ESWT.

Summary points: ESWT was very effective for KD, improving not only VAS on exertion but also the arc of wrist and grip strength without adverse effect. Although a randomized control study is necessary to prove that the outcomes are resultant of ESWT rather than natural processes, ESWT has a possibility of becoming established as a standardized conservative therapy for KD.

A-0600 Should nontraumatic trapeziometacarpal instability be treated surgically?

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Objective: Nontraumatic trapeziometacarpal instability is characterized by attenuation of ligamentous and

capsular structures and hypertrophy of the abductor pollicis longus (APL) tendon. Patient present with pain related to some repetitive, high demand and long-lasting activity, regardless of their age (young musicians and students are frequently affected). Stress X-rays reveal unstable TMC joint in all cases. All traditional techniques seem to be 'too aggressive' given that pain disappears if the activity is discontinued. It is possible to reduce pain and increase thumb stability with a proportionate surgical procedure that seeks to reduce what is excessive and compensate what is absent.

Methods: Surgical technique: A V-shaped dorsoradial incision is performed, with direct approach to APL tendon and volar trapeziometacarpal joint. Accessory tendons to APL (APLA) are identified and sectioned as proximal as possible, remaining distally based. The most suitable strip of APLA is chosen and woven into the oblique anterior and oblique posterior ligaments, obliterating the anterior defect on the articular capsule. The tendon is tied and secured with absorbable braided blocking sutures. A minimal thumb spica cast in abduction and opposition is placed (IP joint is not immobilised). The thumb cast is worn for 3 weeks, and active use of the hand is encouraged during this period. Subsequently, a small removable cast is worn during nighttime for 6 more weeks. We present 27 consecutive cases (23 women and 4 men), between 7 and 53 years of age, who consulted for thenar pain and instability of the thumb. We evaluated preoperative and postoperative QuickDASH scores, pain (AVS), thumb CMC stability, preoperative and postoperative lateral pinch strength, and postoperative Kapandji thumb opposition test.

Results: Mean preoperative QuickDASH was 23 and mean postoperative QuickDASH was 8. Three months after surgery, all patients were pain free. Postoperative course was uneventful in all patients. No patient reported symptoms of instability and all thumbs appeared stable on physical examination. There was a slight increase in mean lateral pinch strength and all patients scored 9 or higher in the Kapandji test.

Conclusions: Trapeziometacarpal instability is probably an often overlooked entity rather than a rare condition and the number of the patients requiring surgical treatment is currently increasing, probably due to the changes in use of the thumb. This technique uses supernumerary tendons that are directly involved in the pathogenesis of both thumb CMC instability and arthritis to reinforce the articular capsule and avoid any morbidity derived from harvesting FCR or ECRL. Our results are consistently good in a wide range of ages and professions.

A-0601 Scapholunate ligaments fixation with dorsal and volar approach: Medium- to long-term results

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Objective: We present our novel surgical technique, and its clinico-radiographical outcome, in the treatment of Scapholunate (SL) dissociation. It consists in the repair of both dorsal and volar SL ligaments through a double dorsal and volar surgical approach.

Methods: From 2000 to 2010, 20 wrists (11 right and 9 left) of 20 patients (17 males and 3 females, with mean age 40 years, min. 22 years, max. 73 years) were operated on with this technique. SL dissociation was acute in 12 cases, subacute in 4 cases, and chronic in 4 cases. All the 20 patients were clinically and radiologically evaluated with a mean follow-up of 125 months (i.e. 10 years), min. 66 months, max. 180.

Results: Pain was absent in 13/20 cases (65%), wrist motion recovered more than 80% respect to the contralateral side in 12/20 cases (60%), and grip and pinch strength recovered more than 90% respect to the contralateral side in 13/20 cases (65%). At X-ray check-up SL reduction was maintained in 18/20 cases (90%), while only in 2/20 cases (10%), reduction failed into relapse. SL angle increased only in 2/20 cases (10%). Carpal height decreased in 3/20 cases (15%).

Conclusions: Our clinical and radiological results, with the maintenance of a good correction of the SL dissociation in most of the cases and up to 15 years, support the choice of the double dorsal and volar approach in repairing both dorsal and volar SL ligaments when dealing with an SL dissociation.

A-0603 Forced expiration lead to increased glenohumeral and decreased scapulothoracic joint motion during arm elevation in children with OBPP: 3-D analysis of a new test

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Objective: Altered scapulothoracic rhythm is observed in children with obstetrical brachial plexus injury (OBPI), which is characterized by increased scapulothoracic (ST) motion, decreased glenohumeral (GH) motion, and decreased GH:ST ratio during arm elevation. Excessive contribution of ST joint to shoulder motion contributes to the development of secondary musculoskeletal pathologies, poor functional outcomes following shoulder tendon transfers and inaccurate clinical assessments. Prevention of compensatory ST motion is addressed throughout the rehabilitation process to increase the quantity and the quality of shoulder movements. The activation of core muscles (transversus abdominis and multifidus), which is induced by forced expiration, has been demonstrated to prevent compensatory movements of the proximal segments during arm elevation. We proposed that performing shoulder movements with forced expiration could decrease compensatory contribution of ST motion through improved proximal stabilization. The purpose of this study was to describe a new test – implementing forced expiration during motions, namely ‘blow out the candles’ – and to investigate the effects of this test on scapular motion.

Methods: A total of 15 children (6 boys and 9 girls) with a mean age of 9.35 years (range 7–12) were included in the study. Three-dimensional scapular and humeral kinematic recordings of scapular internal–external rotation, upward–downward rotation, and anterior–posterior tilt were measured during scapular plane shoulder elevation on the involved side via the Flock of Birds (Ascension Technologies Inc, Burlington, Vermont, USA) electromagnetic tracking device. Humerothoracic (HT) elevation was analyzed in every 10° of elevation and lowering with and without forced expiration. To perform this test, the physiotherapist held a handkerchief in front of the child and asked as though he/she was blowing out a birthday candle to make her/him perform forced expiration during the motion. Five repetitions of HT elevation and lowering in slow speed but without stopping were completed. The movement was guided by a wooden pole. Wilcoxon test used for statistical comparisons for scapular kinematics data between conditions. Data were given as median and the interquartile ranges (median (IQR)).

Results: Comparisons between elevation trials performed without and with forced expiration indicated that scapula was more downwardly rotated at 10° (median (IQR)); [13.2 (7.8), 13.08 (11.7)]; $p = 0.02$, respectively), 20° (10.8 (12.9), 8.4 (9.7)]; $p = 0.01$, respectively), and 30° of HT elevation [6.8 (15.9), 5.4 (13.5)]; $p = 0.04$, respectively) with forced expiration. In addition, scapula was more internally rotated at 40°

HT elevation [40.6 (19.5), 39.1 (16.5)]; $p = 0.04$, respectively) and more externally rotated at 80° HT lowering [41.5 (21.7), 42.1 (21.4)]; $p = 0.01$, respectively) with forced expiration.

Conclusions: Forced expiration through arm elevation is demonstrated to improve scapula stabilization leading to increased GH and decreased ST motion. Implementing this method into clinical assessments may help to accurately assess the functional improvements, which are possibly masked by compensatory motions, following surgery or rehabilitation. In addition, deep breathing may be integrated into exercises from the early stages of rehabilitation to optimize scapular motion in OBPI.

A-0604 In vivo measurement of distal radioulnar joint instability following distal radius fracture

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Objective: The incidence of distal radioulnar joint (DRUJ) instability following a distal radius fracture is estimated in previous publications around one of three based upon clinical examination. An objective measure of DRUJ shear in vivo has been established. We used this to measure DRUJ stability following distal radius fracture.

Methods: Dorso-palmar translation of the DRUJ was measured in 50 adults with previous distal radius fractures. These were analysed against the fracture of the distal radius, position of bone union, and injury to the ulnar styloid. Measurements were compared of the injured against the uninjured, contralateral uninjured wrist. The data were compared with a previous database of measurements of DRUJ shear.

Results: Translation at the DRUJ wrists was greater in nearly all of the injured than the uninjured wrists. DRUJ translation was almost always outside the established ranges for normal DRUJ translation (4–9 mm). There was no statistically significant link between the degree of DRUJ shear and the severity of the injury as measured radiologically.

Conclusions: This is the first study measuring DRUJ instability following distal radius fractures rather than just assessing it clinically. The data show that DRUJ instability is almost inevitable following wrist fracture. This challenges previous published work. It also implies that biomechanical rather than clinical measurement of DRUJ may be important in further understanding these problems. It may be that some DRUJ instability is part of the mechanism of energy dissipation reducing the risk of a more severe wrist injury.

A-0608 Free vascularized fibular graft for upper limb reconstruction: Is it still a valuable option? A long-term follow-up of our case series

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Introduction: Large post-traumatic bone defects of upper limb have always been a major concern for hand surgeons. Depending on the size of the bone loss and nonunion, different grafts can be used, either vascularized or not. For decades, free vascularized fibular graft has been the gold standard to fill bone gaps of more than 6 cm, either as a whole or in its 'double-barrel' version. We present a long-term follow-up of our case series of free VFG for upper limb reconstructions.

Methods and Materials: Since 2001, in our Institution (Hand Surgery Unit, CTO Trauma Center, Turin, Italy), 19 cases of free VFG have been performed for treatment of complex post-traumatic nonunions of the arm and forearm, with a bone loss of more than 6 cm. Among these, all patients with at least 10 years of follow-up have been selected. This group was composed by 13 patients (10 men and 3 women). Mean age at the time of surgery was 32 years. Mean follow-up was 11.2 years. In nine cases, there was an involvement of the radius and in four cases of the ulna, with a mean bone defect of 8.7 cm. All grafts were fixed with LCP plates and in two cases, autologous platelet-rich plasma gel was added. Two patients had a concomitant arthrodesis of the wrist. All patients were evaluated preoperatively with angiography and/or magnetic resonance imaging. Either objective (pain, range of motion (ROM), and grip strength recovery) or subjective (Disabilities of the Arm, Shoulder and Hand (DASH) score) and radiological outcomes were evaluated.

Results: Both functional recovery and patients satisfaction were good and increased with time. Mean visual analogic scale (VAS) score was 3.4, mean wrist ROM of 126° in flexion–extension and 97° in pronosupination, and mean grip strength was 73% compared to contralateral side. Mean DASH score was 17.3 and 11/13 patients returned to their previous working activity. We had no complications such as bone fractures or hardware mobilizations. All wounds healed primarily and no patient had problems related to the donor leg. Radiologically, 12/13 nonunions healed within an average time of 5.2 months. A continuous remodeling of the callus was observed over time and after 10 years, a hypertrophy of the fibula was evident in nine cases.

Conclusions: Free-vascularized fibular graft is nowadays the gold standard technique to treat large bone defects of upper limb. The outcomes observed in our case series were satisfying and in line with those found in literature. It is important to underline that an accurate preoperative planning is crucial to identify the patients requiring such treatment, without forgetting all the possible alternatives (vascularized or nonvascularized iliac crest grafts, allografts, etc.). It is crucial a strict postoperative protocol because the healing process can be very long (up to 1 year). After a 10-year follow-up, it was possible to observe complete integration of the graft, with a hypertrophy of the fibula adapting to the new environment.

A-0613 Radioscapholunate fusion for SLAC 2 wrist and post-traumatic radiocarpal joint osteoarthritis: A comparative analysis

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Objective: To identify if there are differences in results when radioscapholunate (RSL) fusion was performed for SLAC 2 wrist compared to RSL fusion performed for post-traumatic osteoarthritis of the radiocarpal joint. To determine if RSL fusion, with a view to preserving midcarpal motion, is a viable third option for treating SLAC 2 wrists in addition to the popular treatments of proximal row carpectomy and four corner fusion.

Methods: A retrospective analysis of all patients who had undergone RSL fusion between 1997 and 2014 for either SLAC 2 wrist or post-traumatic radiocarpal arthritis was performed. All patients identified were invited to take part in the study and attend for outpatient clinical assessment. Outcome measures included Disabilities of the Arm, Shoulder and Hand (DASH) and PRWE functional questionnaires, pain visual analogic scale (VAS) scores, wrist range of motion, and grip strength. Follow-up X-rays were also taken and assessed for evidence of bony union, loosening of metalwork and midcarpal arthritis.

Results: Twenty-four RSL fusions were identified which were eligible for analysis: 11 in the SLAC group and 13 in the post-traumatic osteoarthritis (PTOA) group. The mean age at time of surgery was 52 years (46–80) and 53 years (29–74) in the SLAC and PTOA groups, respectively. The median follow-up time 24 months (12–72) in the SLAC group and 39 months (12–184) in the PTOA group. There was a total of four RSL failures (three in the SLAC group) which had gone on to complete wrist fusion during the follow-up period. The SLAC group had mean range of motion values of

28.3–33.2° (flexion–extension) and 10.75–13.0° (radialulnar deviation) and mean grip strength of 26.8 kg. The PTOA group had mean range of motion values of 30.6–24.4° (flexion–extension) and 17.6–15.1° (radialulnar deviation) and mean grip strength of 20.4 kg. The SLAC group had mean DASH and PRWE scores (max. 100) of 26.5 and 34.9. The PTOA group had mean DASH and PRWE scores of 32.6 and 39.4.

Conclusions: Rate of RSL failure was higher in the SLAC group than the PTOA group (27% vs. 7.7%). The SLAC group demonstrated better grip strength. Range of motion was comparable in both groups. However, range of motion was still less than that achieved following four corner fusion for SLAC wrist in other published series. Functional scores of DASH and PRWE were better in the SLAC group. RSL fusion performed for SLAC 2 wrist can achieve good functional results, but performing RSL fusion for SLAC 2 wrist is more technically demanding than for PTOA. Despite achieving good functional outcomes in our series, the high rate of failure and better comparative results of four corner fusion for SLAC 2 wrist may make four corner fusion the better option.

A-0614 Resurfacing Capitate Pyrocarbon Implant versus first row carpectomy alone: A comparative study to evaluate the role of capitate prosthetic resurfacing in advanced carpal collapse

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Objective: In the past decade, the Resurfacing Capitate Pyrocarbon Implant (RCPI) associated to first row carpectomy (FRC) has been used to treat symptomatic advanced carpal collapse, widening the indications of FRC to patients with capitate head arthritis. In order to prove its efficacy, we retrospectively compared our case series of RCPI associated with FRC vs. FRC alone, analyzing whether outcomes of the prosthetic implants could be similar to those of FRC even if starting from a higher stage of osteoarthritis (OA).

Methods: Among all patients who underwent surgery for wrist OA in our Hand Surgery Department between July 2007 and August 2013, 50 patients, with similar population characteristics and disease etiology, with a minimum follow-up of 2 years, were retrospectively selected. Twenty-five patients, presenting SLAC-SNAC stage III–IV and Kienbock stage IV underwent FRC + RCPI implant (Group A); 25 patients with SLAC-SNAC stage I–II and Kienbock stage III underwent FRC alone (Group B). The mean follow-up was 34 months (min. 24 and max. 89) for

Group A and 32 months for Group B (min. 25 and max. 56). All patients were clinically (pain, range of motion, and grip strength) and radiographically evaluated. PRWE and Disabilities of the Arm, Shoulder and Hand (DASH) scores were assessed. Similarly, return to previous working and sport activities was investigated.

Results: In Group A, patients showed consistent pain relief (VAS 2.52), while preserving wrist mobility (mean FE 25.6–31.6°) and grip strength (53% compared to contralateral side), with a satisfactory recovery allowing previous working activities. The average DASH score was 24.2 and the average PRWE score was 32.8. No implant mobilization or capitate fracture was detected during the follow-up. One patient presented volar carpal dislocation 1 week after surgery and underwent immediate open reduction and stabilization. One case of persistent pain and poor grip strength recovery lead to surgical revision with total wrist arthrodesis 1 year later. No acceleration of distal radial OA was observed. No statistically significant difference was underlined by statistical analysis among Groups A and B for all the measured outcomes and scores, except for a better extension ($p < 0.05$) in Group B. Similarly, a supplementary group analysis, according to patient age and diagnosis, did not show any differences in pain, range of motion, and grip strength. Consistently, DASH and PRWE scores were not found to be statistically significant between the examined groups.

Conclusions: According to these outcomes, even starting from a higher grade of OA (SNAC/SLAC stage III or IV), RCPI associated to FRC showed satisfying results, comparable with those obtained with FRC alone at a follow-up of more than 2 years. These data support the hypothesis that indications of FRC can be widened by using the RCPI, without worsening the outcomes. RCPI could therefore be considered a useful alternative to more aggressive salvage procedures in case of capitate head and lunate fossa OA involvement. A higher number of patients and a longer follow-up are needed to fully evaluate the role of these implants in the future.

A-0628 Reconstruction of the proximal pole of the scaphoid using a vascularized osteochondral femoral trochlea flap – A single surgeons experience

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Objective: Reconstruction of a destroyed proximal pole of the scaphoid using a vascularized osteochondral femoral trochlea flap is now the treatment

of choice in this difficult situation. This presentation reports the preliminary results of this procedure in a single surgeon's experience with emphasis on difficulties, pitfalls, and failures.

Methods: From 01.09.2011 until 31.12.2014, the senior author operated 36 patients (31 men and 5 women) using a vascularized osteochondral femoral trochlea flap to reconstruct a destroyed proximal scaphoid pole. Destruction of the proximal scaphoid was caused by a nonunion in 27 cases and by a Preiser's disease in 9 cases. Technical aspects were fixation of the graft using a screw from dorsal and vascular anastomoses to the radial artery and vein on the palmar side. Twenty-five patients could be reexamined after a mean follow-up time of 1.4 (minimum: 0.4 and maximum: 2.9) years. Follow-up examination consisted of a clinical examination including the history and establishing a Disabilities of the Arm, Shoulder and Hand (DASH) score and a modified Mayo wrist score according to Krimmer. Objective data of the other patients with incomplete follow-up were included in the evaluation of the results.

Results: Clinical results of the 25 patients with complete follow-up were good with a mean DASH score of 19 (minimum: 0 and maximum: 60) and a mean modified Mayo wrist score of 73 (minimum: 45 and maximum: 98) points. Bony consolidation could be found in 29 (81%) of all 36 patients. In the patients with Preiser's disease, bony healing was confirmed in 6 (67%) of 9, and in the patients with scaphoid nonunion in 23 (85%) of 27. Acute revision surgery was necessary because of hematoma in three cases and because of compartment syndrome in one case. Minor revisions were done to remove exostoses in three cases and hardware in six cases. Salvage procedures are documented in four patients – 1 four corner fusion because of persisting nonunion and 2 four corner fusions and one proximal row carpectomy because of secondary osteoarthritis after bony healing. With regard to the knee only, one patient needed a surgical revision and no patient had persisting problems with the knee. Analysis of the failures revealed technical problems especially in patients with complex defects combined with humpback deformity resulting in secondary osteoarthritis. But in six of the patients with persisting nonunion, we were not able to identify an obvious cause of the failure.

Conclusions: Reconstruction of a destroyed proximal scaphoid pole using a free vascularized osteochondral medial femoral trochlea flap yields good clinical and radiological results in the majority of cases in the short term. Meticulous operative technique with exact fitting of the graft and restoration of the correct shape of the scaphoid is mandatory. Nevertheless failures cannot be avoided completely. Long-term

results will show the true value of this demanding procedure, which now remains our method of choice in the treatment of destruction of the proximal scaphoid pole.

A-0629 Outcomes of complex intra-articular distal radius fracture fixation using the variable angle volar rim plate

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Introduction: Marginal intra-articular distal radius fractures are situated at or distal to the watershed line, therefore standard volar plate placement cannot buttress the distal fragments, and can result in secondary carpal translation with the volar lip fragments.

Aim: To evaluate the outcome of these complex fractures using a volar approach and the DePuy Synthes variable angle 2.4-mm distal radius rim plate. This plate is pre-contoured to the volar rim for placement distal to the watershed line allowing purchase of the rim fragment of the lunate facet. Its low profile and smooth edges are designed to minimize flexor tendon irritation.

Method: We report on a consecutive series of far distal AO-23B3 and AO-23C3 fractures treated using this plate in a tertiary hand centre between November 2011 and May 2014. Medical and therapy records were reviewed to assess range of motion, grip strength and complications at the final clinic review. Disabilities of the arm, shoulder, and hand (DASH) score and patient evaluation measure (PEM) were also obtained.

Results: Twenty-six patients were treated with this implant. This is 6.8% of all distal radius fractures treated with open reduction and internal fixation at our institution. Six patients were lost to follow-up at three months. This plate was used in isolation in seventeen cases and in combination with a dorsal plate, in cases of dorsal instability after volar plating, in ten patients. All fractures had united radiographically by twelve weeks of surgery. DASH and PEM scores one year after surgery were 12.98 and 27% respectively. Visual analogue scores for patient treatment satisfaction and severity of pain showed good satisfaction with treatment and mild intermittent pain on activity. Post-operative range of motion was variable, with mean dorsiflexion of 43 degrees and palmarflexion of 39 degrees; grip strength of 71% of the uninjured contralateral side. There were no cases of flexor or extensor tendon rupture. Tendon irritation was noted

in two patients. Removal of metal was performed in four patients. Loss of reduction occurred in one case and neurological complications in two cases.

Conclusion: This implant is specifically designed for the management of far distal complex intra-articular fractures of the distal radius. Despite the complexity of these fracture patterns and the challenge they pose to accurate reduction and stable fixation, outcomes were satisfactory in this small series.

A-0634 Benefits of the 'e-informed consent' in hand surgery for the surgeon and the patient: A study of 50 carpal tunnel syndrome cases

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Information consent is a legal and ethical requirement when planning a surgical procedure. Information shared must be clear and honest to achieve a real process of shared decision-making. The purpose of this study was to validate an online tool of information consent. This web application provided to the patient multimedia information resources (informations about the pathology and its inherent risks of treatment) and allowed the surgeon to ensure suitable understanding of the patient with a conclusive evidence in a personal folder. We conducted a prospective study from February to May 2015. Fifty adult patients (12 men and 38 women, mean age of 48 years) suffering of a unilateral carpal tunnel syndrome (CTS) were included. They all had a personal mobile phone number for an e-signature. The questionnaire applied to CTS consisted of 18 items with binary answers yes/no, with a possibility of re-information. Indeed, the patient was asked to reevaluate his answer with the possibility not to validate the issue. Each item must be checked and validated by the patient before discovering next one. The questions concerned the knowledge of the disease (physiopathology and causes) and its treatment (technical procedures), the risks (infection, reflex sympathetic dystrophy, pain, and lack of grip strength), and the expected benefits (disappearance of paresthesia/pain and sensitivity of finger tips). At the end, the questionnaire was validated with an electronic signature via an SMS code. The average duration of consent was 7.30 min (3–31). All patients validated their e-consent. In decreasing order, the items which needed reformulation were the risk of injury to the median nerve (12%), reflex sympathetic dystrophy (7%), the ability to adapt to the intraoperative gesture circumstances (5%), and the hygiene regulations

(4%). There were no electronic signature failure. The use of this online application allowed patients to have access to informative and suitable content that seemed subjectively relevant (no invalidation). It allowed the patient to participate its therapeutic options. Thus, the surgeon could assess the quality of the information that he delivered and the insurance that the consent was obtained. Further questionnaires about other pathologies will be developed thanks to this first experience.

A-0637 Transfer of triceps nerve branches to a vascularized ulnar nerve sensory conduit for reinnervation of intrinsic hand muscles in mid-cervical tetraplegia – A cadaveric feasibility study

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Objective: Reinnervation distances to intrinsic hand muscles in mid-cervical cord injury remain a challenge. Unlike recently described nerve transfers to hand extrinsics, direct suturing to motor nerves at the mid-arm leaves insufficient time to recover denervated intrinsic muscles of the hand. We carried out a feasibility cadaveric study proposing a two-stage procedure using the ulnar nerve as a vascularised sensory conduit.

Methods: We carried out formalin fixed and fresh frozen cadaveric dissections to delineate the proximal and distal anatomy of the ulnar nerve using the sensory fascicles as a vascularized conduit. Proximally, the triceps motor axons can be transferred to the ulnar nerve. Distally, despite lack of volitional control, the paralyzed intrinsic muscles from upper motor neuron lesions remain innervated. Once axonal growth has occurred along the conduit, a second-stage-delayed procedure is carried out. The dorsal and superficial sensory branches of the ulna nerve are coapted to the deep motor branch thereby potentially achieving the goal of intrinsic reinnervation.

Results: The radial nerve was exposed proximally and the triceps nerve branches dissected posteriorly. The triangular interval was dissected medially and triceps branches transferred through this space onto the ulna nerve. The distance from this point to the intrinsic hand muscles was then measured. Nerve lengths from their origin to the muscle bellies of the long, medial, and lateral head of triceps were 77, 85, and 60 mm, respectively. The ulnar nerve at the distal forearm was dissected in 13 cadavers and the branching sensory anatomy in relation to the pisiform was also measured. The dorsal sensory branch

takeoff was on average 95 mm from the pisiform. This in turn allowed coaptation of both sensory fascicular groups onto the motor ulnar branch. The total distance nerve between proximal coaptation site and intrinsic muscle was 490–510 mm, giving an innervation time of 16–17 months.

Conclusion: This study confirms the anatomical feasibility of transferring triceps nerves through the triangular interval to the ulna nerve. With this proposed technique, reinnervation times are not unreasonably longer compared with transfer procedures for extrinsic hand muscle restoration.

A-0639 Splinting versus extension block pinning technique in the treatment of mallet finger fracture – A randomized controlled trial

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Treatment of mallet finger fractures with a bony fragment of more than one-third of the articulating surface is controversial. Surgery is commonly recommended but associated with complications, and conservative treatment has been proposed regardless the size of the bony fragment. The aim of this study was therefore to compare the outcomes after conservative treatment with splinting and surgical extension block pinning (EBP) of mallet finger fractures. Based on sample size calculation, we included 28 patients in this study. The median age was 33 years (interquartile, 26–48 years). The inclusion criteria were acute mallet finger fracture with a bony fragment of at least one-third of the articulating surface and no subluxation. Patients were randomized to 6 weeks of splinting or surgical EBP. Patients were followed up at 6 weeks, 3 months, and 6 months. The primary outcome was degrees of distal interphalangeal (DIP) joint extension lag. Secondary outcomes were DIP joint flexion and finger pulp–palmar crease distance. At final follow-up, patients reported pain intensity on a numeric rating scale (NRS), and Disabilities of the Arm, Shoulder and Hand (DASH) score was filled in and complications were recorded. At 6 months follow-up, the extension lag was 12° [95% confidence interval (CI); 8–16°] in the splinting group and 10° [95% CI; 4–16°] in the surgical EBP group

($p = 0.67$). DIP joint flexion was 65° [95% CI; 59–71°] in the splinting group and 50° [95% CI; 39–61°] in the surgical EBP group ($p = 0.01$). The finger pulp–distal palmar crease distance was 0.4 centimeter [95% CI; 0.1–0.7] and 1.6 centimeter [95% CI; 0.6–2.5] in the splinting and surgical EBP group, respectively ($p = 0.02$). We found no significant differences in DASH scores and pain intensity on NRS between groups. To our knowledge, this is the first randomized controlled trial comparing splinting and surgical treatment with EBP in mallet finger fractures. Based on results from this study, we recommend splinting in the treatment of mallet finger fractures without subluxation.

A-0641 Novel methodology for automated quantification and assessment of bioactive laminin endoneurial tube scaffolding in peripheral nerve repair implants

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Introduction: The affinity of regenerating neurites and migrating Schwann cells for the basal laminal scaffolding of the nerve endoneurium is well characterized. Both structural configurations, in the geometric form of an aligned tubular architecture and the β -2 laminin-rich substrate lining the scaffold, provide biophysical and biochemical activity to a regenerative substrate. Image analysis software can be utilized to assess both the key structural components and their configuration. Quantification of both the laminin content of a physical scaffold and the architectural geometry of the scaffold may be used to provide a methodology for assessing potential activity of implants in peripheral nerve repair.

Methods: Sections of processed nerve allografts were fixed, dehydrated, and embedded in paraffin. Immunoperoxidase staining with anti-laminin antibody was then performed on 4 μ m transverse cross sections to identify the laminin component of the substrate. Image analysis was performed using Image J. Manual selection of organized scaffolding is performed; in this instance, isolation of the fascicles and their endoneurium from the internal epineurium of the nerve tissue. Thresholding was performed to prepare for particle counting during image analysis. The known diameter and circularity of peripheral nerve endoneurial tubes were used to set the criteria for automated identification and quantification of the available laminin-rich architecture. Correlation analysis was conducted between the automated quantification and histological assessments with qualitative scoring of structural integrity.

Results: Histology and analysis were performed on 192 nerve sections. Quantification of the number of endoneurial tubes per fascicular area, the percent of endoneurial lumen area within the fascicular area, and the laminin perimeter of endoneurial tubes per fascicular area was achieved. Histologically confirmed disruption of laminin structure resulted in diminished quantification. The automated quantification correlated well with qualitative histologic evaluation.

Conclusion: Automated measurement of laminin area and perimeter provide a viable methodology for quantification of regenerative scaffolding and is closely correlated with qualitative assessment. The test quantifies the amount of the available laminin structure for neurite and Schwann cell extension, thereby measuring the bioactivity of the scaffold. This methodology may be applied to future peripheral nerve repair implants to assess these important compositional and structural characteristics.

A-0642 Review of 60 implants of pyrocarbon adaptive scaphoid implant in treatment of radioscaphoid osteoarthritis: Our experience

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Pseudarthrosis and necrosis of scaphoid often lead to radioscaphoid arthritis, involving especially young patients. Options of treatment are not so easy including savage procedure with bone graft vascularized or autologous, proximal row carpectomy, four bone corner fusion, and wrist arthroplasty up to total arthrodesis. We report our experience with 60 implants with pyrocarbon adaptive scaphoid implant (APSI).

Materials and methods: Sixty implants with APSI were performed between 2007 and 2015. Indications were pseudarthrosis and osteonecrosis of proximal scaphoid, failure of bone graft for savage of scaphoid, SNAC and SLAC wrist grade 1–2, and Preiser's disease. Range of age was from 17 up to 60. We performed dorsal approach; radial styloidectomy was always performed no more than 7 mm in height just to avoid detaching the extrinsic ligaments of the wrist. Capsulotomy was performed in two patterns: radial-based squared flap and Berger–Shin flap. No arthroscopy was used to set the implant. The postoperative treatment requires 15–25 days of immobilization followed by assisted physiotherapy. Mean hospitalization was 1 day.

Results: Clinical outcome was assessed by interview and clinical examination, sharing patients in four stages of satisfaction; evaluation of range of motion

(ROM); and evaluation of pre- and postsurgery level of pain with visual analogic scale, Mayo Wrist score, and X-rays. The most of patients reported good results in order to pain decrease and improvement of movement and function of the wrist. ROM varies from 10° to 80° of extension, 20° to 70° of flexion, 10° to 40° of ulnar deviation, and 10° to 30° of radial deviation. We didn't observe any difference related to capsulotomy techniques; in the same time, no statistical difference has been found in order to time of immobilization. We had five implants dislocations, three due to oversized implants. Four periarticular calcifications required further surgery. The mean healing time was 3 months with a minimum of 5 weeks and maximum of 8 months.

Conclusions: Our experience shows good results and offers an important option in management of proximal scaphoid necrosis, SNAC wrist, and radioscaphoid arthritis, in order to decrease of pain, and obtain good movement and function of the wrist, restricting the danger to perform more invasive surgery. We strictly recommend correct indications and positioning of smaller implant in order to avoid dislocations.

A-0646 Thoracic outlet syndrome secondary to clavicle fracture

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The common treatment of the clavicle fracture in the middle third is conservative by the use of a figure-of-eight harness. Most of them heal uneventfully. In rare cases, malunion or nonunion can lead to thoracic outlet syndrome (TOS), due to narrowing of the costoclavicular space. In our retrospective study, we report on four cases (three women and one man) who developed a TOS secondary to a middle-third clavicle fracture. In three patients (two women and one man), the diagnosis of neurogenic TOS, with a delay of several months after the onset of symptoms, was made based on the patients history, physical examination, imaging studies, and neurophysiological tests. In one case (woman), a neurovascular TOS was diagnosed secondary to reconstruction of a deficiency pseudarthrosis (nonunion resection, vascularized myoosteo flap, and plating). The three patients with the neurogenic TOS were treated surgically by nonunion resection, scalenotomy, neurolysis, and plating of the clavicle. In one of these cases, a first rib resection was performed. The fourth patient, neurovascular TOS, was treated surgically by decompression of the neurovascular structures, scalenotomy, and first rib resection. The surgically treated patients obtained

solid bony union of the clavicle and relief from their symptoms without complications. In all our cases, a good result could be achieved. TOS secondary to clavicle fracture is rare and often will not be recognized as such. Our patients developed symptoms of a TOS at varying intervals following trauma to the clavicle. The delayed onset of symptoms may lead to diagnostic confusion and delay in the beginning of appropriate treatment. There is no reliable method for diagnosis of a TOS, it is only the synopsis of the findings that results in diagnosis.

A-0647 The branching motor supply of supinator: A cadaveric feasibility study for a two-level targeted reinnervation of the posterior interosseous nerve for restoration of finger and thumb extension in tetraplegia.

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Objective: In mid-cervical tetraplegia, finger extension, and flexion are absent. A supinator motor branch to posterior interosseous nerve (PIN) transfer has been shown to aid recovery of thumb and finger extension. We investigated the branching anatomy of the supinator muscle with a view to carrying out a two-level-targeted nerve transfer using the consistent motor branching anatomy. Fresh frozen cadaveric dissection was used to develop the transfer. We propose this modification of the supinator to PIN transfer highlighting the advantages over the standard transfer.

Methods: Through an anterior forearm approach between brachioradialis and brachialis, the radial nerve and superficial radial nerve are identified. Deeper dissection reveals the PIN. This approach allows easier identification of the proximal edge of supinator (the arcade of Frohse) and any proximal motor branches to supinator. This allows for a separate targeted transfer at this level. The PIN then divides into terminal branches, as it emerges from the distal edge of supinator. The anterior approach allows for earlier identification and protection of all these motor branches. The separate reinnervation of the motor fascicular groups within the posterior interosseous nerve has the potential of independent control of finger and thumb extension.

Results: In all five cadavers dissected, a more proximal lateral branch to supinator was seen. This consistently supplied the superficial head. We propose sectioning this for the proximal nerve transfer. Division of the muscle identified a second distal branch supplying the deep head. The mean longitudinal

distance between these branches was 2.3 cm. The mean distance from the second branch to the more distally innervated extensor pollicis longus was 5 cm. We advise using the intramuscular supinator branch for the more distally innervated motor target. The synergistic nature of these actions makes relearning achievable. By identifying a more proximal branch, a greater overall axon transfer can be achieved by separate coaptation to the PIN.

Conclusions: In mid-cervical tetraplegia, supinator muscle function is normally preserved, because innervation stems from the C6 root. We carried out fresh frozen cadaveric dissections to determine the branching anatomy of the PIN. A consistent proximal motor branch to supinator was identified. We propose a refinement of the technique via an anterior approach and a targeted two-level reinnervation for finger and thumb extension.

A-0649 A novel combination of upper limb blocks for dorsal hand surgery reduces supination and improves hand position: A randomized placebo controlled study

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Objective: We have experienced that in patients scheduled for hand surgery with a dorsal approach, the standard lateral and sagittal infraclavicular block tends to leave the patient with a supinated hand and forearm, which often need to be forcefully held in pronated position or the patient converted to general anaesthesia. We asked our anesthesiologists for an alternative block and they hypothesized that the supination may be reduced by also blocking the suprascapular nerve, measured by the degree of supination after the block and the surgeons' assessment of the patients' hand position during surgery.

Methods: In a placebo-controlled study, 30 patients scheduled for dorsal hand surgery were randomized to two groups. They received an ultrasonic-guided infraclavicular block with or without the supplement of an anterior ultrasound-guided suprascapular nerve block. In both groups, the patients got 31 ml ropivacain 7.5 mg/ml for the infraclavicular block. For the suprascapular nerve block, we gave 4 ml ropivacaine 5 mg/ml in the intervention group and 4 ml sodium chloride 9 mg/ml in the placebo group

(sham group). After 30 min, the wrist angle (as a measure of supination) was measured with an electronic water level apparatus placed dorsally on the wrist between the styloids of the radius and ulna, and the wrist angle was defined as the angle between this plane and the table plane. The block was tested by sensory capability and muscle strength. Finally, the surgeons' assessment of the hand/forearm position before and during surgery and ease of pronation was recorded at the end of surgery as 'good or 'poor.' The Mann-Whitney test was applied to test for differences of patients characteristics. Ordinary linear regression models were used to test for group difference in changes of wrist angles and lateral rotation force of the humerus. Linear mixed models were used to test for group differences in change from baseline over four repeated measures. An unstructured covariance matrix was specified to control for dependencies between repeated observations. The surgeons' evaluation of the hand position was analyzed using The Fisher's exact test for categorical data.

Results: The study demonstrated that the wrist angles (supination) were lower ($p = 0.018$) and the surgeons' satisfaction about the hand position was better ($p = 0.04$) in the intervention group than in the placebo group. The surgeons' assessment of the hand position was good for all 11 patients in the intervention group but only for 6 of 11 in the placebo group.

Conclusions: We concluded that in patients scheduled for dorsal hand surgery, the novel combination of a suprascapular block and infraclavicular block provided a better hand/forearm position than after the infraclavicular block alone. This can be used to ease the surgical access, especially in the absence of an assistant, and reduce the need for general anaesthesia.

A-0652 Revision surgery after total wrist arthroplasty

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Objective: Third-generation implants for total wrist arthroplasty (TWA) have now been available for more than 17 years. Consequently, an increasing number needs revision. The aim of this study is to report on our experience with revision surgery after failed TWA.

Methods: We prospectively and consecutively collected data on all TWAs that were revised in two clinics and made a general follow-up examination in May to June 2015.

Results: Nineteen wrists were revised in 19 patients (15 females and 4 males). Mean age at primary operation was 54 years (range: 28–78). The diagnosis was

rheumatoid arthritis in eight cases, SLAC wrist in four, idiopathic osteoarthritis in two, SNAC wrist in one, syringomyelia in one, Kienboeck's disease in two, and Preiser's disease in one. The primary operation was performed in other clinics in seven cases. Indication for revision was loosening/subsidence in 11 cases, wrist ankylosis in flexion in 2, malposition of implant components in 3, severe periprosthetic osteolysis in 1, dislocation and instability in 1, and pain without loosening in 1. Nine implants were revised to a cemented Remotion total wrist arthroplasty (TWA), three to an uncemented Remotion TWA, one to an Amandys interposition pyrocarbon prosthesis, and six were fused. Subsequent re-revision of three Remotions to fusion was done. One Remotion rearthroplasty was reoperated a second time with a new Remotion with bone graft due to massive osteolysis. Mean follow-up time was 31 months (3–102). The median QuickDASH score was 42 at follow-up (range 11–68). Median QuickDASH for patients with fused wrist was 52. Median QuickDASH for patients with an implant was 36. Scores improved in all except one (median improvement 25 points). Median visual analogic scale (VAS) score for general pain level at follow-up was two on a scale from 0 to 100. Median VAS score for patients with a fused wrist was 8 and for patients with an implant 1. Median VAS score improvement was 50 points. QuickDASH and VAS scores did not differ statistically significantly between patients with a new implant and patients with a fused wrist. At follow-up, one implant was loose (tilted carpal plate, VAS 84, QuickDASH 68). This patient is scheduled for a re-revision. All fusions were consolidated. One of the patients with fusion complained of severe problems (VAS 80, QuickDASH 66), despite consolidated fusion. We attribute these complaints to a difficult psychological profile.

Conclusions: Both fusion and revision to a new TWA are feasible after a failed TWA. Revision to a new TWA may require supplementary major procedures.

A-0653 Osteoporotic distal forearm fractures – Stabilization with an angle stable minimal invasive intramedullary polymer

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Introduction: In progressed osteoporotic disease, conventional operative treatment of distal forearm fractures often leads, especially in presence of long segment comminuted fractures in close proximity of the joint space, to unsatisfactory results.

Materials and methods: Through a small incision using the Seldinger technique, a Dacron balloon catheter is inserted into the medullary canal after reaming with a flexible cannulated drill. The balloon is filled with a liquid nontoxic plastic monomer. After confirmation of the correct positioning of the intramedullary device, curing of the monomer using blue light (wavelength 436 nm) through a fiber optic cable is achieved within 300–600 s creating a customized intramedullary rod comparable in strength to steel or titanium. The balloon adapts to the often irregular shape of the medullary cavity. After the curing process and polymer formation, an angle stable locking screw or a plate may be used in combination with the implant to increase stability.

Results: Nine female patients with distal forearm fractures with an average age of 77.6 years were treated from 09/2011 to 06/2014. Six patients suffered an A3-AO-type fracture of the distal radius, one patient a B2-AO-type fracture, and two patients a C2, respectively, a C3-AO-type fracture. All ulnar fractures were A1.2 or A1.3-AO-type fractures. Three of nine distal radial fractures were treated with the polymer in a retrograde fashion in combination with a locking screw. One of nine patients was operated with a hybrid osteosynthesis consisting out of the polymer and an angle stable palmar plate. Three of nine radial fractures obtained an extraarticular external fixator without the polymer. Two of nine patients were treated with palmar plate in combination with an external fixator. Six of nine distal ulnar fractures were stabilized with the polymer in combination with a distal locking screw. Two of nine got a hybrid stabilization and one of nine ulnar fracture was treated conservatively. Mean follow-up was 150.6 days (43–392 days). In all fractures (radius and ulna), bone healing was documented radiologically. The mean Disabilities of the Arm, Shoulder and Hand score was 34.1.

Conclusion: Treatment of osteoporotic distal forearm fractures using an intramedullary polymer implant is suitable to manage long segment fractures. The radiolucent polymer allows radiological visualization of the entire bone and facilitates radiation therapy in select cases. Stability may be increased either with locking screws placed at any position of the implant as determined by anatomical safe zones or with plates.

A-0658 Vascularized fibula with physis reconstruction of type 4 radial dysplasia

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Radial dysplasia is usually reconstructed by radicalisation or centralization, however, frequent recurrence

occurs. Skeletal reconstruction of radial aplasia may offer greater stabilization. Skeletal reconstruction may be performed by vascularized transfer of the free fibula with physis. We demonstrate our technique of vascularized transfer of the fibula with physis based on the posterior epiphyseal vessel and the peroneal artery in seven cases. All seven were successfully transferred. Six have grown adequately to maintain the skeletal correction of the radial deviation, whilst maintaining joint movement.

A-0660 Long-term outcomes after digital replantation or revascularization: Does function improve with time?

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Introduction: Digital replantation and revascularization has been a challenge for all hand and microsurgeons in the past 40 years. Improvement of the surgical techniques and progressive development of microscopes and instruments granted an extremely high survival rate, in almost all studies close to 90%. Currently, the main concern is not just restoring a viable tissue but obtaining a satisfactory function of the replanted segment. The aim of our study was performing a long-term evaluation (over 10 years of follow-up) in order to understand if function progresses with time.

Methods: In our Department of Hand Surgery, between January 2004 and December 2005, 55 digital replantations or revascularizations have been performed in 43 patients. The survival rate was 88%. In 2006, all successful cases were clinically evaluated, by measuring sensibility (disk-criminator, test of Semmes-Weinstein, protection sensibility), range of motion, strength (key grip and jamar test), pain (VAS score), and cold intolerance. Disabilities of the Arm, Shoulder and Hand (DASH) score was assessed to analyze the subjective satisfaction. At the end, patients were classified by using the Chen's criteria. The mean follow-up was 15 months. In 2015, a new study was performed, using the same parameters. Thirteen patients were lost at follow-up and one patient died. The remaining patients were therefore evaluated with a minimum follow-up of 10 years. Then, the outcomes of the two studies were compared.

Results: After 1 year, the functional results were fairly good, with 18% of Chen's grade 1, 35% grade 2, 36% grade 3, and 11% grade 4. Mean DASH was 35.7. At 10 years follow-up, the functional outcomes slightly improved, with 14% of Chen's grade 1, 41% grade 2, 36% grade 3, and 9% grade 4. Mean DASH was 17.3.

Conclusions: Assessing outcomes after replantation is challenging because of the high variability of the mechanism and level of injury among all selected cases. Considering these limitations, it was interesting to observe that objective results were comparable at 1 and 10 years. On the contrary, subjective outcomes significantly improved with time. This evidence of subjective satisfaction without significant functional improvement underlines the ability of all patients to adapt themselves in order to perform their day-living activities.

A-0668 Dual mobility trapeziometacarpal Maia prosthesis: A preliminary report

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The aim of this preliminary study is to evaluate the feasibility and the very short-term outcome of the new dual mobility trapeziometacarpal Maia prosthesis. Fifty Maia prosthesis has been implanted by five surgeons between January and July 2015 for the treatment of thumb arthritis Dell stage 2 or 3. The implant was still a ball and socket prosthesis with hemispherical cup and press-fit fixation, hydroxyapatite-coated stem; the innovations were a dual mobility system of the head, shorter stems and smaller cup caliber (8 and 9 mm). The surgical approach was radial. The metacarpal basis was cut at 5 mm with a new special device. The tourniquet time was never longer than 1 h. The thumb column was immobilized for 3 weeks and after that rehabilitation was gently encouraged. At the minimal 4 months follow-up, we observed one dislocation because of a technical problem but no trapezium/metacarpal fracture, no infection, and no seek of the implants. The disparition of the pain was comparable as the outcome of the classical Maia prosthesis. In conclusion, the new innovative devices was helpful for the surgeons but the short-term results were comparable as the classical prosthesis. Longer follow-up is necessary to observe eventually an improvement of the outcomes.

A-0670 Hemodynamic study in vivo on retrograde arterialized free venous flaps

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Free venous flaps are still rising concerns about their reliability and problems of monitoring. In several previous studies, it was shown that retrograde free venous flaps are an interesting option because of their more physiological behavior with regard to peripheral vascularization and presence of an intraoperative visible refill, when compared to conventional anterograde arterialized free venous flaps. Retrograde arterialized free venous flaps also present a more usable vessels configuration in clinical practice with both feeding vein and draining vein emerging from the same side of the flap. Still the presence of an arteriovenous shunt or the absence of valves might compromise the outcome. Six patients with variable defects to the hand were operated by the mean of a retrograde arterialized free venous flap harvested from the palmar side of the forearm. There were five men and one women of a mean age of 41 (28–56) years old. The flaps size was of an average of 65 cm². After the harvesting, the flaps were temporarily fixed with stitches to the margins of the defect, and the feeding vein and the draining vein were anastomosed to the donor artery and vein. At this point, the flap was immediately released from the temporary skin sutures and turned 180° upside down with the fat tissue and its vessels facing the infrared camera on the microscope. Indocyanine green was injected systemically into the patients, and a film was recorded about the vascularization pattern of the flaps after the Acland's clamp was removed from the feeding vein and draining vein. The vascular pattern was similar in five flaps showing a good peripheral vascularization and delayed filling of the draining vein. In one case, there was an immediate filling of the draining vein because of a shunt. In this case, we observed clinically an arterial pulsation of the draining vein. The shunt was then clipped. We recorded no flap loss and, only in one case, a little epidermolysis at the periphery of the flap. Intraoperative inspection of retrograde arterialized free venous flaps with indocyanine green seems to be beneficial to the outcome of the flap by demonstrating arteriovenous shunts that need to be closed. We also demonstrated a close to physiological vascularization in these flaps.

A-0671 Long volar locking plate fixation for distal radius fractures with metaphyseal extension

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Introduction: Distal radius fractures with metaphyseal extension are uncommon and result from high-energy trauma. Their treatment is challenging and there is no consensus about the best options.

Objectives: The present study aims to evaluate retrospectively a group of patients with distal radius fractures with metaphyseal extension treated with a 2.4-mm extra-long volar locking compression plate fixation.

Methods: We have evaluated a sample of nine consecutive patients (10 wrists) submitted to surgery by the senior author with an average follow-up of 21 months and a medium age of 61 years. There were 60% AO Type C3, 20% Type A3, and 20% Type C1. Four cases (40%) were open fractures, two Type II, one Type I, and one Type III according to the Gustilo–Anderson classification. Three of these had an external fixator initially and were converted when safe. The functional result was evaluated using the QuickDASH score. For statistical analysis, we used IBM® SPSS® Statistics 21 program and applied *t*-test, Pearson correlation, and analysis of variance.

Results: All fractures united within an average 20.5 weeks. The reduction obtained was 26.2° ulnar tilt, 3.1° palmar tilt, and a 0.9-mm ulnar plus variance. The final range of motion was within the functional range, and pronation and supination were fully restored. The average QuickDASH was 30 (0–100). There was no significant correlation between the functional result and age, fracture classification, or being an open fracture.

Conclusions: The reduced sample size and short follow-up period are shortcomings to our study. However, our results compare favorably to the published series of long volar locking compression plate fixation. Open fractures have similar results, even in patients submitted to external fixator initially. Osteosynthesis with long volar locking compression plate fixation is a valuable, comprehensive and efficient option in these challenging fractures.

A-0678 Abductor pollicis longus and first dorsal interosseous muscles strength evaluation in healthy patient: Normal parameter for evaluating neuromuscular training results in trapeziometacarpal arthritis

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Introduction: Evaluation of results in patients treated with muscle strengthening and physical therapy for trapeziometacarpal joint arthritis is based only in subjective results and pain control.

Objective: We evaluated the muscle strength of the first dorsal interosseous muscle (D1), abductor pollicis longus (APL), and the grip strength in a group of 30 healthy female subjects. The dominant hand was the right in all subjects.

Method: Strength was measured using a Delsys Load Cell (500 Newton capacity) placed in a costume made mold for each hand (right and left) and grip strength with a jamar dynamometer (kg). Three evaluations for each muscle were made on each hand.

Results: Right APL was 73.42 Newton, left APL 70.1 Newton, right D1 107.31 Newton, left D1 124.89 Newton, right grip 22.3, and left grip 18.68.

Conclusions: In this exploratory study, we recognized a muscle strength normal relation between the APL and 1D, this relation can be our objective to return balance to the thumb when trying neuromuscular balance and also can be a diagnostic tool in cases where this relation is altered. A larger group of patients may be needed.

A-0680 Comparison of computed tomographic arthrography with intrinsic ligament instability findings in wrist arthroscopy

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Objective: This study evaluates the diagnostic performance of computed tomographic arthrography (CTA) in detecting intrinsic ligament instability, compared to findings in wrist arthroscopy.

Method: Thirty-nine patients with clinical findings and CTA study compatible with intrinsic ligament tears underwent wrist arthroscopy after failed conservative treatment. The mean age was 34.3 years old (range 17–62), and the mean time between the two procedures was 53 days. Clinical records and surgery protocols were evaluated retrospectively. Findings in CTA were recorded according to which component of scapholunate interosseous ligament (SLIL) and/or lunotriquetral interosseous ligament (LTIL) was torn. All images were analysed by one of two musculoskeletal radiologists. Wrist arthroscopy was performed by the same surgical team, at Indisa Clinic in Santiago, Chile. During surgery, stability was assessed for SLIL and LTIL through midcarpal portals. This was used as gold standard for intrinsic ligament instability. Findings were then compared with CTA, using criteria for intrinsic ligament instability as described in anatomical studies: Complete, full-thickness, tears as well as dorsal tears for SLIL and volar tears for LTIL were considered unstable.

Sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV) and accuracy were calculated.

Results: Sensitivity and specificity for SLIL instability were 43.5% and 93.8%, with PPV and NPV of 90.1% and 53.6%. The overall accuracy was 64%. For LTIL instability, sensitivity was 42.9%, specificity 88%, PPV 66.7% and NPV 73.3%. Accuracy was 69.2%.

Conclusions: The accuracy of CTA in our study is lower than international literature reports. However, adding concepts of ligament stability, rather than purely descriptive studies, is useful for medical practice and clinical approach.

A-0681 Wrist reconstruction with autologous osteochondral grafting from the patellofemoral joint

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Background: Autologous osteochondral grafting from the patellofemoral joint is a well-documented for repair of articular surface in the knee, ankle, and elbow joints. However, there are few reports regarding reconstruction of the wrist joint using this procedure. The purpose of this study was to evaluate the radiological and clinical outcomes of the articular surface reconstruction for various wrist joint disorders using osteochondral grafts from the patellofemoral joint.

Methods: Six patients (mean age 36 years, range 26–48 year) underwent reconstruction of the articular surface for wrist joint disorders with autologous osteochondral grafts from the patellofemoral joint. Three cases were affected with degenerative arthritis of the wrist. Two cases were affected with an intra-articular fracture malunion of distal radius fractures. One case involved with unknown etiology. Clinical outcomes were evaluated with grip strengths, range of wrist motion, Mayo wrist score (MWS), patient-related wrist evaluation (PRWE), and disabilities of the arm, shoulder, and hand (DASH) score.

Results: Mean follow-up durations were 27 months (range 17–49). The patients' grip strength improved significantly from a mean of 14.5 kg preoperatively to 29 kg at most recent review. The preoperative range of motion of palmar flexion and dorsal flexion improved significantly from a mean of 19–38° and from a mean of 27–50°, respectively. MWS, which was preoperatively poor in all cases, was rated as good in one patient and fair in five patients at latest follow-up examination. The scores of PRWE improved from a mean of 66.5 points to 26.1 points. The DASH score improved from a mean of 55 points to 19.0 points.

Conclusions: Although this procedure is a challenging one, it can be an effective option for the joint reconstruction of wrist cartilage lesions.

A-0683 Reconstruction of scaphoid nonunions with free vascularized medial femoral condyle

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Nonunions of scaphoid are routinely treated by reconstruction with avascular bone grafts from the hip or distal radius. In unfavorable situations, as persistent pseudarthrosis after presurgery or avascular proximal pole, usually vascularized grafts are preferred. The free vascularized bone graft from the medial femoral condyle seems to result in promising results. In this prospective study, 71 scaphoid nonunions were treated with vascularized bone graft from the medial femur. In 15 cases, an osteocartilaginous graft was used. After a minimum follow-up of 6 months (64 patients), following data were evaluated: healing rate, complications, donor-site morbidity, pain in rest and stress, range of motion, grip strength, and Krimmer score. Healing rate was 88%; in 19.6%, minor complications occurred. Range of motion did not change significantly, and 89% grip strength of opposite site could be regained. Pain in rest was reduced by 73%, in stress by 51%. Donor-site morbidity is low, and 14.5% had mild symptoms after 3 months, reducing to less than 2% after 6 months. Krimmer score resulted in very good and good results in 60% of the cases. Reconstruction of scaphoid union with the free femoral condyle bone graft is an adequate technique to reach high healing rates in unfavorable situations. Postoperative function improves in terms of grip strength and pain reduction. Lack of range of motion usually persists. The surgical technique is mandatory, but the quality of the bone graft is superior to the pedicled bone grafts of the distal radius. In addition, the distal femur offers the possibility of an osteocartilaginous graft to replace the complete proximal pole. In complex situations, salvage surgery like four corner fusion can be avoided by this technique.

A-0689 Microsurgical techniques restore of the upper limb's function for children with electric burns

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Introduction: Tissue damage involved with electric injury can be so deep and serious (especially in high-voltage electric injuries), which after necrectomy might become impossible to apply traditional techniques of skin grafting. In such cases, the microsurgical methods of treatment have to be employed to cover the exposed anatomically important structures. The use of vascularized tissue complexes in children with electric burns accompanied by deep defects in cutaneous covering, fascia, muscles, and bones allows to restore, in a single-stage procedure, the full-value cutaneous covering as well as, when necessary, the muscular tissue and the bone tissue, which can be included in autotransplants.

Materials and methods: Twenty-three children with electric burns in early stages and 14 children with after-effects of electric burns have been operated on in our clinic since 2010. All patients have undergone autotransplantations of vascularized tissue complexes with the vascular pedicle. Fourteen of the operated children had low-voltage electric injuries and nine of the operated children – high-voltage electric injuries. The variants for use of vascularized autotransplants in treating children with extensive tissue injuries can be divided into three groups, according to the aim to be achieved: (1) In order to restore the integumentary system function, skin fascial grafts such as Littler graft, radial graft, graft from the basin of 1 TMA, and thoracodorsal graft have been used. (2) In order to restore the active muscle function, skin fascia muscle grafts such as thoracodorsal graft with the inclusion of a transplant from the broadest muscle of back have been used. (3) In order to restore the frame function of bones, composite tissue complexes with a bone fragment such as a tissue complex on the basis of the broadest muscle of back with a rib fragment or a fragment of the lateral side of a blade bone.

Results and Conclusions: The data obtained from the analysis of treatment results prove that the microsurgical transplantation of tissue complexes has very good prospects and is indispensable when treating children patients with heavy injuries involved with electric burns of upper extremities. The method also allows to perform early surgery and to restore, in a single-stage procedure, the full-value cutaneous covering as well as, when necessary, the muscular tissue and the bone tissue of upper extremities. Despite the obvious advantages and the great promise, the use of flaps with axial type of blood circulation must have clear indications. Such operations should carry out a surgeon wielding a microsurgical technique in the operating room, equipped with the operating microscope and microsurgical instruments.

A-0690 Ultrasound sonography in recurrent carpal tunnel syndrome: Predictivity and accuracy

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Introduction: Recidive of CTS is unfrequent after correct treatment. Incomplete syndesmotomy, hypertrophic scar tissue and reduction of nerve gliding are cause of persistence or recurrence of symptoms. Ultrasound (US) sonography can help in diagnose of persistent compression of median nerve and site of compression evaluating nerve morphology, dimensions, degenerative changes, and gliding.

Materials and methods: Twenty patients with positive electromyography (EMG), clinical diagnosis of recurrent carpal tunnel syndrome (CTS), and with surgical program underwent to US sonography preoperatively. Sonography was performed by the same operator (neurologist specialized on peripheral nerve diseases). Dimensions, cross-sectional areas, morphology, and gliding capacity in carpal tunnel were evaluated with high-resolution US probe 12–15 Mhz. During surgery, neurolysis was performed, and sites and causes of persistent compression were evaluated. Intraoperative and sonography findings were compared and correlated.

Results: There was always a good correspondence on site of compression, dimensions, and degenerative changes of median nerve between sonography description and imaging and surgery. It was not possible to evaluate intraoperatively and then compare nerve gliding.

Discussion: Recurrence of CTS is usually diagnosed by clinical findings and EMG but this can be often insufficient especially in case of incomplete neurophysiological improvement after first surgery. Even if is common opinion that US sonography results depend on operator experience, our results suggest that US sonography can be predictive of pathology showing persistent median nerve compression with good accuracy when performed by a specialist. We think that US sonography can be used in diagnosis of recurrent carpal tunnel.

A-0691 Does Xiapex have a roll in the treatment of flexion deformities of the proximal interphalangeal joint of the little finger caused by Dupuytren's disease – Experiences after 1 year follow-up of 85 treatments

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Objective: Dupuytren's contracture (DC) is a fibro-proliferative disorder effecting the palmar fascia causing flexion contractures and impairing hand function. The aim of this study is to evaluate the efficacy of Xiapex® in the treatment of DC effecting the PIP joints of the little finger at least 12 month after injection.

Methods: The study is an ongoing prospective study on a consecutive series of patients with primary and recurrent DC and flexion deformities of the proximal interphalangeal joint of $>20^\circ$ of the little finger. Primary endpoint is reduction in contracture.

Results: Eight-five treatments have been enrolled, 65 men and 20 women, with mean age of 67 years (22–83). Forty-four treatments of primary DC and 41 treatments of recurrent DC were conducted. Forty-one percentage had skin rupture, and no infections were seen. Mean preinjection contracture was 65° . Mean QuickDASH preinjection was 12 (0–52). Excellent results defined as 0– 10° of extension lack was achieved in 47% of the treatments. Mean follow-up was 16 months (12–22). Improvement in contracture was 40° . Mean QuickDASH at 12 month follow-up was 10 (0–57). In seven cases (8%), there had been a need for further treatment of the Xiapex®-treated finger joint at 12 months (unacceptable recurrence). At 12 months, 56% of the patients were satisfied or very satisfied. Adverse events were mild in all cases. Recurrence defined as $>20^\circ$ of extension was seen in 47% of the cases.

Discussion: The treatment does improve hand function, but excellent results can be difficult to achieve. Choosing Xiapex for treatment for contractures of the fifth PIP joint may not be the best solution for the patient

A-0692 Loss of deactivation in ipsilateral somatosensory areas following altered afferent nerve signaling from the hand

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Objective: Cutaneous stimulation of a hand results in activation of neurons in the contralateral primary somatosensory cortex (S1) and, at the same time, inhibition of neurons in the ipsilateral S1. This ipsilateral inhibition can be detected as a negative blood oxygen level-dependent (BOLD) signal on functional magnetic resonance imaging (fMRI). It is well known that an altered afferent signal pattern, as seen, for

example, following a peripheral nerve injury result in substantial functional changes in the contralateral S1. Since afferent signals are processed bilaterally in the somatosensory cortex, it seems reasonable to hypothesis functional changes in the ipsilateral S1 as well; however, this has merely not been studied. The aim of this study was to assess BOLD response in the bilateral somatosensory cortex following altered afferent nerve signaling from the hand.

Material and Method: Three patient groups, all with changed afferent nerve signal pattern from the hand, were included; 18 patients with traumatic median nerve injury sustained during adolescence, 10 patients suffering from neuropathy following long-term use of hand-held vibrating tools, and 11 healthy volunteers who had their dominant hand and wrist immobilized during 72 h. In addition, 36 healthy subjects were used as controls. fMRI in a whole-body 3T MR scanner was used to investigate cortical activation following cutaneous stimulation of median nerve innervated fingers in all study participants. Evaluation of fMRI data was performed using the BrainVoyager QX 2.6 software. All data were analyzed using mixed effects modeling. All participants gave their written consent and the Ethics Committee at Lund University approved the study.

Results: All three groups showed enlarged activation in the contralateral S1 during tactile stimulation compared to healthy controls. In addition, the inhibition of the ipsilateral S1 typically seen in healthy controls was greatly decreased and even completely lost in patients with a history of peripheral nerve injury. Cerebral reorganization following peripheral nerve injury, neuropathy, and unilateral hand immobilization included functional changes in the contralateral somatosensory cortex as well as altered dynamics in the ipsilateral hemisphere. Furthermore, it also constituted an altered balance between excitatory and inhibitory interhemispheric connections where a change in afferent nerve signaling resulted in a decreased inhibition of neurons in ipsilateral somatosensory areas.

Conclusion: Somatosensory areas in the hemisphere ipsilateral to a nerve injury, neuropathy, or unilateral hand immobilization may play a more important role in the cerebral adaptation process than previously know. The loss of inhibition of neurons in the ipsilateral S1 may represent a cerebral compensatory mechanism. In situations where the afferent nerve signal pattern is changed, the brain decreases the inhibition of neurons in the ipsilateral S1 allowing these neurons to be activated and assists the neurons in the contralateral S1 in processing afferent, sensory, information.

A-0697 Online database for prospective and retrospective scientific evaluation of surgical results

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Objective: There is an increased need for evidence-based data in surgery. The scientific value of old-fashioned retrospective studies with a lot of inaccurate data nowadays is limited. A well-designed prospective trial needs a great amount of work and important financial support. We have designed a prospective system for collecting scientifically valuable data on a disease and/or surgical procedure. Our objective is to present and share this system with our colleagues.

Methods: We have prepared the structure of a web-based system with well-designed questionnaires for different hand disorders. The questions are specific for the investigated problem. The number of questions is limited in order to make possible data collection and registration during the real-life patient care. Filling a questionnaire should be less than 2 min at a time. Privacy regarding patient and uploader (the only owner of the uploaded data) has the priority during all the process. As the questionnaires are uniform, the system makes it possible to compare the outcome data of the different users or institutes but only based on their decision and agreement of collaboration. Even small number of cases or rare conditions based on a multicenter upload of the system can provide statistically sufficient series in a relatively short period.

Results: A pilot study using the abovementioned structure is already running for carpal tunnel syndrome, trigger finger, metacarpal fractures, and extensor tendon injuries, and there are several more condition protocols under construction. Only a few months of data collection for the carpal tunnel syndrome has demonstrated the unforeseen value of the system, as in a few hours, five different hypotheses of this condition were able to be confirmed or denied. The easily achievable large number of patients makes possible the construction of several evidence-based data and conclusions in a relatively short time.

Conclusions: By using our register with a little effort on filling a questionnaire at every patient meeting, the benefit will be almost the same as of a prospective trial. This way the cost benefit ratio can be changed to your favor. The information from the database could be used for evaluating your own results, compare them with other colleges, to organize multicenter studies and present them at live events or publishing them.

A-0702 Bionic reconstruction restores hand function after brachial plexus injury

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Objective: Brachial plexus injuries may permanently impair hand function, yet current surgical reconstruction of this loss leads to poor results. Here, we present for the first time a combined technique of selective nerve and muscle transfers, elective amputation, and prosthetic rehabilitation to regain hand function defined as bionic reconstruction.

Methods: Between April 2011 and May 2014, three patients with global plexopathies including lower root avulsions underwent bionic reconstruction. The ethics governing elective amputation of a biologically intact, but nonfunctioning hand, were thoroughly addressed prior to surgery. Treatment occurred in two stages, the first to identify and create useful electromyographic (EMG) signals for prosthetic control and the second to amputate the hand to make place for mechatronic replacement. Before amputation, the patients underwent a specifically tailored rehabilitation program to enhance EMG signals and cognitive control of the prosthesis. Final prosthetic fitting was applied as early as 6 weeks post-amputation.

Results: In all three patients, bionic reconstruction successfully enabled prosthetic hand use. The action research arm test revealed that hand function improved from 5.33 ± 4.73 to 30.67 ± 14.01 . The Southampton Hand Assessment Procedure score improved from a mean of 9.33 ± 1.53 to 65.3 ± 19.4 . The Disabilities of Arm, Shoulder and Hand score improved from a mean score of 46.5 ± 18.65 to 11.67 ± 8.42 .

Conclusion: After complex neuromuscular reconstruction to establish intuitive EMG signals and amputation of a functionless hand, all three patients were fitted with a prosthetic hand and regained function at 3 months. In global plexopathies with lower root avulsions, where there is no alternative treatment, bionic reconstruction thus offers a means to return hand function.

A-0703 Fascicular shifting in the reconstruction of global obstetric brachial plexopathies – From bench to bedside

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Objective: A number of models have investigated different biological and synthetic matrices as alternatives to conventional nerve grafts. However, the autologous nerve graft remains the gold standard, even though here a pure sensory nerve is being used to reconstruct mixed or even pure motor nerves. Furthermore, limited donor sites often necessitate a significant mismatch of needed nerve tissue especially for large proximal nerve defects. Here, we present a new concept that overcomes this problem: the fascicular shift procedure. A fascicle group of the nerve distal to the injury is harvested in appropriate length to bridge the nerve defect.

Methods: The fascicular shift was tested at the rat's sciatic nerve using 45 Lewis rats. In the experimental group, a 15-mm nerve proximal defect was created and reconstructed with a fascicular group, harvested directly distal of the gap. This group was compared to one sham-operated group and three positive control groups. The outcome of nerve regeneration was measured using retrograde labeling, histomorphometric analysis, and electrophysiological investigations.

Results: This procedure provided sufficient guidance to overcome nerve defects had higher ($p < 0.1$) motor neuron counts (1958.75 ± 657.21) compared to sensory graft (1263.50 ± 538.90) and was equal to motor (1490.43 ± 794.80) and mixed grafts (1720.00 ± 866.421). This tendency of improved motor regeneration was confirmed in all analyses. None of the analyses revealed an impairment on nerve regeneration, despite of the partial defect elongation induced by the fascicular shift distal to the repair site.

Conclusion: Experimental investigations and clinical results both show that harvesting a transplant from the nerve segment distal of the injury site offers a mixed graft without causing additional donor-site morbidity. These grafts perform statistically better than a standard sensory graft in regard to motor recovery. The fascicular shift presents a novel method to reconstruct large proximal nerve defects, and thus make it immensely attractive in brachial plexus reconstruction.

A-0705 A quantitative analysis of the sensory and motor fibres of the brachial plexus in man

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Objectives: Any surgical nerve reconstruction must take into account amount of individual nerve fibres at any given level of injury. To date, however, literature on qualitative and quantitative assessment of motor axons of the peripheral nerves of the upper extremity is scarce. Furthermore, none of these studies have depicted the topography of motor fibres along the entire course of these peripheral nerves. The aim of the present study is to present the total number of motor fibres of the brachial plexus from each root down to the level of its corresponding branches.

Methods: Nerve samples have been harvested from 12 organ donors immediately after death. From eight incisions ranging from the neck to the wrist, a total of 36 nerve samples were gained per organ donor. A special immunohistochemical protocol was applied to visualize the specific structure of interest within the nerve cross section. Antibody against neurofilament served to determine the total amount of myelinated and unmyelinated axons. Antibody against choline acetyltransferase (ChAT) was used to detect cholinergic/motor fibres. Histology sections were then scanned and evaluated with a digital software programme to allow quantification of each cross section. These numbers were cross checked in an animal model with standard retrograde tracing methods. Finally, the quality of this method was also cross checked with staining ventral and dorsal roots of organ donors at spinal cord level.

Results: As expected, the majority of any given peripheral nerve contains afferent fibres. To our surprise, however, only around 10% of all axons in a mixed peripheral nerve are efferent fibres. In a 'pure' peripheral motor nerve (thoracodorsal nerve), one-third of the axons are cholinergic. In a pure cranial motor nerve, the motor portion rises to about 60% (accessory nerve) but still has a significant afferent fibre population. The control experiments in a rodent animal model show good correlation between retrogradely labelled motor neurons with ChAT-positive labels in the peripheral nerve section.

Conclusion: Here, we present for the first time a quantitative analysis of all afferent and efferent fibres of the brachial plexus and its consecutive nerves. The surprising finding is that even pure motor nerves with a suspected high number of motor fibres (thoracodorsal nerve) only have a relatively small number of efferents. Since this ratio is relatively constant for motor nerves at different levels of the extremity, these results challenge the traditional view of fibre distribution and innervation density in man.

A-0707 Functional and psychosocial outcomes of hand transplantation compared with prosthetic fitting in below-elbow amputees: A multicenter cohort study

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Objective: Hand transplantation and improvements in the field of prostheses opened new frontiers in restoring hand function in below-elbow amputees. Both concepts aim at restoring reliable hand function; however, the indications, advantages, and limitations for each treatment must be carefully considered depending on level and extent of amputation. Here, we report our findings of a multicenter cohort study comparing hand function and quality of life of people with transplanted versus prosthetic hands.

Methods: Hand function in amputees with either transplant or prostheses was tested with Action Research Arm Test (ARAT), Southampton Hand Assessment Procedure (SHAP), and the Disabilities of the Arm, Shoulder and Hand (DASH) measure. Quality of life was compared with the Short Form 36 (SF-36).

Results: Transplanted patients ($n = 5$) achieved a mean ARAT score of 40.86 ± 8.07 and an average SHAP score of 75.00 ± 11.06 . Prosthetic patients ($n = 7$) achieved a mean ARAT score of 39.00 ± 3.61

and an average SHAP score of 75.43 ± 10.81 . There was no significant difference between transplanted and prosthetic hands in ARAT, SHAP, or DASH. While quality-of-life metrics were equivocal for four scales of the SF-36, transplanted patients reported significantly higher scores in 'role physical' ($p = 0.006$), 'vitality' ($p = 0.008$), 'role emotional' ($p = 0.035$), and 'mental health' ($p = 0.003$).

Conclusions: The indications for hand transplantation or prosthetic fitting in below-elbow amputees require careful consideration. As functional outcomes were not significantly different between groups, patient's best interests and the route of least harm should guide treatment. Due to the immunosuppressive side effects, the indication for allotransplantation must still be restrictive, the best being bilateral amputees.

A-0049 Plate Osteosynthesis of Distal Phalanx fractures

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Conventionally distal phalanx fractures in the fingers have been treated with a conservative approach. We postulate effective management of fractures of the shaft of the distal phalanx by mini-plate osteosynthesis. 7 patients who sustained fractures of the shaft of the distal phalanx underwent open reduction and fixation through a lateral hockey-stick incision using Medartis 1.3/1.5mm Aptus plate system between January 2014 and September 2015 at a 600 bed public hospital in Singapore. All surgeries were performed on Day Care basis with local anaesthesia and finger tourniquet. They were followed up serially in Clinic at 2, 4 and 8 weeks and the fingers were mobilised early under the supervision of an Occupational Therapist. Bone healing was examined radiographically at 4 weeks, and thereafter at regular intervals when bone union was incomplete at 4 weeks post-op. Subsequently at between 8 to 12 weeks they underwent a second elective procedure on day-care basis to remove the implant following which they underwent hand therapy again and were followed up in clinic at 2 and 6 weeks respectively. Sutures were removed at 2 weeks post-op. The patient demographics, injured finger, fracture type, hand dominance, indication for surgery, incidence of infection, wound problems and non-union, time to union, duration of surgery, post-op range-of-motion and lost work hours were recorded. All fractures united successfully. The average time to union was 11 weeks. 1 was an open fracture, rest were closed injuries. 4 were primary fractures, 3 were symptomatic non-unions. There

were no incidents of wound infection or non-union after fixation. The average duration of surgery was 33 minutes. 4 patients had functional range of movement at the DIP joint at time of discharge. Injury involved the dominant hand in 4 patients. 5 returned to light duty by 4 weeks post-fixation. 6 returned to normal activity and to their pre-injury occupation by 2 weeks after removal of implant of which 5 were heavy labourers. In conclusion, mini-plate osteosynthesis may be a good alternative to management of distal phalanx fracture and a reliable approach to symptomatic non-unions of the same with possibly very few complications.

A-0081 Comparison Of The IFSSH And Oberg, Manske And Tonkin (OMT) Classification Systems For Congenital Hand Differences: A Feasibility Study In A Children's Hospital

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Despite on-going dissatisfaction, the IFSSH classification of congenital hand differences (CHD) remains popular due to its simplicity. The Oberg, Manske and Tonkin (OMT) classification groups CHDs according to embryological bases (malformation/deformation/dysplasia/syndromes) and was recently introduced as a potential replacement. We share our experience with the OMT system within our department. A retrospective analysis of outpatients (last 18 months) was performed (n=150, 35 different CHDs) and classified according to 3 systems: 1. IFSSH, 2. OMT-abbreviated (headings only) and 3. OMT-expanded. A congenital hand surgeon, a developmental biologist (DB) and trainees at different grades participated. Certainty levels and timing of each grouping exercise were recorded. There was widespread disagreement within the IFSSH system (mean 62%). Certainty levels were high for consultant and DB (mean 90%) but low for trainees (mean 56%). With OMT-abbreviated, certainty levels for trainees were even lower (33%), indicating poor knowledge of embryology. With OMT-expanded, participants simply matched the CHDs on the prescribed form, with high certainty scores (85.6%) but discrepancies continue, indicating disagreements with the proposed OMT embryological bases of CHDs. Significant time differences were observed: (IFSSH 8.13min; OMT-abbreviated 7.20min; OMT 17.10min). The IFSSH system initially appeared intuitive especially for clinicians but lacks coherence. The OMT system appeared logical for DBs but trainees found the level of embryological

knowledge prohibitive. Widespread adoption of the OMT system requires clinician willingness to increase embryological knowledge but can foster closer collaborations with DBs.

A-0107 CMC Arthritis: Clinical Outcome of 78 Patients

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Objective: Various surgical techniques have been reported for the treatment of carpometacarpal (CMC) arthritis of the thumb; however, no evidence is available that one is superior to another in terms of pain, function, patients' satisfaction, range of motion and strength. This study aims to compare the long term clinical outcomes of three surgical techniques for symptomatic CMC arthritis of the thumb.

Methods: We studied 78 patients (mean age, 68.5 years; range, 53-79 years) with painful CMC arthritis of the thumb. The patients were allocated into 3 groups: group A (16 patients) was treated with trapeziometacarpal arthrodesis; group B (28 patients) was treated with trapeziectomy, ligament reconstruction and tendon interposition (LRTI); and group C (34 patients) was treated with selected hematoma block distraction. The mean follow-up was 5.8 years (range, 4-7 years). We evaluated pain, function, patients' satisfaction, range of motion and grip and pinch strength with the DASH score questionnaire and Mann-Whitney test.

Results: The DASH score and Mann-Whitney test significantly improved over time compared to baseline, however, without any difference between the groups of patients. Range of motion was higher in group A patients, however, without a significant difference. The rate of complications was higher in group A patients, patients' satisfaction was higher in group B and C patients, and operative time was lower in group C patients.

Conclusions: No significant differences were observed in clinical outcome of patients with CMC arthritis of the thumb treated either with arthrodesis, LRTI or hematoma block distraction. Observational results showed a higher rate of complications after arthrodesis and increased patients' satisfaction after LRTI and hematoma block distraction.

A-0177 Operative Treatment for Nonunion of the Distal Scaphoid

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Objective: Many of the clinicians believe that nonunion of the distal scaphoid is uncommon, but actually we have frequently confronted them. Because of repeated abnormal stress by wrist motion, these lesions usually have severe defect or deformity and difficulties of an open reduction and stable fixation. The purposes of this study were to assess the incidence and the types of fracture pattern of distal scaphoid nonunion in one institution, and to evaluate clinical and radiologic outcomes after operative treatment.

Methods: From June 2006 to May 2014, seventy-six patients from one general hospital were identified who have diagnosed scaphoid nonunion, and there were nine patients who had nonunion at distal scaphoid. The medical records and radiologic images of this nine patients were retrospectively reviewed to assess the patients' demographics and the types of fracture pattern according to the Mayo and Herbert classification. Operative treatment had underwent by volar approach, and firm fixation with autoiliac bone graft were performed. Clinical outcomes with a minimum follow-up of one year were evaluated by the wrist range of motion, the visual analogue scale (VAS) pain score, Mayo wrist score, Disabilities of Arm, Shoulder and Hand (DASH) score. For radiologic evaluation, lateral scapholunate angle (LSLA) and intrascaphoid angle (ISA) were measured preoperatively and postoperatively.

Results: The incidence of distal scaphoid nonunion was 11.8% (9/76). The average age was 31.2-years and six were male. The injury mechanisms were hyperextension of the wrist in five, punching the machine in three, and an unknown cause in one. Initial treatments were thumb-spica cast in four, neglected in five. The mean duration of nonunion was 9.5 months and the mean follow-up period was 16 months. There were seven cases of distal oblique fractures (Herbert classification B1) and two cases of distal transverse fractures. For internal fixation of scaphoid, headless screw and mini screw were used in four cases, mini screw and K-wire in three, headless screw and mini screw and K-wire in one, and only K-wires in one. Corticocancellous bone were grafted in eight, and only cancellous bone in one. On clinical evaluation, postoperative wrist range of motion was increased more than preoperative value (extension 45.6° to 57.8°, flexion 50° to 59.4°, radial deviation

12.2° to 19.4°, and ulnar deviation 23.3° to 31.1°). The postoperative VAS pain score, Mayo wrist score, and DASH score document better results than those of preoperation (6.8 to 2.4, 46 to 85.3, and 23.3 to 3.7, respectively). The LSLA and ISA were decreased from 71.7° and 70.6° to 53.5° and 24.6°.

Conclusion: This study document that nonunion of the distal scaphoid is frequent disease, differ from previous common sense. Because these nonunion almost have three-dimensionally difficult structure and often have small bone stock at distal portion, it is difficult to reconstruct their original structures and maintain stable fixation. Nevertheless, the results obtain here suggest that osteosynthesis with autoiliac bone graft for nonunion of the distal scaphoid might have excellent outcomes.

A-0195 How Effective Is Steroid Injection In Relieving Pain And Stiffness For Trigger Digit?

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Purpose: Corticosteroid injection is a time-tested treatment for trigger digit with high resolution rates of mechanical symptoms. Lesser known, however, is its impact on pain and digit stiffness, and how these factors affect patient satisfaction. This study aims to address these knowledge gaps to facilitate patient counselling.

Methods: Patients who received their first corticosteroid injection for idiopathic single digit triggering were surveyed via telephone over a 12-month period regarding symptoms of clicking, pain and stiffness pre- and post-injection, post-treatment satisfaction level, and trigger recurrence. Patient responses were collated and analyzed for trends in post-injection outcomes, and to identify significant predictors of patient dissatisfaction and trigger recurrence.

Results: 104 patients underwent corticosteroid injection for idiopathic single digit triggering from January to June 2014. 84 patients (mean age = 59) were contactable at the end of the 12-month study period. Majority were females (57%). 38% were diabetics. The long finger was most frequently affected (35%). Half the patients presented within three months of symptom onset, with Quinell Grade 3 being the most common stage at presentation. The median pain and stiffness score were 5 and 7 respectively. Age and persistence of clicking, pain and stiffness after injection

were each significant univariate predictors of patient dissatisfaction. Patients older than 60 years were less likely to be dissatisfied compared to their younger counterparts (OR = 0.30; $p < 0.05$). Patients in whom click, pain, or stiffness persisted for more than 3 months were more likely to be dissatisfied (OR = 9.1, 9.5 and 9.6 respectively; $p < 0.005$).

Conclusions: Trigger digit should be thought of as a triad of digit clicking, pain and stiffness. Corticosteroid injections remain an effective treatment for trigger digit. Combinations of persistent click and stiffness, and persistent pain and stiffness for greater than three months, in addition to age younger than 60 years, were more likely to result in patient dissatisfaction based on our model.

A-0264 Carpal tunnel syndrome treated with guided plasticity – a randomized controlled study

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Objective: Guided plasticity, induced by temporary cutaneous forearm anaesthesia improves hand sensibility in patients with nerve injury and vibration induced neuropathy. The aim was to investigate if patients with carpal tunnel syndrome (CTS) benefit from cutaneous forearm anaesthesia.

Methods: 68 patients with clinical and electroneurography (ENeG) verified CTS were randomized to an eight-week treatment protocol where sensory training was combined with application of an anaesthetic cream (EMLA®) (n=32) or a placebo-cream (n=36) on the volar part of the forearm. The treatment was repeated at increasing interval during 8 weeks (15 treatment episodes). Primary outcome were BCTQ Symptom Severity Scale, QuickDASH, touch thresholds, tactile discrimination and ENeG, at baseline, 90 minutes after first treatment and after eight weeks.

Results: 90 minutes after treatment both touch thresholds and tactile discrimination had improved significantly within the EMLA® group. No significant changes were seen in other functions or within the placebo group. There were no significant differences between the EMLA® and placebo group.

After 8 weeks no significant improvements were seen in assessment of function, within or between the groups compared to baseline. However, patient rated outcome measures improved significantly within both groups. 56% in the EMLA®- and 61% in the placebo group had been operated with carpal tunnel release at the 12 months follow-up.

Conclusion: Guided plasticity using cutaneous forearm anaesthesia resulted in a rapid improvement in hand sensibility in patients with CTS. An eight weeks treatment protocol with EMLA® or placebo, in combination with sensory training, improved symptoms in both groups.

A-0358 Free-flap reconstruction for full-thickness burns on the hand: A 3 years follow-up study

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Objective: Severe burn injuries of the hand can easily result in major impairment due to reduced function or even loss of an extremity. Extended personal and socio-economic implications necessitate an individual reconstructive plan as well as treatment in specialized burn centers. Full-thickness burns on the hand frequently lead to the exposure of tendons or bones requiring a fast and stable coverage with full thickness soft-tissue transplants to allow early exercise and to preserve capable hand function. Due to low case-load experience and evidence described in literature safety and effectiveness of free flap surgery in severe burn injuries of the hand remains unclear.

Methods: Primary reconstructions of full-thickness burn injuries of the hand via free-flap surgery performed in a period from 2013 to 2015 were assessed retrospectively in one of the largest burn centers in Germany. Salvage of the extremity, postoperative complications, length of hospital stay and primary reconstructive result were obtained from existing patient data. All patients were invited to a special follow-up examination 3 to 30 month after primary reconstruction to survey complications after discharge, ability to take up former employment and personal satisfaction concerning the reconstructive outcome. Further the DASH score was assessed for each patient as well as a standardized examination of mobility of wrist and digits, sensitivity and strength.

Results: During the period mentioned above twelve patients were identified that received reconstruction of thirteen hands via free-flap transplantation after severe burn injury. In all cases salvage of the affected extremity was achieved although one flap was lost during the early postoperative period requiring secondary reconstruction with a pedicled groin flap. No further major complication were documented and mean length of hospital stay was 49 days. Functional

outcome was very inhomogeneous depending on the pattern of injury and patients' age, but all were personally contented with the reconstructive outcome although some complained about aesthetical appearance.

Conclusions: Free-flap transfer is a capable and valuable tool to cover full-thickness burn injuries of the hand providing an optimal reconstruction to achieve the best functional outcome as possible. Although failure rates in burn patients are higher than in free-flap transfer to the upper extremity after other mechanisms of injury, it can still be performed with reasonable risk and should be preferred if its allowed by the patients' condition. If free-flap surgery is contraindicated or fails, reconstruction through traditional distant flaps can be used as an alternative.

A-0450 A 10-year Review of Histology in Dupuytren's: Time for a Rethink?

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Introduction: Dupuytren's disease is usually diagnosed clinically. Histopathology samples are commonly sent

in operations for Dupuytren's disease, either to confirm the diagnosis, or to exclude rare but serious differentials, such as epithelioid sarcoma. The aim of our study was to quantify the benefit of sending histology samples in Dupuytren's Disease.

Material and Methods: A retrospective review was performed of patients in Salisbury District Hospital who had operations for Dupuytren's disease over a 10-year period (2005-2015). Patient demographics were documented, then histology samples were retrieved and the diagnosis of each sample recorded. A cost-benefit analysis was carried out on the processing of samples.

Key Results: 968 procedures were performed on 818 patients over 10 years. 370 samples were sent for histopathology from 357 procedures. 353 (95.4%) samples were reported to be Dupuytren's disease, 17 (4.6%) were reported to be something other than Dupuytren's disease. Other diagnoses were all benign; there were no reported sarcomas.

Conclusion: Our study shows that samples are sent in 37% of Dupuytren's operations, and only 4.6% samples are not Dupuytren's disease. Therefore we recommend a regional, multicentre trial be carried out, to provide clearer guidance on the need for histopathology samples to be sent during operations for clinically diagnosed Dupuytren's disease.



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