BRUSSELS HAND/UPPER LIMB INTERNATIONAL SYMPOSIUM

Genval
Brussels, Belgium

Hand, Wrist and Elbow Surgery
Classical vs Innovative Concepts and Techniques
February 3-4, 2017

Hands-on Precourse on Elbow and Wrist Arthroscopy
February 2, 2017

Program & Proceedings

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25th BRUSSELS HAND/UPPER LIMB INTERNATIONAL SYMPOSIUM

HAND, WRIST AND ELBOW SURGERY
CLASSICAL VS INNOVATIVE CONCEPTS AND TECHNIQUES

February 3-4, 2017

CHÂTEAU DU LAC
GENVAL-BRUSSELS

DIRECTOR:

F. SCHUIND

DEPARTMENT OF ORTHOPAEDICS & TRAUMATOLOGY,
HÔPITAL ERASME, CLINIQUES UNIVERSITAIRES DE BRUXELLES,
UNIVERSITÉ LIBRE DE BRUXELLES, BRUSSELS, BELGIUM
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INTRODUCTION TO THE SYMPOSIUM

The 25th edition of the annual Brussels/Genval Symposium will take place on Friday, February 3 and Saturday, February 4, 2017. The Symposium is as always dedicated to a specific interdisciplinary topic involving the upper limb. The 2017 edition, the last one organized by F Schuind, will present the best of hand, wrist and elbow surgery: classical techniques vs new, exciting procedures, bringing potentially significant advantages but not having yet stood the test of time. The Château du Lac at Genval will again be the beautiful venue for this symposium. The previous meetings have truly been international with up to 150 participants from 25 different countries.

When comparing the most advanced techniques nowadays performed, a revolution seems to have taken place in our operation rooms, in reference to what we were doing twenty or even ten years ago. Some operations are now performed percutaneously, under sonographic control. Endoscopic neurolysis has found its place at the shoulder and elbow, not only at the wrist, and some use a robot for brachial plexus surgery. Nerve transfers offer improved clinical results in complex nerve lesions. Various new prosthetic arthroplasties and bone fixation techniques are proposed almost every year, yet loosening, corrosion, periprosthetic fractures remain important clinical problems after joint reconstruction. Many elbow and wrist procedures are now performed under arthroscopic control: to give an example, the treatment of a scaphoid non-union. Alternatively, in this indication some authors recommend a free microsurgical bone transfer. What are the results, complications and patients’ satisfaction after these new techniques as compared to the classics, for a scaphoid non-union a non-vascularized bone graft with screw fixation? Computer assisted surgery and navigation have not yet found a good place in upper extremity surgery, but preoperative planning based on 3D-imaging and guides have revolutionized upper extremity osteotomies. Perforator flaps and super-microsurgery have improved our skin reconstruction armamentarium. Fresh frozen allografts or treated allografts are to our disposal, not only for skeletal reconstruction but also for nerve and skin repair, the most remarkable successful allograft being the hand transplant. Do the results of hand transplantation favourably compare to those of bionic prostheses? New drugs are available, for example collagenase to treat fibrous contractures, botulinum toxin to diminish muscular tone, or long-acting liposome or crystal local anaesthetics to control postoperative pain. In rehabilitation, mirror therapy and related computer techniques help many patients suffering of chronic upper extremity pain. And there are many other examples of innovation in the care of upper extremity affections.

The symposium will comprise debates between classical techniques and innovations. We expect interesting “clashes” between the defenders of each procedure, from which the participants will forge their own opinions. As usual, much time will be set aside for the discussions. Presentations will be by invited faculty, but a limited number of free papers will be as well accepted.

SPECIFIC AIMS

- To discuss innovative upper extremity concepts and techniques, to evaluate their results and complications, in light of the classics;
- To formulate, on these bases, recommendations to the medical community;
- To discuss unsolved problems and possible solutions;
- To explore future directions of research.

F. Schuind
Erasme University Hospital, Brussels, Belgium
ORGANIZING COMMITTEE

PROGRAM DIRECTOR

F. Schuind, MD, PhD
Department of Orthopaedics and Traumatology
Erasme University Hospital
Route de Lennik 808, B-1070 Brussels, Belgium
Tel. +32 2 555 36 45
E-mail: scientific@kingconventions.be

SCIENTIFIC DIRECTORS

F. Schuind (Brussels, Belgium)
A. Aly (Brussels, Belgium)
J. Bahm (Brussels, Belgium and Aachen, Germany)
K. Cermak (Brussels, Belgium)
W. El Kazzi (Brussels, Belgium)
F. Moungondo (Brussels, Belgium)
L. Van Overstraeten (Tournai, Belgium)
R. van Riet (Deurne and Brussels, Belgium)

INTERNATIONAL FACULTY

A. Aly (Brussels, Belgium)
J. Bahm (Brussels, Belgium and Aachen, Germany)
G. Bain (Adelaide, Australia)
O. Barbier (Brussels, Belgium)
E. Camus (Maubeuge, France)
N. Cuylits (Brussels, Belgium)
V. Créteur (Brussels, Belgium)
I. De Greef (Leuven, Belgium)
L. De Smet (Leuven, Belgium)
K. Drossos (Brussels, Belgium)
W. El Kazzi (Brussels, Belgium)
PC. Ho (Hong Kong, China)
M. Jayankura (Brussels, Belgium)
D. Koukalis (Athens, Greece and Brussels, Belgium)
J-P. Moermans (Brussels, Belgium)
F. Moungondo (Brussels, Belgium)
C. Robert (Brussels, Belgium)
F. Schuind (Brussels, Belgium)
M. Shahabpour (Brussels, Belgium)
F. Stockmans (Kortrijk, Belgium)
L. Van Overstraeten (Tournai, Belgium)
R. van Riet (Deurne and Brussels, Belgium)
A. Van Tongel (Ghent, Belgium)
F. Verstreken (Deurne, Belgium)
E. Vögelin (Bern, Switzerland)
INFORMATION FOR PARTICIPANTS

Welcome to Belgium. We hope that you had a pleasant journey and that your stay in Genval will be enjoyable. Please, read this important information.

BADGES
Your badge should be worn at all times.

OPENING HOURS OF THE REGISTRATION DESK
Friday, February 3, 2017: 08.15 - 18.00
Saturday, February 4, 2017: 07.30 - 18.00

MEETING ROOM
The scientific presentations will be held in the room Geneviève.

LUNCHES
On Friday and on Saturday, lunch will be served at the Guillaume Tell Room. The price is included in the registration fee.

WIFI
Free Wireless Internet access is available at the rooms.
CODE: ulb20mb

CONTINUING MEDICAL EDUCATION CREDIT
A certificate will be provided to interested participants. We will send the certificate to the participants who wish to receive this document, when available.

INFORMATION FOR PRESENTERS

We would like to draw your attention to the following points:

- The allocated time of presentation should be strictly respected.
- The standard presentation format is by computer. The audiovisual projection system in the meeting room will include a Personal Computer (PC) along with PowerPoint for Windows and USB port. Request to use any equipment other than this must be arranged at the presenter’s expense.

Each presenter should check with the technician 20 min before the session, and introduce himself to the moderators of the session. The technician will be available in the meeting room from 08h00 on both congress days. There will be a laser pointer at your disposal.

SOCIAL PROGRAM

Friday, 3 February 2017
Private visit of the Horta Museum - 18h30-23h00

The Horta Museum, a World Heritage Site, is located in the private house and studio of Victor Horta (1861-1947) and as UNESCO aptly describes, a work of ‘human creative genius, representing the highest expression of the influential Art Nouveau style in art and architecture.’ In other words, it is a must-visit that is sure to impress all who enter, whether an Art Nouveau aficionado or amateur. The visit of the Horta Museum will be followed by a guided Art Nouveau walks in the area until reaching the restaurant ‘La Quincaillerie’.
ACKNOWLEDGEMENTS

Frédéric Schuind, Director of the Symposium, and the Members of the Organizing Committee, gratefully acknowledge the following authorities, companies and individuals for their precious support:

- the FNRS ("Fonds National Recherche Scientifique")

- Companies

SYMPOSIUM SECRETARIAT

King Conventions bvba
Korte Meer 18 - Belgium, 9000 Ghent
Tel: +32 (0)9 235 22 95  Fax: +32 (0)9 233 85 97  Email: info@kingconventions.be
HANDS-ON PRECOURSE ON ELBOW AND WRIST ARTHROSCOPY

THURSDAY, FEBRUARY 2, 2017

07.00 Bus transfer Genval- Brussels, registration, coffee and croissants
08.30 Change and instructions
08.45 **Demonstration:** Installation for Wrist Arthroscopy, Portals, Radio-Carpal Arthroscopy
   L. Van Overstraeten (Tournai, Belgium) and E. Camus (Maubeuge, France)
09.15 **Demonstration:** Elbow Arthroscopy Portals and Orientation
   F. Moungondo (Brussels, Belgium) and R. van Riet (Deurne and Brussels, Belgium)
09.45 **Hands-on workshop**
   Group A: Radio-Carpal Arthroscopy / Group B: Elbow Arthroscopy, Portals and Orientation
11:00 **Demonstration:** Evaluation of Radio-Carpal Extrinsic and Intrinsic Ligaments, TFC Assessment and Repair
   E. Camus ((Maubeuge, France) and L. Van Overstraeten (Tournai, Belgium)
11:30 **Demonstration:** Lateral Epicondylitis Debridement
   R. van Riet (Deurne and Brussels, Belgium) and F. Moungondo (Brussels, Belgium)
12.00 **Hands-on workshop**
   Group A: TFC Assessment and Repair / Group B: Lateral Epicondylitis Debridement
13.15 Lunch
14.00 **Demonstration:** Medio-Carpal Arthroscopy
   L. Van Overstraeten (Tournai, Belgium) and F. Moungondo (Brussels, Belgium)
14.30 **Demonstration:** Arthroscopic Elbow Arthrolysis
   R. van Riet (Deurne and Brussels, Belgium) and F. Moungondo (Brussels, Belgium)
15.00 **Hands-on workshop**
   Group A: Medio-Carpal Arthroscopy / Group B: Arthroscopic Elbow Arthrolysis
16.15 **Demonstration:** Trapezio-Metacarpal Arthroscopy, Partial Trapeziectomy and Mini-Tightrope Suspension
   F. Moungondo (Brussels, Belgium) and E. Camus (Maubeuge, France)
16.45 **Demonstration:** Biceps Tendon Endoscopy and Tendon Re-Insertion
   R. van Riet (Deurne and Brussels, Belgium) and F. Moungondo (Brussels, Belgium)
17.15 **Hands-on workshop**
   Group A: Trapezio-Metacarpal Arthroscopy / Group B: Biceps Endoscopy
18.30 **Demonstration:** Metacarpo-Phalangeal Ligamentoplasty
   W. El Kazzi (Brussels, Belgium) and A. Aly (Brussels, Belgium)
19.00 Cocktail in Museum of Anatomy, Campus Erasme, Université libre de Bruxelles
20.30 Return bus to Genval

with the support of Arthrex
# SYMPOSIUM SCIENTIFIC PROGRAM

## FRIDAY, FEBRUARY 3, 2017

08.15 - 18.00 Registration

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<th>Topic</th>
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<td><strong>09.00 – 10.20 SESSION 1: AN INTRODUCTION TO THE SYMPOSIUM (1)</strong></td>
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<td><strong>Moderators:</strong> M. Jayankura, A. Van Tongel</td>
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<tr>
<td>09.00</td>
<td>Opening Address: Twenty-Five Years of Upper Extremity Symposia at Genval</td>
<td>F. Schuind (Brussels, Belgium)</td>
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<tr>
<td>09.15 001</td>
<td>Free Latissimus Dorsi Flap for Upper Limb Coverage, Classical versus Robotic Harvesting</td>
<td>N. Cuylits (Brussels, Belgium)</td>
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<tr>
<td>09.45 003</td>
<td>Elbow Arthroscopy and Endoscopy</td>
<td>G. Bain, H. Saeed, J. Phadnis (Adelaide, Australia)</td>
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<td>10.00</td>
<td>Discussion</td>
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<td>10.20</td>
<td>Coffee-Break and Visit of the Commercial Exhibition</td>
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<th>Time</th>
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<th>Topic</th>
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<td><strong>10.50 – 12.05 SESSION 2: AN INTRODUCTION TO THE SYMPOSIUM (2)</strong></td>
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<td><strong>Moderators:</strong> D. Koulalis, E. Vögelin</td>
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<tr>
<td>10.50 004</td>
<td>3d Technology in Various Aspects of Hand Surgery</td>
<td>F. Verstreken (Antwerp, Belgium)</td>
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<tr>
<td>11.05 005</td>
<td>Upper Limb Casts: from Plaster of Paris to 3D Scanning and Printing</td>
<td>O. Barbier, M. Pignot, L-P. Broze, F. De Boeck, B. De Smet, X. Libouton (Brussels, Belgium)</td>
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<tr>
<td>11.20 006</td>
<td>Setting Up a Home Microsurgical Lab</td>
<td>F. Youssef, A. Aly (Cairo, Egypt)</td>
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<td>11.35 007</td>
<td>Home Based Exercise Program - Why, How, How Often</td>
<td>Ch. Robert, D. Mouraux (Brussels, Belgium)</td>
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<tr>
<td>11.50</td>
<td>Discussion</td>
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<td>12.05</td>
<td>Lunch and Visit of the Commercial Exhibition</td>
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13.50 – 16.20 SESSION 3: SHOULDER AND ELBOW (1)

*Moderators: F. Moungondo, G. Bain*

13.50 008 **Management of Shoulder Contracture in Obstetrical Brachial Plexus Palsy, between the Past and the Present**
A. Aly, H.Al-Attar (Cairo, Egypt)

14.00 Discussion

14.05 009 **Rotator Cuff Tears: Arthroscopic versus Open Technique**
D. Koulalis (Athens, Greece and Brussels, Belgium)

14.20 Discussion

14.25 010 **Innovative Complex Compound Shoulder Fracture Fixation via Improvised Angle Blade Plate and Vancomycin Paste**

14.35 Discussion

14.40 011 **The Function of the Brachioradialis during Elbow Flexion**
B. Caufriez, E. Brassinne, D. Mouraux, P.M. Dugailly, F. Schuind (Brussels, Belgium)

14.50 Discussion

14.55 012 **Complex Elbow Instabilities**
G. Bain (Adelaide, Australia)

15.05 Discussion

15.10 013 **Arthroscopic versus Open Elbow Lateral Collateral Ligament Reconstruction**
R. van Riet (Antwerp, Belgium)

15.25 Discussion

15.30 014 **Distal Humeral NonUnions: Biological Healing**
F. Schuind, F. Moungondo (Brussels, Belgium)

15.40 015 **Hinged External Elbow Distractor: Salvage to Arthrodesis in Joint Destruction**
I. Degreef, J. Lammens (Leuven, Belgium)

15.55 Discussion

16.05 016 **Rehabilitation after Intraarticular Fractures of the Distal Humerus: the Effect of Combination between PNF with Elastic Resistance, Pilates Machines, and Kinesiotaping Applications - how they work together?**
A. Nikolova, D. Encev, A. Baltov, Ch. Rangger (Sofia, Bulgaria and Frankfurt, Germany)

16.15 Discussion

16.20 Coffee-Break and Visit of the Commercial Exhibition

*Coffee break Sponsored by Stryker®*
16.50 – 17.40 SESSION 4: ELBOW (2)

**Moderators:** I. Degreef, R. van Riet

16.50 017 An Update about Tennis Elbow  
A. Van Tongel (Ghent, Belgium)

17.05 Discussion

17.10 018 Endoscopic versus Open Distal Biceps Repair  
R. van Riet (Antwerp, Belgium)

17.20 Discussion

17.25 019 A Ratio Based Approach to Identification of the Posterior Interosseous Nerve in the Proximal Forearm  
V.M. George, T.S. Jepegnanam, I.J. Prithishkumar (Vellore, India)

17.35 Discussion

17.40 – 18.10 SESSION 5: INNOVATIVE CONCEPTS AND TECHNIQUES - CASE PRESENTATIONS

**Moderators:** F. Schuind, A. Aly

18.30 – 23.00 **Social Program:**  
Private visit of the Horta Museum, followed by a guided Art Nouveau walk and dinner in Restaurant ‘La Quincaillerie’.
SATURDAY, FEBRUARY 4, 2017

07.30 - 18.00 Registration

08.00 – 09.45 SESSION 6: PERIPHERAL NERVES

**Moderators:** J. Bahm, E. Vögelin

08.00 020  The Effects of Humeral Shortening on the Three-Dimensional Configuration of the Brachial Plexus
J. Valcarenghi, A. Andrzejewski, F. Moungondo, V. Feipel, F. Schuind (Brussels, Belgium)

08.10 021  The Value of Sonography and MR Neurography in Peripheral Nerve Lesions
E. Vögelin, J. Schnider, O. Scheidegger (Bern, Switzerland)

08.25 022  Sonographic Evaluation of Upper Extremity Nerve Pathology
V. Créteur, A. Madani, F. Moungondo, F. Schuind (Brussels, Belgium)

08.40 023  Practical Demonstration of Sonography
V. Créteur (Brussels, Belgium)

08.50  Discussion

09.00 024  Endoscopical Nerve Decompression around the Elbow
E. Vögelin, L. Haug, T. Adler (Bern, Switzerland)

09.10  Discussion

09.15 025  A New Indication for the Hypothenar Fat Pad Flap: End Stage Carpal Tunnel Syndrome
T. Lattré, S. Brammer, S. Parmentier, C. Van Holder (Waregem, Belgium)

09.25 026  Nerve Transfer as an Alternative to Tendon/Muscle Transfer
L. De Smet (Leuven, Belgium)

09.40  Discussion

09.45  Coffee-Break and Visit of the Commercial Exhibition

10.15 – 11.25 SESSION 7: DISTAL RADIUS AN DRUIJ

**Moderators:** F. Stockmans, L. Van Overstraeten

10.15 027  Comminuted Articular Fractures of the Distal Radius : External Fixation or Volar Plate ? A Prospective, Randomized Study
N. Pedini, F. Schuind (Brussels, Belgium)

10.25  Discussion

10.30 028  Tips and Tricks to Avoid Complications on the Distal RadioUlnar Joint following Palmar Plating of Unstable Distal Radius Fractures
J. Rois (Vienna, Austria)

10.40  Discussion

10.45 029  Diagnosis and Management of Foveal tear vs Dorsal Tear of TFCC
P.C. Ho (Hong Kong, China)
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<tr>
<td>11.00</td>
<td>Discussion</td>
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<tr>
<td>11.05</td>
<td>030</td>
<td>Arthroscopic Osteotomy for Intra-Articular Distal Radius Malunion</td>
<td>F. Moungondo (Brussels, Belgium)</td>
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<td>11.20</td>
<td>Discussion</td>
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**11.25 – 12.10 SESSION 8: SCAPHOID**

*Moderators: F. Verstreken, L. De Smet*

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<tr>
<td>11.25</td>
<td>031</td>
<td>Arthroscopic Bone Grafting for Scaphoid NonUnion with DISI Deformity</td>
<td>P.C. Ho (Hong Kong, China)</td>
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<tr>
<td>11.35</td>
<td>032</td>
<td>Reconstruction of the Proximal Pole of the Scaphoid using a Vascularised Osteochondral Femoral Trochlea Flap</td>
<td>K. Kalb, B. Blanarsch (Bad Neustadt, Germany)</td>
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<tr>
<td>11.45</td>
<td>033</td>
<td>Prognostic Factors in the Treatment of Scaphoid Nonunions</td>
<td>F. Schuind, F. Moungondo, W. El Kazzi (Brussels, Belgium)</td>
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<tr>
<td>11.55</td>
<td>034</td>
<td>Effect of Neurodynamic Mobilizations on Fluid Dispersion on Median Nerve at the Level of the Carpal Tunnel: A Cadaveric Study</td>
<td>M. Boudier-Revéret, K.K. Gilbert, D.R. Allégue, M. Moussadyk, J-M. Brismée, V. Feipel, P-M. Dugailly, S. Sobczak (Trois-Rivières, Québec, Canada, Lubbock, Texas, USA and Brussels, Belgium)</td>
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<tr>
<td>12.05</td>
<td>Discussion</td>
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<td>12.10</td>
<td>Lunch and Visit of the Commercial Exhibition</td>
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**13.15 – 15.05 SESSION 9: CARPAL INSTABILITIES**

*Moderators: P.C. Ho, L. De Smet*

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<tr>
<td>13.15</td>
<td>035</td>
<td>Arthroscopic Classification of Extrinsic Ligaments and Dorsal Capsulo-Scapho-Lunate Septum</td>
<td>L. Van Overstraeten, E. Camus, M. Shahabpour (Brussels, Tournai, Belgium and Maubeuge, France)</td>
</tr>
<tr>
<td>13.30</td>
<td>036</td>
<td>Place of ECRL Tenodesis for the Treatment of ScaphoLunate Instability</td>
<td>W. El Kazzi (Brussels, Belgium)</td>
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<tr>
<td>13.45</td>
<td>037</td>
<td>SLAC and SNAC Treatment's: CarpalFix® Device</td>
<td>A. Andrzejewski, Ph. Etienne (Brussels, Belgium)</td>
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<tr>
<td>13.55</td>
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<td>Discussion</td>
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<tr>
<td>14.05</td>
<td>038</td>
<td>Complex Wrist Instabilities</td>
<td>G. Bain (Adelaide, Australia)</td>
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<tr>
<td>14.15</td>
<td>039</td>
<td>Normal and Pathologic MR Imaging of Extrinsic and MidCarpal Ligaments</td>
<td>M. Shahabpour, A. Milants, L. Van Overstraeten, M. De Maeseneer (Brussels, Tournai, Belgium)</td>
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<td>14.30</td>
<td>040</td>
<td>MR Arthrography of Secondary Carpal Stabilizers with Arthroscopic</td>
<td>M. Shahabpour, M. De Maeseneer, B. Staelens, E. Camus, L.</td>
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<td>Correlation</td>
<td>Van Overstraeten (Brussels, Tournai, Belgium and Maubeuge,</td>
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<td>14.40</td>
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<td>Discussion</td>
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<tr>
<td>14.50</td>
<td>041</td>
<td>Diagnosis and Ligament Reconstruction for Palmar Mid-Carpal Instability</td>
<td>P.C. Ho (Hong Kong, China)</td>
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<tr>
<td>15.00</td>
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<td>Discussion</td>
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<td>15.05</td>
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<td>Coffee-Break and Visit of the Commercial Exhibition</td>
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<td>Coffee break Sponsored by</td>
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**15.30 – 16.45 SESSION 10: TRAPEZIO-METACARPAL JOINT**

**Moderators:** W. El Kazzi, K. Drossos

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<tr>
<td>15.30</td>
<td>042</td>
<td>Dynamic Evaluation of CarpoMetacarpal Instability</td>
<td>F. Stockmans (Kortrijk, Belgium)</td>
</tr>
<tr>
<td>15.45</td>
<td>043</td>
<td>CarpoMetacarpal Stabilization by only Reconstructing the DorsoRadioLateral Ligament</td>
<td>F. Stockmans (Kortrijk, Belgium)</td>
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<tr>
<td>15.55</td>
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<td>Discussion</td>
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<tr>
<td>16.05</td>
<td>044</td>
<td>Retrospective Analysis of a Series of Trapezo-Metacarpal Prostheses type ISIS</td>
<td>M. Bazi, S. Boulares, Ph. Everaert (Charleroi, Belgium)</td>
</tr>
<tr>
<td>16.15</td>
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<td>F. Stockmans (Kortrijk, Belgium)</td>
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**16.45 – 17.35 SESSION 11: HAND**

**Moderators:** N. Cuylits, F. Schuind

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**SESSION 12: INNOVATIVE CONCEPTS AND TECHNIQUES - CASE PRESENTATIONS**

**SUMMARY AND CONCLUSION**

**Moderators:** F. Schuind, K. Bahm

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ABSTRACTS
SESSION 1: AN INTRODUCTION TO THE SYMPOSIUM (1)

001 Free Latissimus Dorsi Flap for Upper Limb Coverage, Classical versus Robotic Harvesting
N. Cuylits (Brussels, Belgium)

002 Peripheral Nerves in Hand, Wrist and Elbow Surgery: a 2017 Update
J. Bahm (Brussels, Belgium and Aachen, Germany)

003 Elbow Arthroscopy and Endoscopy
G. Bain, H. Saeed, J. Phadnis (Adelaide, Australia)
001 Free Latissimus Dorsi Flap for Upper Limb Coverage, Classical versus Robotic Harvesting
N. Cuylits
ULB - Hôpital Erasme, Brussels and Clinique du Parc Léopold, Brussels, Belgium

Microsurgical muscle flap transfer remains an excellent method to cover complex soft tissue defects of the upper and lower limbs. It allows the surgeon to provide a highly vascularized coverage for complex bony trauma or infections. Moreover, muscle flaps are very easily pliable and fit perfectly to 3D defect or big cavities.

Latissimus Dorsi (LD) muscle, given its large surface and its long pedicle, is often chosen by the surgeon to cover large defects in the context of high energy trauma.

Classical harvesting of LD is technically easy and quickly done by experienced microsurgeons but it becomes a challenge if the surgeon try to limit donor site morbidity and scar length to a minimum. For this purpose, endoscopic harvest has been tried out but is even more challenging technically and has never become popular among plastic surgeons.

Since years, robotic minimally invasive surgery is currently used by other specialties and has even become a gold standard for prostatectomy.

Robotic LD harvesting technique has first been described since 2012. We have been seduced by the possibility to harvest the all muscle with only three little scars and we have thus started to use this method in January 2016 and 4 cases have been done until now. In this keynote, we will try to share our learning experience with the audience. The presentation will specially focus on the difficulties we have encountered, the advantages of such a technique but also on the reasons why it has not become the gold standard technique for LD harvesting since it was first published.

Reference(s)

002 Peripheral Nerves in Hand, Wrist and Elbow Surgery: a 2017 Update
J. Bahm1,2, S. Vossen1, S. Bouslama1, W. El Kazzi2, F. Schuind2
1 Plastic and Hand Surgery Unit, Franziskushospital Aachen, Aachen, Germany; 2Department for Orthopaedics and Traumatology, ULB University Hospital Erasme, Brussels, Belgium

After over 20 years dedicated to peripheral nerve and hand surgery, the presenting author sees an opportunity for an update on how peripheral nerves are dealt with in upper limb surgery. Although microsurgical operation techniques did not change recently, some specific procedures became routine like nerve transfer procedures, end-to-side coaptations and surgery for neuropathic pain.

Basic research provides increasing knowledge about the biology of nerve regeneration and bioartificial tubes and nerve allografts found their way into clinical practice to bridge short gaps, mainly of digital nerves.

In a parallel way, reeducation focused more on sensory revalidation and a multifactorial approach to CRPS II neuropathic pain, including several aspects of cortical plasticity and re-learning [mirror therapy and related technology].

Does this mean that we treat nerve lesions and compression better today? Standard procedures like carpal tunnel or ulnar nerve release are certainly performed in great number and safe manner, but rare and more proximal compressive neuropathies still warrant further development, like disputed neurogenic TOS surgery.

Nerve transfers in neuroorthopaedic conditions [like axillary or radial nerve lesions] challenge muscle / tendon transfer indications and results.
Neuroma surgery has become more eclectic and performant, able to reduce or erase chronic neuropathic pain conditions. Distal nerve transfers are aimed to counteract irreversible target amyotrophy [like the intrinsic muscle waste overcome by a distal motor nerve transfer onto the anterior motor branch of the distal ulnar nerve before its entry into Guyon’s canal].

Where most orthopaedic surgeons were taught before to identify and protect [and avoid] the peripheral nerves in the upper limb when performing bone surgery, they actually are very active reconstructive actors in the immediate or delayed repair strategy. Especially nerve transfers and more routine nerve microsurgery help to provide faster functional recovery for severely injured or affected upper limbs, either by competent monospecialists or within interdisciplinary teams, both in University hospital departments and smaller surgical facilities.

003 Elbow Arthroscopy and Endoscopy
G. Bain, H. Saeed, J. Phadnis (Adelaide, Australia)
18.1 Introduction

Endoscopic surgery around the elbow has grown to encompass a wide range of pathologies over the last few decades, owing to increased breadth, safety and reproducibility of practice. As these techniques evolve, soft tissue endoscopy about the elbow has expanded to include ulnar nerve release and transposition, olecranon bursectomy, resection of the olecranon spur and endoscopic suturing.

Ulnar nerve entrapment at the level of the elbow is the second most common entrapment neuropathy of the upper limb behind carpal tunnel syndrome [7, 17]. The sites of ulnar nerve compression are the arcade of Struthers, the cubital tunnel (most common site) and the flexor carpi ulnaris fascia [17]. Failing conservative management, treatment options include open or endoscopic [18] cubital tunnel release and open or endoscopic anterior ulnar nerve transposition if the ulnar nerve is found to be unstable or is in a hostile bed.

Olecranon bursitis refers to inflammation of the subcutaneous synovial-lined sac of the bursa overlying the olecranon process at the proximal aspect of the ulna [5]. It is the most common form of superficial bursitis at the elbow [31]. Inflammation can result from abrasions around the elbow leading to infection, but is often caused by acute injuries during sport (i.e. direct impact to the posterior elbow), autoimmune inflammatory process (e.g. rheumatoid arthritis) or secondary to crystal deposition disease (e.g. gout or pseudogout). Patient with diabetes mellitus, uraemia, intravenous drug abuse, alcohol abuse or long-term use of steroids are at increased risk [38]. Two-thirds of cases are sterile bursitis, with one-third of cases being septic, secondary to Staphylococcus aureus and requiring bacterial cultures, drainage, irrigation and antibiotics [24].

The two conditions can be differentiated based on clinical examination [6], and surgery is indicated when conservative management has failed. Wet or dry endoscopic techniques can be performed, using incisions away from the apex of the olecranon that lead to faster healing rates and lower reoperation rates [13, 14].

Before any endoscopic procedure is performed, familiarity with the open technique is essential and provides a backup should the endoscopic procedure fail. Furthermore, a thorough understanding of surgical anatomy of the elbow is paramount due to the close proximity of neurovascular structures that can be damaged.
18.1.1 Surgical Anatomy

The ulnar nerve, a terminal branch of the medial cord of the brachial plexus, enters the arm with the axillary artery where it passes posterior and medial to the brachial artery, travelling between the brachial artery and vein [26].

At the level of the insertion of coracobrachialis in the middle third of the arm, the ulnar nerve pierces the medial intermuscular septum (MIMS) to enter the posterior compartment of the arm approximately 8 cm proximal to the medial epicondyle, where it lies on the anterior aspect of the medial head of triceps. The MIMS extends from the coracobrachialis proximally to the medial humeral epicondyle distally where it is a thick and distinct structure [16].

The ulnar nerve then courses anterior to the arcade of Struthers, a thin fibrous band extending from the medial head of triceps to the MIMS that is found 8 cm proximal to the medial epicondyle [16]. It then passes behind the medial epicondyle in the epicondylar groove where it continues through the cubital tunnel, a space bounded medially by the medial epicondyle and laterally by the tip of the olecranon. It is converted into a tunnel by the cubital tunnel retinaculum (arcuate ligament of Osborne), which are fibres that run perpendicular to the flexor carpi ulnaris (FCU) aponeurosis.

Next, the ulnar nerve passes between the ulnar and humeral heads of the FCU and penetrates the flexor-pronator aponeurosis about 5 cm beyond the medial epicondyle before descending into the forearm between FCU and flexor digitorum profundus as it courses down the forearm to the wrist.

18.1.2 Presentation and Investigations

A careful history is important to determine the chronicity, extent and nature of ulnar nerve compression. Symptoms can range from transient numbness, tingling or burning sensation in the ring and small fingers to clawing of these digits and intrinsic muscle atrophy in severe cases [4]. The most common symptoms are sensory disturbances along the ulnar nerve distribution, pain at the elbow and weakness of ulnar-innervated intrinsic hand muscles [12].

Pain may be present in the elbow region, and there may be a history of trauma at or near the elbow. Symptoms may worsen during the day with repeated elbow use, producing increasing weakness and sensory changes. Physical examination involves examining elbow range of motion and assessing for areas of tenderness or ulnar nerve subluxation over the epicondylar groove. In addition, the examiner should look for intrinsic muscle weakness, clawing or inability to abduct the small finger in extension. Assessing sensory changes provides additional information for localisation of ulnar nerve lesions. An elbow flexion test, where the examiner flexes the patient’s elbow past 90°, supinates the forearm and extends the wrist, may be performed. This is considered positive if discomfort is reproduced, or paraesthesia along the ulnar nerve distribution occurs within 60 s [8, 33].

Examination of ulnar nerve instability, where the elbow is taken through full range of movement, is used to assess for chronic subluxation and relocation of the ulnar nerve during flexion and extension, respectively. The ulnar nerve may directly be visualised for subluxation or snapping as it lies superficially over the medial humeral epicondyle [3].

In patients presenting with bursitis, there is often a history of local repetitive or direct trauma. Patients may complain of swelling at the posterior elbow, associated with increased pain exacerbated by pressure or prolonged elbow flexion. The onset of symptoms may be acute in setting of infection or trauma or chronic if secondary to autoimmune disease or crystal deposition and chronic irritation. However, patients may also present with painless swelling in the setting of chronic disease. Examination of the posterior elbow in olecranon bursitis often reveals a fluctuant swelling felt over the olecranon process. There may be tenderness on palpation, especially in the acute setting. Skin inspection may reveal areas of abrasion or local infection, rheumatoid nodules or gouty tophi. Elbow range of movement is often normal, but may be reduced in severe cases.
Examination should also be directed at assessing if previous surgery has been performed. Significant scarring around the elbow joint may make endoscopic surgery increasingly difficult or unsafe, and an open technique may be required.

**18.1.3 Imaging**

*Plain radiographs* are required for assessment of anatomy, such as deformity secondary to trauma, bony spurs or fragments, shallow olecranon groove or destructive lesions.

*Ultrasound* examination may be useful in assessing specific compressive pathologies and allow for real-time visualisation of the nerve through its course. It is particularly useful in the assessment of bursitis, as it allows for the demonstration of effusions, inflammatory collections or presence of loose bodies [19].

**18.2 Treatment Options**

**18.2.1 Endoscopic Ulnar Nerve Release**

Several endoscopic techniques for ulnar nerve release have been published, including those by Hoffman (Storz), Cobb (Integra) and Tsai (glass tubes). Using the Hoffman technique, the subcutaneous plane is opened with tunnelling forceps and a hooded endoscope is introduced [11].

The hooded endoscope acts to keep the workspace open, making visualisation possible and allowing scissors and cautery to be introduced [2].

Cobb’s technique makes use of the Integra Endo Release System, utilising a cannula specifically designed for cubital tunnel release, to protect the ulnar nerve whilst the roof of the cubital tunnel is released [1]. Tsai utilises glass tubes to house an endoscope and guide a meniscus knife [35].

The senior author published a technique utilising the Agee MicroAire endoscopic carpal tunnel device. This device has a trigger to activate a retractable cutting blade from a protected sheath immediately distal to the endoscopic tip, allowing for direct visualisation of both blade and tissue at all times. Blunt dissection to the level of the cubital retinaculum is made, and the Agee device is introduced directly adjacent to the nerve, and the overlying constrictive tissue is released with the nerve and its branches in view at all times [7, 17] (Fig. 18.1).

Rehabilitation following endoscopic repair involves early active range-of-motion activities and a return to normal activities as tolerated.

**18.2.2 Endoscopic Ulnar Nerve Anterior Transposition**

If the ulnar nerve is found to be unstable, an endoscopic anterior transposition can be performed [29]. A standard ulnar nerve release is performed. The MIMS is excised. Care is required to ensure any adjacent vessels are identified and cauterised if required. The ulnar nerve is then mobilised and transposed anterior to the medial epicondyle (Fig. 18.2). Once the nerve is checked proximally and distally to ensure no kinking, the subcutaneous fat is sutured to the soft tissue over the medial epicondyle. Rehabilitation involves placing the elbow into a sling in flexion for 1 week to allow for soft tissue healing and stabilisation of the nerve in its new bed.
18.2.3 Olecranon Bursitis

Surgery traditionally involves open bursectomy, with incision over the point of the olecranon. However, wound healing can be a problem owing to the area of bridging skin. Endoscopic techniques allow for faster healing with improved outcome.

Utilising the wet technique, two separate 1.5 cm longitudinal portals are made 2 cm proximal and distal to the margins of the bursa, in the midline. Distension is maintained via saline inflow and arthroscopic cannula to prevent fluid draining away. The scope can then be placed into the bursa, resecting the bursa from inside-out until normal tissue planes are visualised. Care should be taken to protect the overlying skin and to prevent any perforations that may develop into sinuses.

The senior author’s preferred technique is the dry endoscopic procedure, specifically for treatment of sterile olecranon bursitis [36], utilising the Storz endoscopic equipment described above (Fig. 18.3). A 2 cm incision distal to the bursa is made to allow the introduction of the hooded scope, and the subcutaneous tissues are elevated off the bursa and olecranon. A separate proximal portal is made, and a pituitary rongeur is used to resect the bursa and cautery to control bleeding and fluid accumulation postoperatively (Fig. 18.4). To prevent recurrence in the dead space, the elbow should be placed in a sling at 90° of flexion.

18.2.4 Olecranon Spurs

Once the position of the spur is identified using fluoroscopy, dry endoscopy can be used to resect
the spur by introduction of high-speed burr. Fluoroscopy can then be used to ensure complete resection (Fig. 18.5).

### 18.2.5 Dry Elbow Arthroscopy

Dry arthroscopy has been utilised in elbow, providing greater appreciation of the anatomy of the elbow joint, reducing the risk of fluid extravasation and compartment syndrome. When the joint is distended with air, the synovial and articular surfaces are able to reflect light, allowing superior clarity and better understanding of subtle findings of the soft tissues and articular cartilage (Fig. 18.6). This technique has been shown to be particularly useful in synovitis, as fluid distension in wet arthroscopy may compress the soft tissues, change the shape of the synovium and reduce its vascularity [30, 34].

However, there are relative contraindications to using dry arthroscopic techniques. When radiofrequency ablation is required, wet arthroscopy should be used to provide cooling effect to the joint and prevent risk of chondrocyte damage. Furthermore, there is a theoretical risk of air embolus when arthroscopy is performed under air pump pressure and when a tourniquet is not inflated. Therefore, this technique should not be used with an air pump until further research is available [34].

It can also be used for any of the therapeutic procedures, such as synovectomy, resection of osteophytes and capsulectomy (Fig. 18.7).
18.2.6 Arthroscopy and Elbow Arthroplasty

Arthroscopic management of elbow arthroplasty has been utilised as a valuable adjunct in the diagnosis of painful or swollen arthroplasty. Arthroscopy in this setting allows for targeted biopsies for microbiological diagnosis and for assessment of mechanical factors before an informed decision regarding definitive management is made [34]. Mechanical diagnosis can be made, and sometimes running repairs can be performed (Fig. 18.8).

18.2.7 Endoscopic Suturing

The senior author has performed deep suturing endoscopically using barbed sutures (Fig. 18.9). These are ideal for endoscopic repairs, as they do not require knot tying. The sutures can be inserted in the same way as we perform microsurgery. They can be used to repair deep fascia and other soft tissues [36].

18.2.8 Other Procedures

Soft tissue endoscopy has grown to encompass a range of pathologies (Table 18.1). In the elbow, endoscopy has been successfully utilised in biceps bursoscopy and distal biceps tendon repairs [9, 15, 37], which is described in more detail in another chapter in this series. In the forearm, endoscopic techniques have been used for decompression of the anterior interosseous nerve [22, 25], pronator syndrome [27], and performing fasciotomy in cases of chronic exertional compartment syndromes [10, 32]. Furthermore, endoscopic soft tissue release of DeQuervain’s tenosynovitis and intersection syndrome has been successfully performed [21]. Endoscopic harvesting of the radial artery has been utilised in patients undergoing coronary artery bypass grafting (CABG) with an overall patency at 10 years of 82% [23].

18.3 Outcomes

A prospective study comparing the outcomes of the open versus endoscopic ulnar nerve release reported better patient satisfaction with the endoscopic technique and a lower complication rate, including elbow pain, scar tenderness and medial elbow paraesthesia [17]. Endoscopic decompression has been shown to be as effective as the open decompression, with additional advantages of being less invasive, a smaller incision, less vascular insult to the nerve and
faster recovery [17, 20]. Furthermore, Cobb et al. [21] have shown that patients experience less pain with quicker functional recovery and return to work. Meta-analyses have shown that in situ decompression has comparable outcomes with anterior transposition but with fewer complications [28, 39]. Additionally, endoscopic technique of olecranon bursectomy has shown faster healing and lower reoperation rates when compared to open technique, leading to shorter hospital stays [13, 14].

### 18.4 Complications

Potential complications, especially in the early phases of using these new techniques, are related to a lack of appreciation of the anatomy from an

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**Fig. 18.9** Endoscopic suturing using barbed sutures in a cadaveric model. The suture technique is similar to the microsurgery. Once positioned, the sutures are pulled tight, and the barbs of the suture hold the suture in place (Copyright Dr. Gregory Bain)

**Table 18.1** Indications for endoscopic procedures about the elbow, forearm and wrist

<table>
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<tr>
<th>Procedure</th>
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<tr>
<td>Releases</td>
<td>Ulnar nerve release at cubital tunnel anterior interosseous nerve release</td>
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<td>DeQuervain’s tenosynovitis, intersection syndrome</td>
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<td>Forearm fasciotomy in chronic exertional compartment syndrome</td>
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<tr>
<td>Excision</td>
<td>Bursectomy (olecranon bursitis)</td>
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<td>Tenosynovectomy (e.g. of the extensor tendons)</td>
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<td>Excision of lesions (e.g. olecranon rheumatoid nodules)</td>
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<td>Olecranon spur resection</td>
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<tr>
<td>Harvesting</td>
<td>Vessel graft (e.g. radial artery for CABG)</td>
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<td>Nerve graft (e.g. distal PIN, MCNFA)</td>
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<td>Tendon graft (e.g. FCR, palmaris longus)</td>
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<td></td>
<td>Bone graft (e.g. distal radius and olecranon)</td>
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<td>Nerve transposition</td>
<td>Ulnar nerve transposition</td>
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<tr>
<td>Stabilisation</td>
<td>Repair of distal biceps tendon</td>
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<td>Fixation of ulnar fractures/ulnar osteotomies</td>
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<tr>
<td>Reconstruction</td>
<td>Tendon transfer (e.g. extensor indicis to EPL)</td>
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endoscopic perspective, familiarity with endoscopic dissection techniques or inexperience with effective use of instrumentation.

**Pearls of Treatment**

Before any soft tissue endoscopic procedure is performed, familiarity with the open technique is essential and should be utilised as a backup if the procedure cannot be performed endoscopically. A thorough understanding of the surgical anatomy is paramount owing to proximity of neurovascular structures and risks of damage. When using scissors to incise internal structures, for example, the fascia, care should be taken to have limited opening of the scissors and do multiple small releases to ensure safety of neurovascular bundles. Below is a summary of the senior authors’ tips for training and development of these techniques:

1. Become competent with the open procedure
2. Develop familiarity with the instrumentation on mock models
3. Attend cadaveric courses and trial on cadaveric models
4. Visit colleagues who are experienced in the surgical methods
5. “Mind map” the procedure, i.e. plan out the steps of the procedure prior to operating
6. Commence with diagnostic endoscopic procedures, before therapeutic
7. Have a low threshold for use of a backup open procedure, or avoid endoscopic procedure completely, if:
   (a) There are difficulties or safety concerns with the procedure
   (b) There is previous surgeries and development of severe scar tissue
   (c) There is a revision or complex case
   (d) Procedure, staffing or logistical issues are time consuming

**References**

SESSION 2: AN INTRODUCTION TO THE SYMPOSIUM (2)

004 3d Technology in Various Aspects of Hand Surgery
F. Verstreken (Antwerp, Belgium)

005 Upper Limb Casts: from Plaster of Paris to 3D Scanning and Printing
O. Barbier, M. Pignot, L-P. Broze, F. De Boeck, B. De Smet, X. Libouton (Brussels, Belgium)

006 Setting Up a Home Microsurgical Lab
F. Youssef, A. Aly (Cairo, Egypt)

007 Home Based Exercise Program - Why, How, How Often
Ch. Robert, D. Mouraux (Brussels, Belgium)
004 3d Technology in Various Aspects of Hand Surgery
F. Verstreken
Monica Hospital, Antwerp and Antwerp University Hospital, Belgium

The use of 3d technology in hand surgery is based on precise cross-sectional imaging and powerful computer software. This allows the generation of highly accurate 3D images of anatomical structures, which can be manipulated and provide surgeons with better ways to evaluate pathology and plan surgical procedures. Based on 3D surgical planning, patient specific surgical guides and implants can be 3D printed and used during surgery. Following the very successful use of this technology in the correction of malunion, expertise has grown and indications have expanded to other fields of hand surgery, which also resulted in the setup an “in hospital 3D lab” at our institution.

Malunion

Bone Tumor

Distal Radius Fracture
The immobilisation of a limb in case of non-surgical treatment of a fracture is usually ensured by a plaster of Paris or synthetic casting. Synthetic splints or thermoplastic splints are used for less rigid immobilisation or during revalidation periods. All these means of immobilization are molded on the member of the patient by a specialized medical or paramedical staff. The molding is possible by an exothermic reaction of the material or a heating process. The removal of rigid plasters (calcium or fiberglass often) requires sawing, source of noise and dust. All this produces a good amount of waste.

New developments in easy acquisition of the 3 dimensions of a volume and the 3D printing at limited cost bring the opportunity to print casts specific to the member of the patient.

1. Immobilisation device:
- Good adaptation to the limb, also in case of complex shape (with soft and rounded edges);
- Possibility of adding appendices to the cast (to suspend, to limit certain movements, to adapt rehabilitation equipment, ...);
- Rigidity / thickness chosen when printing;
- Lightweight material with mesh;
- Resistant to water (hygiene and leisure);
- Two-part production for easy placement;
- Locking system (but opening possible in case of emergency)
- Recyclable material;
- No dust or ablation noise
2. Process:

- Production possible without staff specialized in the molding of devices on the limb;
- No stock of specific thermoplastic splints depending on the anatomical site or size.

Some difficulties still need to be analyzed:

- The limb may vary in volume in the course of trauma or operation;
- Time for printing (hours);
- Actual costs and financing / reimbursement opportunities;
- The implementation of the process and the machines adapted to the medical environment.

Case report: We illustrate the process by the realization of a cast for wrist immobilization by a patient operated after a fracture of the distal radius. The volume was acquired during postoperative consultation. The printed cast was delivered after a few days. The patient found it light and comfortable. This is the beginning of a series of printed casts produced as part of a clinical trial approved by our ethics committee to refine the process and determine the best indications of the method.

006 Setting Up a Home Microsurgical Lab
Abstract not received in due time.

007 Home Based Exercise Program - Why, How, How Often
Abstract not received in due time.
SESSION 3: SHOULDER AND ELBOW (1)

008 Management of Shoulder Contracture in Obstetrical Brachial Plexus Palsy, between the Past and the Present
A. Aly, H.Al-Attar (Cairo, Egypt)

009 Rotator Cuff Tears: Arthroscopic versus Open Technique
D. Koulalis (Athens, Greece and Brussels, Belgium)

010 Innovative Complex Compound Shoulder Fracture Fixation via Improvised Angle Blade Plate and Vancomycin Paste

011 The Function of the Brachioradialis during Elbow Flexion
B. Caufriez, E. Brassinne, D. Mouraux, P.M. Dugailly, F. Schuind (Brussels, Belgium)

012 Complex Elbow Instabilities
L. Camarda, G. Bain (Adelaide, Australia)

013 Arthroscopic versus Open Elbow Lateral Collateral Ligament Reconstruction
R. van Riet (Antwerp, Belgium)

014 Distal Humeral NonUnions: Biological Healing
F. Schuind, F. Moungondo (Brussels, Belgium)

015 Hinged External Elbow Distractor: Salvage to Arthrodesis in Joint Destruction
I. Degref, J. Lammens (Leuven, Belgium)

016 Rehabilitation after Intraarticular Fractures of the Distal Humerus: the Effect of Combination between PNF with Elastic Resistance, Pilates Machines, and Kinesiotaping Applications - how they work together?
A. Nikolova, D. Encev, A. Baltov, Ch. Rangger (Sofia, Bulgaria and Frankfurt, Germany)
Management of Shoulder Contracture in Obstetrical Brachial Plexus Palsy, between the Past and the Present
A. Aly1, H. Al-Attar2
1Orthopedic Department, Ain Shams University, Cairo, Egypt; 2Hand and Microsurgery Unit, Children’s Hospital for Health Insurance, Cairo, Egypt

**Background:** Internal rotation contracture due to muscle imbalance is the most common deformity in obstetric brachial plexus palsy (OBPP). Persistence of contracture hinders normal shoulder development. The goals of treatment are improvement of range of motion, stable concentric glenohumeral articulation, and balanced muscles. Methods of treatment depend on the age and the degree of shoulder dysplasia.

**Purpose:** We present recent trends in the management of internal shoulder contracture in OBPP.

**Methods:** Over a six years period, children presented to our hospital with OBPP were assessed for the presence of internal shoulder contracture.

From birth till the age of six month physiotherapy was the main line of prevention of shoulder contracture, while after that age till 1.5 years subscapularis muscle botox injection was done aiming at decreasing internal rotators power. Children presenting after 1.5 years of age with internal shoulder contracture were managed through arthroscopic capsular release with or without tendon transfer, the only contraindication of such technique is advanced shoulder dysplasia.

In cases with advanced shoulder dysplasia, a new technique was attempted combining both arthroscopic capsular release and glenoid osteotomy with or without humeral derotational osteotomy.

**Results:** All patients were available for follow-up, and all have completed a minimum of one year clinical follow-up. There was no intra- or postoperative complications. All patients had a centered position of the glenohumeral joint at the time of intervention. A significant increase in the active external rotation was observed in all patients.

**Conclusions:** Recent techniques evolved in the management of internal shoulder contracture depend on both age and degree of shoulder dysplasia. They have succeeded in the prevention and the treatment of shoulder joint abnormalities. Long term follow-up is warranted to approve our protocol for management of shoulder contracture in OBPP.

Rotator Cuff Tears: Arthroscopic versus Open Technique
Abstract not received in due time.

Innovative Complex Compound Shoulder Fracture Fixation via Improvised Angle Blade Plate and Vancomycin Paste
Hospital Banting, Jalan Sultan Alam Shah, 42700 Banting, Selangor, Malaysia

An 18 year old man presented to the casualty following a road traffic accident with a Gustillo Anderson Grade 3A compound fracture of the Left Arm with no Neurovascular Deficit. Radiographic imaging revealed an AO 12-C3 fracture pattern of the proximal half of the Left Humerus. Emergent irrigation and suturing of wound was performed bedside under Local Anaesthetic. Intravenous Cefuroxime was administered pending definitive surgery.

Significant financial restraints demanded implementation of 2 significant innovations. Firstly, an improvised Helical Humeral Angle Blade plate was fashioned from a long straight locking plate to facilitate stable minimally invasive osteosynthesis, which was vital in complex compound fractures with minimal blood loss compared to conventional fixation approaches as well as reduced neurovascular damage risks compared to conventional plate designs. Secondly, the use of commercially available antibiotic impregnated collagen mesh was impossible and an improvised alternative was conceived in the form of a Vancomycin paste enveloped in an oxidized cellulose polymer (Surgicel). At time of writing, the Authors could not find any recorded literature of minimally invasive osteosynthesis of the humerus via an improvised long helical Humeral Angle Blade Plate.
On Post Trauma Day 5, definitive surgery was performed for this patient under Image Intensifier guidance. The initial shoulder wound was utilised as the proximal entry point for fracture fixation. A 4.5 mm drill bit was then used to prepare the blade entry point at the humeral head. A series of 6 contiguous holes were drilled in a horizontal alignment distal to the greater tuberosity and an osteotome was used to complete the blade insertion site. A distal incision on the arm was made to accommodate the distal screws of the humeral angle blade plate on the distal humerus diaphysis between the lateral borders of the biceps and the brachialis, taking great care to preserve the musculocutaneous nerve beneath the biceps muscle. Once beneath the biceps muscle, the brachialis was split lengthwise to access the distal humerus. A periosteal elevator was then used to prepare a musculo-osseus tunnel for plate insertion in a distal to proximal fashion.

The improvised plate was inserted from proximal to distal and once in its desired position, the plate was rotated, facilitating the blade to slide into the insertion site. An impactor was used to persuade the blade into its desired final position. Screws were then inserted with the arm in traction and elbow flexed to reduce incidence of musculocutaneous nerve damage.

Advantage of the improvised plate includes a wide blade which provides for improved angular stability, permitting early physiotherapy. Drawbacks of such device include a bulky implant, increasing the risk of shoulder impingement.

A bactericidal agent in the form of a Vancomycin paste enveloped in Surgicel was then inserted into the incisions, which would theoretically confer superior healing properties.

Postoperatively, the wounds healed uneventfully. The patient’s shoulder gained 90° Flexion, 120° Abduction and 45° External Rotation. Other shoulder movements were normal. Prophylactic implant removal was performed at 6 weeks to reduce incidence of shoulder impingement.

Improvised Helical Humeral Angle Blade Plate with Vancomycin paste successfully treated this complex compound fracture whilst providing comparable outcomes with commercially available solutions at a reasonable cost. Vancomycin paste also permitted early definitive fixation of compound fracture with favourable soft tissue outcomes.

011 The Function of the Brachioradialis during Elbow Flexion
B. Caufriez¹, E. Brassinne², D. Mouraux², P.M. Dugailly², F. Schuind¹
¹Department of Orthopaedics and Traumatology, ²Department of Physical Therapy and Rehabilitation, Hôpital Erasme, Université libre de Bruxelles, ULB, Bruxelles, Belgium

The hypothesis of this study was that, at least in certain positions of elbow flexion and forearm rotation, the brachioradialis is, along with the biceps and brachialis, one of the main elbow flexors. Materials and methods Fifteen young healthy male volunteers participated in this research. The activities of the biceps, brachialis and brachioradialis muscles were studied using surface electromyography, while the subjects were performing elbow flexions/extensions with as much strength as possible, forearm in neutral position, then in full pronation, then in full supination. The elbow flexion torques were isokinetically measured at 60°/sec for an arc of 120°. Results The biceps, brachialis and brachioradialis muscles were electromyographically very active throughout resisted elbow flexion, in all three investigated positions of forearm rotation. At certain positions, the electromyographic activities were much higher than the maximal voluntary contraction signal. For what concerns specifically the brachioradialis, in all three forearm rotation investigated positions, the activity curve demonstrated a slow increase during the first part of elbow flexion, reaching in 73.3% of subjects its peak at the end of flexion ; in the remaining 26.7%, the brachioradialis had a flat activity without significant peak. The activity was slightly higher in supination. Discussion This study indirectly supports the idea that the brachioradialis is one of the main elbow flexors, especially when the elbow flexion is done with the forearm in supination. This observation could be important in clinical elbow and wrist surgical practice. Further investigations should study the instantaneous changes of elbow moment arm of the brachioradialis during flexion.

012 Complex Elbow Instabilities
L. Camarda, G. Bain (Adelaide, Australia)
Treatment of Combined Medial and Lateral Collateral Ligament Insufficiency

Lawrence Camarda and Gregory I. Bain

Background

The most common mechanism of elbow ligament injuries occurs with a dislocation. The most common types of elbow dislocations are those that occur posteriorly (simple dislocations) involving only soft-tissue injuries, whereas complex dislocations have associated fractures. In these specific cases, medial and lateral ligament insufficiency could be observed, despite osteosynthesis of the skeletal injury. Further, outcome studies demonstrate that injuries resulting in significant ligamentous disruption have worse results than isolated fractures [1, 2]. Key aspects such as instability patterns, pathoanatomy, diagnosis, and treatment options of elbow ligament insufficiency are reviewed.

Instability Classification

Lateral Instability

(a) Posterolateral rotatory instability (PLRI)— Described by O’Driscoll, it is considered to be the most common pattern of symptomatic chronic instability of the elbow [3]. Most commonly it results from a simple elbow dislocation [4, 5]. The primary cause of PLRI involves the disruption of the LCL complex, more specifically the LUCL. However, MCL and overlying flexor–pronator muscle group rupture could also be observed, depending on the degree of the trauma progression.

(b) Varus—This is caused by disruption of the LCL complex. It is seen in acute elbow dislocations and in severe cases where the LCL has failed to heal. The physiological forces across the elbow are principally valgus because of the anatomical alignment, and therefore this pattern of instability may not be clinically obvious. PLRI is a more likely clinical problem with disruption of the LCL complex [6]. Chronic attenuation of the lateral ligament complex may also be secondary to overuse, such as in patients who use their arms as weight-bearing extremities (e.g., polio with crutch-walking) [6].
Medial Instability

(a) *Posteromedial varus instability*—This is a rare instability pattern and it is associated with anteromedial facet fractures of the coronoid secondary to varus/posteromedial injuries of the elbow with axial loading. They almost always present with an associated injury to the LCL. Generally, the posterior band of the MCL is ruptured while the anterior band is intact and attached to the anteromedial coronoid facet. The lateral joint space is usually widened and there is no radial head or neck fracture.

(b) *Valgus*—This instability pattern involves disruption of the MCL complex. It is uncommon in the general population and it is often seen in most athletes (throwing athletes) as a result of repetitive micro-trauma and chronic overload. However, it could be observed following an acute trauma such as a dislocation. In these patients, MCL insufficiency is usually associated with radial head fractures and possibly disruption of the common flexor origin.

Anterior Instability

This is typically seen in association with olecranon fractures [6]. Because of good outcomes of treatment of olecranon fractures, chronic anterior instability is rarely encountered.

Global Instability

This is a rare condition and it is characterized by a severe multidirectional instability of the elbow. It usually follows severe trauma such as fracture-dislocation. It is associated with rupture of both collateral ligament complexes and circumferential capsular stripping of the elbow.

Pathoanatomy

**PLRI**

Posterolateral rotatory instability [3] classically refers to an injury to the lateral ulnar collateral ligament (LUCL) that results in external rotatory subluxation of the ulna on the humerus, with posterior and valgus displacement. Specifically, the radial head rotates away from the capitellum, and the ulna essentially “pivots” on the MCL rotating off the lateral trochlea.

The LCL complex most commonly fails by avulsing the capsule and common extensor origin from the lateral epicondyle [7]. LCL injury is most commonly the result of trauma such as a fall on an outstretched hand or any other mechanism that imparts axial compression, valgus force and supination. Other causes of injury to the LCL complex include chronic cubitus varus, multiple steroid injections for lateral epicondylitis, and/or connective tissue disease [8–10]. Iatrogenic causes can include an open or arthroscopic procedure to the lateral side of the elbow with inadequate repair/reconstruction of the lateral ligaments or of the common extensor, providing some dynamic stability [8, 11]. Resection of the radial head, even in the presence of intact ligament, has also been shown to be a risk factor for the development of PLRI [12]. A staging system (Table 13.1) developed

<table>
<thead>
<tr>
<th>Stages</th>
<th>Degrees of capsuloligamentous disruption</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Subluxation of the elbow in a posterolateral direction</td>
</tr>
<tr>
<td>2</td>
<td>Subluxation of the elbow joint with the coronoid perched underneath the trochlea</td>
</tr>
<tr>
<td>3</td>
<td>Complete dislocation with the coronoid resting behind the trochlea</td>
</tr>
<tr>
<td>3A</td>
<td>Includes the posterior band of the medial collateral ligament tear</td>
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<tr>
<td>3B</td>
<td>Includes the anterior and posterior bands of the medial collateral ligament tear</td>
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for PLRI has been described by O’Driscoll [3] and may influence a patient’s history, clinical examination and choice of treatment. Disruption of the LCL complex (particularly the LUCL) results in posterolateral rotatory subluxation of the elbow. With further injury, there is a disruption of the anterior and posterior capsules, and finally the MCL. When the lateral and medial soft tissues are disrupted, the joint can dislocate even with immobilization of the elbow in 90° of flexion. This progression of injury is also referred to as the Circle of Horii [12].

**Medial Instability**

MCL complex injury occurs when the elbow is subjected to a valgus force, which disrupts the medial side of the elbow, exceeding the tensile properties of the MCL. The chronic injury is more commonly seen in athletes, in particular overhead athletes, such as pitchers, javelin throwers, tennis, and water polo players. Acute disruption of the MCL can occur following a significant traumatic event.

Like the LCL, the MCL most commonly avulses from the humeral origin [13]. Cadaveric studies indicate that 100% of the anterior bundle of the MCL must be sectioned before demonstrating significant valgus or rotatory elbow instability [14]. In the presence of an associated coronoid process fracture, the MCL complex may fail in a “Z” configuration where the anterior band of the MCL remains intact at its distal insertion on the coronoid fragment while the posterior band avulses from the proximal origin on the humerus. If there is no fracture of the coronoid process, then there is a rent in the anterior capsule that extends to the medial epicondyle, and the entire MCL complex is then avulsed from the medial epicondyle [13].

**Evaluation**

The first step in assessment is acquiring a good history and examination. A detailed history of the event must be obtained, including the mechanism of injury and the position of the arm at the time of the trauma. Beginning with inspection, clinicians may observe an effusion or ecchymosis over the elbow. Elbow deformity and swelling on the medial or lateral side of the elbow suggest injury to the underlying soft tissue and bony structures. A neuromuscular examination should be performed. Two-dimensional X-ray images should be taken before and after repositioning maneuvers and should include evaluation of the radial head and the olecranon. On a true lateral radiograph, lateral ligament instability may be identified by subtle opening of the trochlea–trochlear notch interval, and is referred to as the “drop sign”[15]. Furthermore, fluoroscopy represents an additional valuable tool to assess instability. It allows the surgeon to observe medial or lateral joint space widening, while a varus or valgus force is applied to the elbow. When the level of suspicion is high and radiograph results are normal, magnetic resonance imaging (MRI) could be performed. While the utility of MRI is still controversial [16–18], damage of the LCL complex can be typically seen in the presence of a significant injury.

Arthroscopic evaluation can be used for direct visualization of the elbow joint and its surrounding structures as an adjunct procedure to reconstruction. The primary advantage includes the evaluation of the joint space opening of the ulnohumeral joint during rotational, varus, and valgus stresses to the elbow [14]. This can allow for accurate clinical staging and appropriate corrective surgery. Further, arthroscopy may also help to identify elbow joint arthritis and loose fragments associated joint injuries [19].

**PLRI Assessment**

Diagnosis can be made historically based upon presentation of painful, recurrent clicking, snapping, or locking of elbow with pain located posterior to the proximal radioulnar joint as the elbow moves into supination and extension. Patients often report their elbow feels loose or like it is sliding out of place. On physical exam, patients often have normal upper extremity strength and
elbow range of motion. Often the only abnormality in the examination is a positive pivot shift test. During this test the radial head is subluxed with a combination of full supination, axial compression, and valgus load as the elbow is placed in 40° flexion. The patient would have apprehension when performing this maneuver, which may mask the instability and make the assessment difficult. Discomfort and the sensation of instability can be reduced with local anesthetic, and fluoroscopy can identify subtle forms of instability. Surgery is indicated in patients with symptomatic instability and involves a LCL repair in the acute setting or a reconstruction in those cases without adequate ligamentous tissues.

### Medial Instability Assessment

Patients with medial instability usually report medial elbow pain and decreased strength during overhead activity. Further, patients may complain about ulnar neuropathy, generally owing to a valgus stretching of the nerve. In case of an isolated MCL injury, patients can present with tenderness 2 cm distal to the medial epicondyle. Valgus instability is tested with the patient’s elbow flexed between 20° and 30° to unlock the olecranon from its fossa as valgus stress is applied. The test is positive if there is a loss of a firm end point and increased medial side joint opening, comparing with the contralateral upper extremity. The test produces pain in approximately 50% of patients with a torn MCL, and it has a sensitivity and specificity of 66% and 60% respectively [20, 21]. The “milking maneuver” is performed by either the patient or the examiner pulling on the patient’s thumb to create valgus stress with the patient’s forearm supinated and elbow flexed beyond 90° [22]. The “moving valgus stress test” is a modification of the milking maneuver where valgus stress is applied constantly, while the elbow is moved through an arc of flexion and extension [23]. For both tests, the subjective feeling of apprehension, instability, or localized pain to the MCL indicates MCL injury.

### Nonoperative Treatment

In acute setting, simple elbow dislocations without associate fractures should be managed with closed reduction. It can be completed with or without sedation [24]. The reduction is performed by flexing the elbow to approximately 25° while applying longitudinal traction combined with supination at the forearm and countertraction at the upper arm provided by an assistant [25, 26]. Complete range of motion of the elbow should be evaluated as well as the joint stability. Crepitus during joint motion suggests a fracture or an osteochondral fragment trapped in the joint. If the elbow is unstable, the point of instability should be noted. Specifically, valgus and varus instability should be assessed with the elbow in 30° of flexion and full extension. If dislocation occurs during extension, the elbow should be reassessed with the forearm in pronation. If greater than 45° of pronation is required to maintain the reduction, operative intervention is indicated [6, 25, 26]. For stable elbows, short-term immobilization should be followed by early ROM exercises. For unstable elbows, initial management includes immobilization for approximately 2–3 weeks, followed by flexion and extension in a hinged split for 4 weeks. Afterwards, complete ROM may be allowed. Lateral injuries should be treated by placing the forearm in pronation with the elbow flexed at 90° for 1–2 weeks, followed by use of an elbow brace. For incomplete injuries that involve disruption of the MCL complex, the forearm should be placed in supination for 2–3 weeks. However, after elbow immobilization care should be taken to avoid excessive valgus load.

In asymptomatic patients, chronic instability could be managed nonoperatively with avoidance of instability-causing activities, elbow bracing to limit supination and valgus loading, application of a sugar tong cast, pain control, and/or physical therapy [8, 27]. If symptoms or instability persist, operative intervention is then indicated.
**Surgical Management**

**Approach to the Elbow**

The patient is placed in the lateral decubitus position with the arm supported over a bolster. The lateral structures are approached through the Kocher interval between anconeus and extensor carpi ulnaris. The anconeus is reflected exposing the LCL complex remnants. Typically, in acute trauma, this procedure reveals an avulsion of the majority of the soft tissue off the lateral epicondyle in one soft tissue sleeve, exposing the joint. In chronic situations, the avulsion ligament may be partly healed or attenuated.

A number of methods to access the MCL complex have been described. In cases of acute injuries, there is usually a rent in the common flexor muscles that leads to the joint. In the chronic case the muscle rent will be healed and a muscle-splitting approach through the common flexor muscles could be performed [28]. Independently from the approach used, the ulnar nerve should be identified and protected throughout the entire procedure. It is important to not leave the nerve unstable or in a hostile bed, in which case an ulnar nerve transposition is required.

**Acute Injuries**

**LCL and MCL Repair**

In the acute setting a repair is performed. Acute primary repair of the LCL and MCL can be performed within the first few weeks following the injury. Anatomic repair of soft-tissue avulsions from bone can be performed with transosseous suture or suture anchors. Our preferred technique of LCL repair is an anatomical repair using grasping sutures and tensionable suture anchors [29]. In the sub-acute setting the ligaments are soft and do not hold sutures well. In chronic cases there may be significant scar tissue and the ligaments may be retracted so that they cannot be delivered onto the epicondyle.

The advantages of using tensionable anchors are as follows:

1. Tensioning of the ligaments can be performed in a controlled manner.
2. Sequential tensioning of the MCL and LCL may be performed.
3. They allow cycling of the elbow and on-table clinical assessment of stability and balance before final tensioning.
4. They allow locking of the repair at the desired tension.

Once having identified the lateral capsule complex, grasping sutures (e.g., Bunnell or Krackow) are placed in the avulsed LCL complex. The suture ends are then loaded into the eyelet of the tensionable anchor. The anchor is then placed into the lateral epicondyle at the anatomical insertion site of the LCL. At this point, the sutures remain unlocked and un-tensioned in the anchor. We term this “prefabrication” where all anchors and sutures are initially placed, before final tensioning. The elbow is examined for the full ROM and a gentle assessment of stability is performed. If there is any persistent instability, then further stabilization is required. This may include stabilization of the medial structures.

Once having identified the MCL instability, grasping sutures are placed in the avulsed ligament. The anchors are then deployed into the anatomical MCL footprint before any tensioning is performed. That is the mid-position of the sharp distal surface of the medial epicondyle. If both the MCL and LCL are being repaired, the authors recommend tensioning each side alternatively. During a combined repair, the MCL is tensioned first with the elbow in flexion and the forearm in supination. The LCL is then tensioned with the forearm in pronation. The surgeon should perform repeated reassessments of elbow stability and range during tensioning. It is important not to over tension one side as this may lead to an inability to reduce the opposite side [29]. During MCL repair, the ulnar nerve should be protected without transposition.
**Chronic Injuries**

**LCL Reconstruction**

Open ligament reconstruction is indicated in patients with poor ligamentous tissue quality, when a prior repair has failed, or in the presence of chronic recurrent instability. Ligament reconstruction using graft tissue can offer an isometric, extracapsular and anatomic solution [30] Many techniques and choices of graft have been described, including advancement and imbrication of the LCL, autologous palmaris longus tendon, a strip of the triceps tendon, plantaris tendon, and synthetic ligament augmentation [30–32].

**Surgeons preferred technique:** The technique we use is different from the Nestor or docking technique [30]. We know that the site of primary failure of the acute instabilities is usually from the humerus. We therefore use a technique that “wraps around the lateral condyle” so that it is intrinsically stable, so that the weakest point is distal. The final construct obtained is extremely stable on the table (Fig. 13.1).

**Graft selection:** The authors prefer to use an autogenous hamstring graft, which is robust and gives the required length (15–20 cm) needed for the technique. However if allograft is available, it is a reasonable alternative with comparable outcomes in the literature.

**Ulna drill holes:** Two full 4.5-mm drill holes are created in the insertion point of the LUCL on the supinator crest of the ulna. We place them just proximal and just distal to the ulnar insertion of the LUCL, just distal to the capsular attachment. The exit sites of the drill holes are identified on the medial side of the ulna.

**Humeral drill holes:** The isometric point of the origin of the LCL complex is identified, on the lateral epicondyle, at the center of the capitellum as seen from the lateral side. A position 2 mm proximal is identified and a 4.5 mm drill is advanced through this point. The drill is directed from anterior to posterior, and exits posteroinferiorly. The drill is then removed and advanced again through the isometric point to create a second drill hole that exits posteroinferiorly.

We smooth the entrance of the hole with a curette, so the tendon graft can easily pass through the drill holes. If the ulnar cortex is particularly hard, we will “tap” the hole so that the screw does not cut the graft.

**Tendon passage:** Both free ends of the tendon graft are sutured with a nonabsorbable suture allowing graft hole transfer and tensioning. One free end of the graft is passed through the posterior inferior hole and exits the anterior hole. The other through the posterior superior hole and exits the anterior hole. This creates a loop of tendon around the posterior condyle.

Each end of the graft is then advanced through the drill holes in the ulna from lateral to medial. At this point, the graft is tensioned while the elbow is cycled through a range of motion and the stability is assessed.

**Graft fixation:** The graft is secured into the drill holes with interference screws. The first screw is inserted into the anterior humeral drill hole. The graft is again tensioned and cyclic loading is performed. Interference fit screws are then

![Fig. 13.1](image-url) Lateral view of the elbow demonstrating the LCL reconstruction. © Gregory I. Bain
inserted into the ulna drill holes. We usually use the 5.5 mm screws in the humerus and either 4.0 or 5.5 mm screws in the ulna. Any redundant capsule is then plicated.

We use the above principles of osseous preparation, graft preparation and fixation for all of the ligamentous elbow reconstructions described in this manuscript.

**MCL Reconstruction**

MCL Reconstructive surgery is indicated in patients in which conservative therapy fails, in patients with delayed presentation of acute traumatic ruptures, or in chronic dislocations where it is not possible to perform a primary repair. Further, it has been shown that in competitive throwing athletes, MCL reconstruction using a free tendon graft yields better results over direct repair of the tendon.

Jobe developed the original MCL reconstruction and described the technique with initial results [33]. The technique used a tendinous detachment and reflection of the flexor-pronator muscle group, sub muscular transposition of the ulnar nerve, and creation of humeral tunnels that penetrated the posterior humeral cortex. Since then different modifications of the original technique have been described.

**Surgeons Preferred Technique**

**Ulna drill holes:** Two full 4.5-mm drill holes are created in the ulna and placed in the site of the anatomic origin of the anterior and posterior bundles of MCL. Specifically, one drill hole is made adjacent to the sublime tubercle and another at the medial margin of the greater sigmoid notch.

**Humeral drill holes:** On the humeral side, the medial epicondyle is drilled in a “V” fashion creating two proximal divergent tunnels. The base of the “V” is at the origin of the MCL on the anteroinferior aspect of the medial epicondyle and the limbs diverge proximally in a posterior and posterosuperior direction. In this fashion, two separated tunnels that connected to the primary humeral tunnel at the origin of the MCL are created.

*Tendon passage:* At this point, the hamstring graft is passed through the drill holes in the medial epicondyle, with the two limbs of the graft passed then through the drill holes in the ulna side. Finally, graft is tensioned with the elbow in varus and supination and fixed with interference screws both in the ulna and in the medial epicondyle.

**Graft fixation:** We use the same size screws as used for the lateral side reconstruction. The elbow is brought to full range of motion, and care is taken to smooth any rough edges that might abrade the graft. Any part of the native MCL remaining is sutured and incorporated into the bone tunnel to reinforce stability.

**Complications**

Good or excellent results following surgery have been reported for isolated MCL and LCL surgery. However, despite an accurate repair or reconstruction up to 11% of patients may have complications [31, 34]. Specifically, instability can still occur after ligament reconstruction. Other reported complications include infection, bony bridge fracture, ulnar neuropathy, cutaneous nerve injury, and arthrofibrosis resulting in flexion contracture. Primary ligament repair combined with early postoperative exercise have been reported to produce satisfactory outcomes in unstable elbow dislocation, with low rate of residual instability [35–37]. Jones et al. reported residual instability in eight patients (25%) treated for PLRI with the docking technique at a mean of 7 years. Nestor et al. described results on 11 patients (three repairs and eight reconstructions) who underwent surgery for PLRI reporting excellent outcomes in patients that underwent ligaments repairs. Further, four patients that underwent ligament reconstruction noted fair and poor outcomes. Sanchez-Sotelo et al. reported their outcomes in 44 patients (12 repairs and 22 reconstructions) that underwent surgery for PLRI. Five patients (11%) noted further instability, and 27% of patients described fair or poor results [31].
Combined LCL and MCL Reconstruction for Global Instability

In some cases, the soft-tissue injury is not limited to the medial or lateral aspect of the joint, but rather presents as multidirectional elbow instability with insufficiency of the entire collateral ligament complex. For these patients, the authors have developed a less invasive reconstruction technique using a single circumferential tendon graft technique that addresses both the medial and lateral instability with a single tendon graft [38]. This technique may also be used in patients with complex fracture dislocations or terrible triad injuries, when there is residual instability following fixation of fractures. This may also be used as an alternative to dynamic or static external fixation when fracture fixation and ligament repairs have failed to restore stability [38]. Finally, it may also be considered in cases of severe elbow stiffness where heterotopic ossification involves the ligaments and needs removal in order to restore motion but in doing so will compromise the function of the ligaments.

Limited data is reported on the results of a double ligament reconstruction. Van Riet et al. originally reported on the surgical technique of simultaneous medial and lateral collateral ligament reconstruction utilizing a single or double loop technique [38]. More recently, Finkbone et al. has reported on a similar technique of reconstruction [39]. The authors described this as a “box-loop” reconstruction where a donor tendon is passed through a humeral tunnel along its flexion-extension axis and an ulnar tunnel connecting the sublime tubercle and supinator crest. The graft is then tied back on itself creating one continuous graft. The technique was performed on 14 patients with an average follow-up of 64 months. The authors reported an average ASES score of 81. The average Quick DASH was 13 and the average MEPS was 88. Radiographs showed all ulnohumeral joints were congruent without signs of instability and no patients required additional surgery for instability, range of motion or arthritis.

Surgeons Preferred Technique

A midline posterior skin incision is preferred because it allows access to medial and lateral structures [40]. Full-thickness fasciocutaneous flaps are created and elevated to expose the medial or lateral aspect of the elbow. Laterally, structures are approached through the Kocher interval between anconeus and extensor carpi ulnaris. On the medial side, a muscle-splitting approach through the common flexor muscles could be performed. Following the circumferential tendon graft technique, a single-loop or a double-loop technique could be performed depending on the severity of the elbow instability. The single-loop technique provides a reconstruction of the anterior band of the MCL and the LUCL, while the double-loop technique reconstructs all four ligament units (LUCL, posterolateral capsule, and anterior and posterior bands of the MCL).

Circumferential Single-Loop Technique

**Humeral drill holes:** A 2-mm guidewire is drilled through the lateral epicondyle to the anteroinferior aspect of the medial epicondyle, which is the isometric points that make up the axis of rotation. A 4.5-mm drill hole is reamed through the humerus over this guidewire.

**Ulna drill holes:** A 4.5-mm drill hole is created passing from the sublime tubercle on the medial side to the supinator crest on the lateral side.

**Tendon passage and fixation:** The hamstring tendon graft is passed through the humeral tunnel and secured with 5.5 mm interference screws on the medial and lateral sides. Each tendon end is then passed through the ulnar tunnel and also secured with a single 4.0 mm interference screw (Fig. 13.2). The flexor-pronator mass is repaired back to the medial epicondyle, and the Kocher interval is closed.

Circumferential Double-Loop Technique

This is similar to the single-loop technique but also reconstructs the posterior band of the MCL and the posterolateral capsule. This is accom-
plished by creating a second ulnar drill hole from the posterior supinator crest laterally to the posteromedial olecranon facet at the attachment of the posterior band of the MCL. The humeral side is the same as the single loop technique.

Tendon passage and fixation: The free ends of the graft, exiting the humerus, are then split longitudinally to create two free tails of equal size. One tail from each side is passed through the posterior ulnar drill hole, and the other tails through the anterior drill hole. The graft is tensioned and secured with interference screws (Fig. 13.3).

External Fixation

We have previously used many external fixators, but now only use them in very selected cases. Some surgeons will manage a terrible triad injury with stabilization of the radial head and an external fixator. Our preference would be to surgically stabilize the radial head, coronoid process and the associated ligmentous injuries.

We reserve the use of external fixation in complex cases where we can’t obtain stability with a...
repair or reconstruction. Therefore we use them as a primary stabilizer most commonly in open elbow dislocations with bone and or soft tissue loss. However even in these cases, we would prefer to primarily reconstruct the tissues and if required apply a flap to the elbow. The other indication for an external fixator is with distraction arthroplasty, which we use only for chronic elbow conditions where an arthroplasty is contraindicated (e.g., infection or higher demand younger patient such as a 45 year old farmer with post-traumatic arthritis).

**Internal Fixation**

Although we rarely use external fixators, we are now using internal fixators. There are two types. The plate fixation method as proposed by Jorge Orbay and manufactured by Skeletal Dynamics [41]. The other option is to create an internal fixator, with sutures. The method the authors use involves placing a suture anchor with multiple strands into the isometric point on the lateral epicondyle. Any ligament tears are repaired. The free suture limb is then advanced through another anchor, which is secured to the supinator crest.

**Post-operative Protocol**

At the completion of the procedure the stability is assessed. If good stability has been obtained we often apply a plaster slab for 1 week at 90° of flexion. The arm is positioned in pronation or supination to protect the stabilization. A hinged brace is then worn for 2–4 weeks depending upon complexity of the case. An extension block at 30° is used for complex cases, and reduced every few weeks, aiming for full extension by 3–6 weeks. The patient can return to light work activities at 6 weeks and heavy work activities at 3–6 months postoperatively.

**Conclusions**

Elbow instability includes a wide variety of disorders ranging from simple acute dislocations to complex dislocation with additional injuries. The diagnosis can be accurately made with a combination of history, physical examination, imaging, and arthroscopic surgery. The key to a good result is knowledge of the normal anatomy and recognizing the pathoanatomy of the injury. In acute cases, the principles of surgery are to repair the soft tissue and bony fragments to yield stability. In chronic recurrent instability, reconstruction of the collateral ligament complexes is mandatory.

**References**


Introduction
The physical exam will include the pivot shift test, posterior drawer test and tabletop test, together with varus-valgus stress. Typically, more than one test is positive. Radiographs and MRI scanning complete the decision making process. Radiographs are often negative in patients with chronic PLRI. If there is gross instability, with severe soft tissue damage, as evident on the MRI, an open ligament reconstruction is performed. Another possibility is, that tests are positive but without gross signs of instability. The MRI often confirms lateral collateral ligament tearing or scarring. In these patients, we prefer to use an arthroscopic technique. When in doubt, an exam under anesthesia could be done before deciding which technique to use.

Open ligamentoplasty
The patient is placed supine with the arm on an armtable. The elbow is re-examined once adequate anaesthesia is administered.

The incision starts 2cm proximal to, and is centered over, the lateral epicondyle. The incision continues between the middle and posterior two-thirds of the radial head towards the subcutaneous border of the ulna.

Kocher’s interval is identified between the anconeus muscle posteriorly and the extensor carpi ulnaris anteriorly.

The supinator crest is palpated on the ulna. Proximally, the posterior insertions of the common extensor tendon, as well as any remnants or scarring of the lateral collateral ligament complex, are sharply elevated from the lateral epicondyle.

Both autograft as allograft tendon can be used to reconstruct the ligament.

There are several ways to fix the graft: we prefer to use a cortical button with an adjustable loop, because they provide an immediate strong fixation and the adjustable loop is used to tension the graft.

Arthroscopic repair
The scope is directed to the radial gutter. A needle is used to determine the position of the soft-spot portal and the incision is made. The arthroscopic rotatory instability (ARI) test is best performed at this stage. Unlocking the radius from the humerus is done with a varus stress to the elbow, after that, the forearm is fully supinated. In a positive ARI test, the radial head will be translated posteriorly, while the lateral ulnohumeral joint space opens. In severe cases, the scope can enter the ulnohumeral joint and the ulnar gutter can be visualized or even entered from the lateral side. It is important to realize that this rotatory drive through sign is not the same as medial opening from a medial collateral ligament injury.

A 14G needle is loaded with a PDS II suture. The lateral epicondyle is palpated and the needle is placed at the center of the epicondyle and directed to the radial gutter. The suture can be shuttled into the joint. A grasper is introduced through the soft-spot portal and the suture is pulled out of the joint from the soft-spot portal. The needle is removed and reloaded with the other half of the suture.

Palpate the radial head and the subcutaneous border of the ulna. The needle is inserted on the subcutaneous border of the ulna and directed over the insertion into the radial gutter. This placement is essential as the insertion of the LUCL is located on the supinator crest of the ulna, at the base of the radial head. Care is taken to stay on the bone of the ulna while the needle is inserted. This not only strengthens the imbrication but also directs the needle away from the anterior neurovascular structures. The PDS wire is then shuttled through the needle and taken out of the soft spot portal with a grasper.

Both halves are tied together and the knot is pulled distally or proximally. The PDF is now fully intra-articular and exits the skin at the origin of the LUCL at the lateral epicondyle, runs over the LUCL insertion at the supinator crest and exits the skin distally at the subcutaneous border of the ulna, in line with the LUCL. A knot is tied in the proximal end of the PDF and a second PDF is pulled halfway through the loop. The first PDF is then pulled distally and the removed as soon as the tow strands exit the skin. Now two strands of PDS are intra-articular. A small clamp is used to pull all PDF ends
subcutaneously to the soft-spot portal. The ARI test is repeated with the sutures relaxed and with the sutures tightened. There should be a marked increase in stability once the sutures are tightened. The scope is then removed from the radiohumeral gutter to allow for maximum tightening of the sutures. The elbow is held reduced as both sutures are tied separately. The sutures have now created a loop around the LUCL, lateral capsule and anconeus, imbricating these structures.

014 Distal Humeral NonUnions : Biological Healing
F. Schuind, F. Moungondo
Department of Orthopaedics and Traumatology, Hôpital Erasme, Université libre de Bruxelles, ULB, Bruxelles, Belgium

In an adult, the classical treatment of a humeral supracondylar fracture is plate fixation, which allows early active mobilization of the elbow and good functional results. However, a significant proportion of such fractures do not unite. The management of a non-union at this location remains a therapeutic challenge, particularly when the plates break. In many cases, the best therapeutic option is the implantation of a prosthetic arthroplasty, allowing the patient to quickly regain a stable and mobile elbow. This solution is contra-indicated in young, active patients, and when the nonunion is or has been infected. In these two situations, particularly if the elbow joint is preserved, it is better to try to heal the nonunion. We developed an original technique of external fixation, allowing revascularization of the bone fragments and relatively quick healing of the non-union. Several successful cases will be presented and discussed.

015 Hinged External Elbow Distractor : Salvage to Arthrodesis in Joint Destruction
I. Degroof, J. Lammens
Orthopedic Department, KULeuven, Leuven, Belgium

In severely unstable elbow destruction after trauma and/or septic arthritis, arthrodesis can be considered. However, a fixed elbow is a serious handicap in daily life and should be avoided whenever possible. On top, the surgical technique can be challenging, consolidation is difficult to achieve and an ideal positioning for arthrodesis is non-existent. Due to a history of infection and/or young age of the patient, implant arthroplasty is considered a challenging option. Here, the hinged external distractor can be a reliable salvage alternative. With this technique, active mobilization is possible in a comfortable manner and rehabilitation can be initiated immediately after surgery. Here, with the help of case illustrations, the use of a hinged external distractor of the elbow is presented to demonstrate the option of elbow salvage in a lost joint as an alternative to elbow arthrodesis.
Rehabilitation after Intraarticular Fractures of the Distal Humerus: the Effect of Combination between PNF with Elastic Resistance, Pilates Machines, and Kinesiotaping Applications - how they work together?

A. Nikolova¹, D. Encev², A. Baltov², Ch. Rangger³
¹Military Medical Academy, Sofia, Bulgaria; ²Emergency Hospital "Pirogov", Sofia, Bulgaria; ³Pilates Sport Studio, Sofia, Bulgaria

One third of elbow fractures involve the distal humerus. Many of them are intraarticular. Most of fractures concerning healthy and active adults, are treated surgically and start early active rehabilitation. The elbow particularly is prone to contracture and stiffness, especially after surgery. General physiotherapy goals are to restore motion and strength for optimal function, reduce the pain and swelling. ROM is initiated as early as possible in safe prescribed parameters, without pain. The contractures after elbow surgery are flexion/extension or combined. More often the extension is affected, because of post-surgery immobilization position 90°-70°. Pronation/supination can be also affected depending on fractures.

Material
Physiotherapy program was applied to 10 patients with bicondylar fractures of the humerus, all of them treated surgically. ROM, VAS and goniometry were used for evaluation. MORREY SCORE was used to evaluate the daily activities.

Method
Physiotherapy started no longer than the 7th postoperative day. The physiotherapy program consists of exercises with Pilates machines, PNF methods with elastic resistance TERA-BAND band and kineziotaping applications.

Results
At the end of the 6th month significant evidence demonstrated very good functional results. The muscles strength and range of motion of the elbow was increased. VAS for pain was less than 1.

Conclusions
The integral part of PNF in combination with elastic resistance and exercises with pilates machines consists of neuromuscular adaptation. The combination of methods prevents from risk of injuries and compensatory movements during physiotherapy. Kineziotaping applications can reduce the pain and swelling. The combination program to restore as soon as possible the functional ROM and to prevent from other complications, is integral part of the modern physiotherapy.
SESSION 4: ELBOW (2)

017 An Update about Tennis Elbow  
A. Van Tongel (Ghent, Belgium)

018 Endoscopic versus Open Distal Biceps Repair  
R. van Riet (Antwerp, Belgium)

019 A Ratio Based Approach to Identification of the Posterior Interosseous Nerve in the Proximal Forearm  
V.M. George, T.S. Jepegnanam, I.J. Prithishkumar (Vellore, India)
An Update about Tennis Elbow
A. Van Tongel
Department of Orthopaedic Surgery and Traumatology, Universitair Ziekenhuis Gent, Ghent, Belgium

Tennis elbow is a common cause of elbow pain. The pathology is currently considered as a degenerative process and not an inflammatory process. In a tennis elbow, the extensor carpi radialis brevis (ECRB) is always involved in the degenerative process and in 1/3 of the cases, also the extensor digitorum communis (EDC). Usually the symptoms disappear with a non-surgical treatment. However, there is currently no standardized treatment protocol and there is still insufficient evidence of effectiveness for various non-surgical treatments for tennis elbow. By consequence, these therapies are merely observational and based more on a wait-and-see policy. However, there is more and more evidence that the common used technique of cortisone infiltration has a negative effect on the outcome, and this treatment is not recommended anymore. Various surgical techniques (open, arthroscopically, percutaneous) have been described, with favorable results. There is currently no evidence which surgical technique is most effective.

Endoscopic versus Open Distal Biceps Repair
R. van Riet¹,²,³
¹AZ Monica Hospital, ²University Hospital Antwerp, Antwerp, ³Erasme University Hospital, Brussels, Belgium

Endoscopic technique
Endoscopic techniques are particularly helpful in diagnosing the extent of partial tears. The patient is placed supine, with the arm on an armtable. A tourniquet is used, as retraction is not an issue in partial ruptures. A two-centimeter incision is made centrally on the forearm, three centimeter distal to the elbow crease. Blunt dissection is carried out to the tendon. Care is taken not to injure the lateral antebrachial cutaneous nerve by dissection or retraction. Retractors are used throughout the procedure, to protect neurovascular structures. The scope is entered in the bicipital bursa. The scope is advanced to the bicipital tuberosity and the forearm is supinated. This opens the space between the tendon and the bone and a good view of the insertion can be obtained. We use the following algorithm. If the tear is less than 25% of the surface of the insertion, the tear is debrided. If the tear is between 25 and 50%, the tear is debrided and the tendon is reinserted using a bone anchor. If the tear consists of more than 50% of the tendon, the tendon is detached fully. The stump is debrided and we prefer to repair the tendon to bone, using a cortical bone technique.

Single incision technique
The patient's arm is supinated on the armtable and a longitudinal two cm incision is made centrally on the forearm, three centimeters distal to the elbow crease in the antecubital fossa. The lateral antebrachial cutaneous nerve can be identified superficially to the brachioradialis muscle. We tend not to dissect the nerve and this has significantly decreased the incidence of temporary numbness of the forearm. The biceps tendon stump is typically found proximal to the elbow crease. The stump is debrided to healthy tendon and the tendon is prepared for repair. Preparation of the tendon depends on the type of fixation used. Bone tunnels, bone anchors or different types of cortical bone buttons, with or without interference screw fixation, have been successfully used. We prefer to use a cortical button as this allows for the strongest initial repair. The tendon is sutured to a cortical button using non-resorbable suture. Dissection is then taken to the level of the bicipital tuberosity. The bicipital tuberosity is visualized with the use of retractors. The bone is then prepared, depending on the preferred fixation method. For the cortical bone technique, a guide wire is drilled from the center of the tuberosity through both cortices. To decrease the risk of injuring the posterior interosseous nerve, the forearm needs to be supinated maximally. The guide wire is directed straight posterior or in an ulnar direction and should not be drilled distally or radially. The guide wire is then overdrilled with an 8 or 9 mm canulated drill, through the first cortex. A 4.5 mm canulated drill is then used to drill the second cortex. The guide wire is then removed, as well as, as much bone debris as possible. The wound is then irrigated to remove the last remaining debris.

The arm is then supinated fully and the guide wire is advanced through the tunnel created in the
radius. The guide wire is used to bring trailing sutures through the skin on the posterior forearm. With the elbow flexed, the tendon is pulled into the tunnel and the button is flipped, once it clears the second cortex. The elbow is then extended and this secures the button against the far cortex. The forearm is taken through a full range of pronation and supination to clear any soft tissue between the radius and the button. Fluoroscopy can be used to check the position of the button. As the endobutton technique has the highest initial fixation strength, aggressive rehabilitation can be started early. Postoperatively, the patient is allowed to mobilize the elbow immediately. Loading is permitted as pain allows but patients are instructed not to load more than 20 kg for the first three months and to avoid peak loading.

Two-incision technique
The two-incision technique is started with a transverse or longitudinal proximal incision over the distal biceps sheath. Dissection to the tuberosity is identical to the single incision technique. With the arm supinated, passing a clip through the extensor muscles on the medial side of the radius then creates a path. A second incision is made where the clip can be felt under the skin and progressive dissection through the extensor muscle is performed until the radial tuberosity is visualized. At this stage, be careful not to expose the ulna as this is found to increase the likelihood of radioulnar synostosis. Fixation of the tendon can again be performed with the devices described above.

019 A Ratio Based Approach to Identification of the Posterior Interosseous Nerve in the Proximal Forearm
V.M. George1, T.S. Jepegnanam1, I.J. Prithishkumar2
1 Department of Orthopaedics, 2 Department of Anatomy, Christian Medical College, Vellore, India

Background
The proximal radius often needs to be approached for osteosynthesis and reconstruction of fractures and dislocations of the radial head and for radial head replacement. Prevention of injury to the nerve is facilitated by safe zones, supination of the forearm during anterior exposure and the ‘three finger technique’ for identification of the nerve as described by Thompson. In patients who are smaller or larger than the norm, however, absolute measurements can be misleading - either limiting exposure or exposing the nerve to injury especially so in a small built patient.

Questions/Purposes
(1) We hypothesised that the location of the nerve would be dependent on the length of the forearm/radius. We proposed to define a predictive ratio based on the position of the PIN and the length of the radius.
(2) We also wanted to evaluate if the method for identification of the nerve was reproducible by comparing intra and inter-observer variation.
(3) To assess utility of the ratio, we planned to check whether there was a good correlation between the position of the nerve predicted by the ratio and the actual measurements.

Methods
We dissected 18 cadavers to expose the supinator and the posterior interosseous nerve under it by splitting the muscle. The forearm was kept in supination. The nerve was identified and distances were measured from the radial articular surface using Vernier callipers. The length of the radius was measured from the radial articular surface till the tip of the radial styloid. The measurements were done in turn by all three authors and repeated by the first author after one week. The ratio was calculated using the points where the nerves were identified and the total length of the radius. This ratio was then used to predict the position of the nerve. The predicted value and the measured value were then compared.

Results
(1) The location of the PIN was found to correlate significantly with the length of the radius (, p=0.001, radial length varied between 17 and 25 cm). The PIN was always located between 0.11R - 0.15R where R= radial length.
(2) There was good Intra class correlation for both the intra and inter-observer values. (K= , ICC , Pearson’s coefficient of correlation= )
(3) The ration was able to predict the actual position of the nerve with reasonable accuracy.
Conclusions
We have defined a ratio 0.11-0.15R (where R is the length of the radius) that seems to predict the location of the PIN in the proximal forearm with accuracy. This is especially relevant presently as travel is more prevalent and populations are not homogenous with respect to height and size. We believe this ratio could help identify the nerve more easily, and define safe zones better- thus possibly aid in improving exposure and lowering the incidence of injury to the PIN.
SESSION 6:  PERIPHERAL NERVES

020  The Effects of Humeral Shortening on the Three-Dimensional Configuration of the Brachial Plexus
J. Valcarenghi, A. Andrzejewski, F. Moungondo, V. Feipel, F. Schuind (Brussels, Belgium)

021  The Value of Sonography and MR Neurography in Peripheral Nerve Lesions
E. Vögelin, J. Schnider, O. Scheidegger (Bern, Switzerland)

022  Sonographic Evaluation of Upper Extremity Nerve Pathology
V. Créteur, A. Madani, F. Moungondo, F. Schuind (Brussels, Belgium)

023  Practical Demonstration of Sonography
V. Créteur (Brussels, Belgium)

024  Endoscopical Nerve Decompression around the Elbow
E. Vögelin, L. Haug, T. Adler (Bern, Switzerland)

025  A New Indication for the Hypothenar Fat Pad Flap: End Stage Carpal Tunnel Syndrome
T. Lattré, S. Brammer, S. Parmentier, C. Van Holder (Waregem, Belgium)

026  Nerve Transfer as an Alternative to Tendon/Muscle Transfer
L. De Smet (Leuven, Belgium)
020 The Effects of Humeral Shortening on the Three-Dimensional Configuration of the Brachial Plexus

J. Valcarenghi1, A. Andrzejewski1, F. Moungondo1, V. Feipel2, F. Schuind1
1Department of Orthopaedics and Traumatology, 2LABO (Laboratory of Anatomy, Biomechanics and Organogenesis), Laboratory for Functional Anatomy, Université Libre de Bruxelles, Campus Hospital-Faculty Erasme, Brussels, Belgium

Background
Brachial plexus injuries in adults are infrequent lesions, usually resulting from a motorbike accident. Direct nerve suture is the ideal technique of repair, almost never possible.

Objectives
This study evaluates the gains in length of different brachial plexus segments after three different sizes of humeral shortening osteotomy, and the possibilities of brachial plexus direct suture. Finally, a three-dimensional model of the brachial plexus was built in order to better visualize the parts of brachial plexus that are most susceptible to get benefit from the humeral shortening and to better define the indications of this technique for post-ganglion lesions.

Study Design & Methods
Ten paired brachial plexuses of five fresh frozen cadavers were dissected. The lengths of the different parts of the brachial plexus were measured using a precision three-dimensional mapping system (FARO Arm®), allowing the construction of three-dimensional models of the brachial plexus. The measurements were repeated after humeral shaft shortening of two, four and six centimeters and after a standardized 0.6 Newton tensioning of the plexus. Nerve suturability was then studied, in the various states of humeral shortening, after prior removal of brachial plexus nerve segments. A three-way ANOVA followed by a Bonferroni post-hoc test was used for statistical analysis.

Results
Humeral shortening did not allow significant gains in length at superior trunk and posterior cord (p > 0.05), because these structures were relative fixed by respectively the suprascapular and axillary nerves. Humeral shortening allowed significant (p < 0.05) gains in length at the level of the lateral cord, medial cord, musculo-cutaneous, median and ulnar nerves. When the musculo-cutaneous nerve did not pass proximally through the coraco-brachialis muscle, the gains of length increased by 30 to 50%. A two-centimeter shortening enabled two-centimeter length defect direct suture in 70 to 90% of cases, regardless of the involved trunk.

Conclusions
Despite the fact that in clinical situations, nerves defects may be larger than the gain observed after humeral shortening when performing even a six-centimeter humeral shortening and the potential complications of a humeral osteotomy, this study shows that humeral shortening osteotomy and tensioning of the plexus would enable the direct suture of nerve defects at the level of the lateral cord or medium cord, and musculo-cutaneous, median and/or ulnar nerves avoiding the use of nerve grafts.

021 The Value of Sonography and MR Neurography in Peripheral Nerve Lesions

E. Vögelin1, J. Schnider1, O. Scheidegger2
1Surgery of the Hand and Peripheral Nerves, 2Center for Neuromuscular Diseases, Inselspital Bern, Bern, Switzerland

In peripheral nerve trauma with axonal injury, outcomes range from complete spontaneous functional recovery with mild axonotmetic nerve injuries, to no spontaneous functional recovery with neurotmetic nerve injuries. It is in the group of patients with axonal injury where appropriate interventions may improve functional outcomes, but selection of appropriate patients is essential to optimize surgical interventions and results. Ultrasonography (US) remains on the time-efficient and cost-effective diagnostic imaging modalities of peripheral nerves. However, there is only information about morphologic changes, detection or quantification of functional impairment of axonal injury is not possible with US. Current approaches to diagnosing, quantifying and monitoring peripheral nerve trauma include clinical assessment (tinel sign,
sensory and motor changes) and electrodiagnostic studies supplemented by intraoperative electrophysiological studies in appropriate cases. However, EMNG's only detect nerve regeneration when nerve fibers have reached the target organs. Magnetic resonance (MR) neurography, which indicates a series of MRI sequences that include a heavily fat-saturated T2-weighted sequence, may provide information about the location of nerve injury, the anatomical context of the nerve injury, and associated soft-tissue injury. Optimized MRN sequences have introduced greater anatomical detail by using 2D high resolution sequences, or 3D anatomical sequences, where the 3D-image volume can be rotated and tilted in any orientation while maintaining a high degree of anatomical fidelity. MR neurography can depict pathological T2- signal changes in the nerve, which may also evolve with recovery of nerve injury, but will not predict the recovery of certain axonal nerve injuries. Advanced MRI applications, in particular, DTI (diffusion tensor imaging) and its derived metrics (tractography, fractional anisotropy measures) are promising emerging tools to visualize nerve regeneration or to identify or localize severe non-regenerating nerve injury. However, these new MR techniques need to be validated first, as interpretation is hampered by multiple assumptions and technical peculiarities. With US we can visualize damaged nerve segments by focal thickening or mass-like lesions and surrounding scar tissue. Furthermore, high-resolution US can be used to examine nerve lesions in continuity intraoperatively.

In examples of peripheral nerve injuries, clinical and electrophysiological findings are combined with US and MR Neurography. The advantages and limitations of these diagnostic tools are analyzed.

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022 Sonographic Evaluation of Upper Extremity Nerve Pathology
V. Créteur¹, A. Madani¹, F. Moungondo², F. Schuind²
¹Department of Radiology, ²Department of Orthopaedics and Traumatology, Erasme Hospital, ULB, Brussels, Belgium

The main goal of peripheral nerve imaging is to visualize nerves and their environment. Although conventional radiograph does not visualize the nerves directly, it may reveal anatomical variations, dislocation, fractures or unexpected location of orthopaedic material [1] (Figure 1). Besides radiography, other imaging modalities are often requested, such CT or MR. However, with appropriate equipment and training, Ultrasonography (US) represents a modality of choice for evaluating most peripheral nerves of the upper extremity, providing help in narrowing the differential diagnosis and guiding treatment [2, 3]. As compared to MR, US represents an excellent method to visualize not only a given nerve, with an equal sensitivity (86%) and a higher specificity (93% vs 67%) [4]. At least four advantages of US are recognized: evaluation of a given nerve on a long distance, using the “elevator technique”, evaluation of target muscles in case of sensitivo-motor or motor nerves, comparison between normal and abnormal side and dynamic study [3, 5]. At US, a normal peripheral nerve looks quite similar at different locations. On a transversal view, the nerve has a honeycomb pattern, with hypoechoic fascicles embebbed in a hyperechoic environment. On a longitudinal view, the nerve has a cable pattern [4, 6] (Figure 2). Some studies have determined the sizes of normal nerves by using cross sectional area measurements (CSA). These surfaces vary from less than 1 mm² up to 9 mm² depending on the nerve itself as well as on the location [7]. At US, a pathologic nerve is usually hypoechoic due to edema and thickened due to hypertrophy. When a motor nerve is pathologial, signs of denervation may be observed within corresponding muscles. Denervation edema signs at US (and MR) appear within 24-48 hours, earlier than EMG (2-3 weeks), and consist into a hyperechoïc bulging of the target muscles. Fatty atrophy within denervated muscle is a late finding (several months) ans appears as a hyperechoïc flattened target muscle [8] (Figure 3). US is most frequently asked to evaluate for nerve entrapment, such as carpal or ulnar/radial tunnel syndrome or nerve instability, but also for assessment of nerve morphology in the setting of trauma or after surgical or vascular procedures [1, 5]. In the setting of nerve injuries, US may detect severe
abnormalities such as nerve discontinuity, nerve incarceration within a bone fracture, nerve conflict with orthopaedic material or neuroma, but also less subtle findings such as neurapraxia, perineuritis or inflammatory changing within the nerve [5] (Table 1, Figure 4). Some special situations may orientate US examination toward a special nerve. For example, in shoulder trauma and in posterior stabilization surgery, attention should be given to the suprascapular nerve; in shoulder arthroplasties, axillary nerve lesion may be observed (Figure 5). In the case of cervical node biopsy, spinal accessory or suprascapular nerves may be damaged; during mastectomy or after direct thoracic blow, the long thoracic nerve could be affected [1, 9]. Other indications of peripheral nerve US may include evaluation for nerve tumor, infection or autoimmune disease, congenital or medical involvement [10-12] (Figures 6, 7)

<table>
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<th>Type</th>
<th>Degree</th>
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<th>EMG</th>
<th>Nerve Imaging (MRI/US)</th>
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Table 1 Classification of nerve injuries
Two classifications may be used, but they must be correlated with clinical findings. Seddon classifies nerve lesions into three types based upon conduction abnormality and recovery time, while Sunderland classifies them more anatomically.
Figure 1 Radiographs of the elbow (A, B) and sagittal reformatted CT slice of the wrist (C)
Demonstration of supracondylar processes at the anterior distal humerus. Both patients are complaining of forearm flexor muscles weakness, leading to the suspicion of median nerve lesion. In A, the elbow is otherwise normal. In B, the complex fracture is treated by plates, screws, nail and strapping. The supracondylar process is intact on A, but broken at its basis on B.
On C, the patient is complaining, after a fall, of hypothenar numbness and pain while flexing his 5th finger, leading to the suspicion of hamate fracture and/or ulnar nerve lesion. The reformatted sagittal CT slice demonstrates a longitudinal fracture at the basis of the hook of the hamate.
H = hamate       h = hook       M5 = 5th metacarpal bone

Figure 2 Schema and US of a peripheral nerve (PN)
PN is composed of numerous nerve fibers called fascicles (f) that are embedded into a connective tissue, rich in elastic fibers and vessels (red and blue dots). Each fiber, composed by axons (a), Schwann cells and myelin sheaths, is surrounded by endoneurium (e), each fascicle by perineurium (P), and the entire nerve by epineurium (E). These configurations explain the US aspect of a PN, which looks like a cable on longitudinal view (A), and like a honeycomb structure on transversal view (B)
Figure 3 Examples of muscular fatty atrophy detected by US
Muscular cartography is important to remember, because it helps to determine the pathological nerve and to locate the level the lesion. When a motor nerve is pathological, signs of denervation may be observed within corresponding muscles. Denervation edema signs at US (and MR) appear within 24-48 hours, earlier than EMG (2-3 weeks). Fatty atrophy of the denervated muscle is a late finding (several months). Fatty atrophy signs are characterized on US by loss of bulking and by hyperechogenicity of a given muscle, mainly due to progressive muscular fatty replacement

A. Radial Nerve palsy: fatty atrophy in left forearm extensor muscles
B. Ulnar Nerve palsy: fatty atrophy in interosseous muscles of the left hand
C. Median Nerve palsy: fatty atrophy in left forearm flexor muscles
D. Spinal Accessory Nerve palsy: fatty atrophy in left trapezius and sternocleidomastoid muscles
Figure 4 Radial Nerve (RN) lesions associated with humeral fractures in three different patients

The incidence of RN (yellow arrows) dysfunction is about 11%. Neurapraxia may occur even if post operative radiography shows optimal fracture reduction (A). Furthermore, in case of RN palsy, US may demonstrate nerve incarceration within the callus (B) or the neuroma following burning by a bullet (C).

Figure 5 Axillary Nerve entrapment and iatrogenic axillary pseudoaneurysm

A 80 y/o woman complaints of severe pain and functional disturbance after shoulder arthroplasty. Radiography shows abnormal findings such as heterotopic ossifications at the medial side of proximal humerus (thick black arrow) and at deltoid muscle insertion (thin black arrow), lateral loosening around the humeral component (curved arrow) and humeral head component misalignment (hhc). US demonstrates also a vascular mass (star) stretching Axillary Nerve (white arrow). The pseudoaneurysm has been consecutively treated by ultrasound-guided thrombin injection.
Figure 6 Examples of intrinsic (A, B) and extrinsic (C) peripheral nerve lesions
The nervous nature of the lesion is clearly identified by US because the supporting nerve is demonstrated clearly at both sides of the lesion (in - out). In A, after external fixation device withdrawal, a nevroma is detected on the sensitive branch of the RN. The path of this withdrawn material is still seen as a posterior acoustic shadow (curved arrow). In B, a schwannoma is detected by US and confirmed by MRI within the Median nerve at the elbow, in a patient with neurofibromatosis. In C, the motor branch of the left Radial Nerve (arrow) is stretched by a supinator muscle lipoma (L).

Figure 7 Carpal Tunnel syndrome and Tophaceous Gout
US requested for carpal tunnel syndrome shows displacement of the Median Nerve (thin arrow) by a hyperechoic nodule (star) located within the sheath of the flexor tendon of the second finger (A). Differentiation between nodule, tendon and nerve is obvious on both US (A) and MRI (B), but dual CT (C, D) reveals the monosodium urate composition of the nodule (colored in green).

fcr = flexor carpi radialis tendon    flp = flexor pollicis longus tendon
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V. Créteur
Department of Radiology, Erasme Hospital, ULB, Brussels, Belgium

Major nerves of the Upper Extremity will be demonstrated, with special attention to the “elevator technique” and dynamic evaluation. I would like to address special acknowledgements to Philippe Van Strydonck and Alain Piret from HITACHI ALOKA MEDICAL SYSTEMS for lending their portable Sonograph NOBLUS with two high frequencies probes of 13 and 18 MHz.

http://www.hitachi-medical-systems.com

024  Endoscopical Nerve Decompression around the Elbow
E. Vögelin, L. Haug, T. Adler
Surgery of the Hand and Peripheral Nerves, Inselspital Bern, Bern, Switzerland

Compression neuropathies of median, radial, ulnar nerves around the elbow result during surgical exploration in a conflict between exposure and morbidity. Endoscopic assisted decompression allows a large internal exposure of nerves with small external incisions, especially in unclear clinical situations. Endoscopic assisted decompression of the ulnar nerve is very popular. However, results with mini-open and or endoscopic decompression are similar in the literature. The problems remain subluxed ulnar nerves, whether or not to be decompressed (endoscopically or open) or transposed. We try to measure the position of the nerve preoperatively by X-ray and sonography and test the subluxation intraoperatively. Median and radial nerves around the elbow are endoscopically exposed by mini-incisions. The advantage is the possibility of dynamic testing of the gliding capacity of involved nerves by excellent visualization of deep structures without using large skin incisions. The blood supply of involved nerves is less impaired by endoscopy. Even in epicondylitis, the radial and median nerves may be checked and additionally decompressed. In unclear chronic neurogenic pain syndromes, main nerves may be endoscopically checked and additional pathology excluded, when it remains unclear whether only a sensory end branch or the main nerve may be involved.
References:
3) Leclère et al. Neurochirurgie 2014;60(4):196-203

025 A New Indication for the Hypothenar Fat Pad Flap: End Stage Carpal Tunnel Syndrome
T. Lattré, S. Brammer, S. Parmentier, C. Van Holder
Ziekenhuis Waregem, Waregem, Belgium

The hypothenar fat pad surgery, first described by Cramer in 1985, is a safe flap procedure with vascularised fat and muscle tissue from the hypothenar region to cover the median nerve over the carpal tunnel.

It's use is know for recalcitrant and recurrent carpal tunnel syndrome. Several authors like Strickland, Mathoulin,... made research on these populations.

We researched this surgery on 16 patients suffering “end stage carpal tunnel syndrome”, labelled as grade 6 by the neurophysiological scale by Bland. This means that the sensory and motor potentials are unrecordable and that the surface motor potential from muscle abductor pollicis brevis was > 0.2 mV amplitude.

These elderly patients reported mainly a loss of sensation as a problem but they had no pain. Evaluations of sensibility, strength, pain and functional status were made pre-operative and postoperative after 3, 6 and 12 months.

Significant results were found for sensibility, strength and functional status.

Our results indicate that end stage carpal tunnel syndrome could be a new indication for the use of the hypothenar fat pad flap.

026 Nerve Transfer as an Alternative to Tendon/Muscle Transfer
Abstract not received in due time.
SESSION 7: DISTAL RADIUS AND DRUIJ

027 Comminuted Articular Fractures of the Distal Radius: External Fixation or Volar Plate? A Prospective, Randomized Study
N. Pedini, F. Schuind (Brussels, Belgium)

028 Tips and Tricks to Avoid Complications on the Distal RadioUlnar Joint following Palmar Plating of Unstable Distal Radius Fractures
J. Rois (Vienna, Austria)

029 Diagnosis and Management of Foveal tear vs Dorsal Tear of TFCC
P.C. Ho (Hong Kong, China)

030 Arthroscopic Osteotomy for Intra-Articular Distal Radius Malunion
F. Moungondo (Brussels, Belgium)
027  Comminuted Articular Fractures of the Distal Radius: External Fixation or Volar Plate? A Prospective, Randomized Study
N. Pedini, F. Schuind
Department for Orthopaedics and Traumatology, ULB University Hospital Erasme, Brussels, Belgium

Introduction
Two methods of osteosynthesis are currently recommended for the treatment of closed, displaced, comminuted articular fractures of the distal radius: external fixation, possibly augmented by K-wires, and pre-contoured volar locked plate. The literature on both techniques is extensive but the optimal treatment remains controversial. External fixator has less popular than it used to be. Our hypothesis is that external fixation, being less invasive, provides similar clinical, radiological and functional results than volar plate, at one year of follow up.

Methods
Twenty-eight patients were enlisted from November 2011 to May 2015 and randomized by sealed envelopes into external fixation (15 patients) or volar locked plate (13 patients) groups. The patients were reviewed at one year after surgery. The two groups were compared on the basis of active range of motion, grip strength, radiological parameters (X-ray and CT-Scan), functional DASH score, residual pain, patient satisfaction, post-operative complications and return to work.

Results
The duration of operation was significantly shorter for external fixation (63 vs 106 minutes, p < 0.01). There was no significant clinical, radiological nor functional difference at one year after surgery between the both groups, except that the palmar flexion of the wrist was significantly better at one year after external fixation (61.5° vs 48.8°, p = 0.01). Minor complications were observed in both groups, tending to be more frequent after external fixation, but the difference was not significant. A patient operated by volar plate had a serious complication, a rupture of the flexor pollicis longus which could not be reconstructed.

Conclusion
External fixation and volar locked plate constitute valid methods of osteosynthesis of closed, displaced, comminuted articular fractures of the distal radius. The functional results at one year were in this study similar. The use of a volar plate imposes a re-intervention for implant ablation, in our series in only 23% of the cases.

028  Tips and Tricks to Avoid Complications on the Distal RadioUlnar Joint following Palmar Plating of Unstable Distal Radius Fractures
J. Rois
Trauma Center Vienna Meidling, Vienna Austria

Fractures of the distal radius are the most common fracture in the upper extremity. Open reduction and palmar fixed-angle plating is nowadays the most common used treatment method for unstable distal radius fractures. The complication rate of this treatment reported in the literature vary between 8% and 40%. The most common cause of wrist disability after distal radius fracture is the distal radioulnar joint (DRUJ) involvement. The aim of this study is to find sustainable solutions and to offer practical tips and tricks to prevent this type of complications.

Based on an own retrospective study with 127 cases on the topic of palmar plating of unstable distal radius fractures, and on the literature review the different complication types were studied and classified. Focussed on preventable complications they were classified into surgeon-related and surgeon-independent complications. The surgeon-related complications (malunion, tendon complications, screw length, intraarticular screw placement, secondary dislocation,...) were analyzed.

Based on these results and also taking into account biomechanical studies, possibilities of avoidance of complications on the DRUJ will be offered by means of case reports. To prevent complications is not restricted solely to the surgical technique – approach, reduction, plate position, screw position, screw length – but begins with the preoperative assessment of the fracture which results in surgery planning.
It will definitely not be possible to achieve a complete avoidance of complications that are associated with palmar plating of unstable distal radius fractures. Awareness of the possible complications and how to deal with them may help to minimize the complication rate and on the other hand to recognize complications at an early stage allowing timely treatment.

029 Diagnosis and Management of Foveal Tear vs Dorsal Tear of TFCC
Abstract not received in due time.

030 Arthroscopic Osteotomy for Intra-Articular Distal Radius Malunion
Abstract not received in due time.
SESSION 8: SCAPHOID

031 Arthroscopic Bone Grafting for Scaphoid NonUnion with DISI Deformity
P.C. Ho (Hong Kong, China)

032 Reconstruction of the Proximal Pole of the Scaphoid using a Vascularised
Osteochondral Femoral Trochlea Flap
K. Kalb, B. Blanarsch (Bad Neustadt, Germany)

033 Prognostic Factors in the Treatment of Scaphoid Nonunions
F. Schuind, F. Moungondo, W. El Kazzi (Brussels, Belgium)

034 Effect of Neurodynamic Mobilizations on Fluid Dispersion on Median Nerve at
the Level of the Carpal Tunnel: A Cadaveric Study
M. Boudier-Revéret M., K.K. Gilbert, D.R. Allégue, M. Moussadyk,
J-M. Brismée, V. Feipel, P-M. Dugailly, S. Sobczak (Trois-Rivières, Québec, Canada,
Lubbock, Texas, USA and Brussels, Belgium)
031 Arthroscopic Bone Grafting for Scaphoid NonUnion with DISI Deformity
Abstract not received in due time.

032 Reconstruction of the Proximal Pole of the Scaphoid using a Vascularised Osteochondral Femoral Trochlea Flap
K. Kalb, B. Blanarsch
Clinic for Handsurgery, Bad Neustadt, Germany

Objective
Reconstruction of a destroyed proximal pole of the scaphoid using a vascularised 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, 5 women) using a vascularised osteochondral femoral trochlea flap to reconstruct a destroyed proximal scaphoid pole. Destruction of the proximal scaphoid was caused by a non-union 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. 25 patients could be reexamined after a mean follow-up time of 1.4 (minimum: 0.4; maximum: 2.9) years. Follow-up examination consisted of a clinical examination including the history and establishing a 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; maximum: 60) and a mean modified Mayo wrist score of 73 (minimum: 45, maximum: 98) points. Bony consolidation could be found in 30 (83%) out of all 36 patients. In the patients with Preiser’s disease bony healing was confirmed in 6 (67%) out of 9, in the patients with scaphoid non-union in 24 (89%) out of 27. Acute revision surgery was necessary because of hematoma in 3 cases and because of compartment syndrome in one case. Minor revisions were done to remove exostoses in 3 cases and hardware in 5 cases. Salvage procedures are documented in 5 patients – one four corner fusion because of persisting non-union and 2 four corner fusions and one proximal row carpectomy because of secondary osteoarthritis after bony healing. Another patient required a wrist arthrodesis. 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 6 of the patients with persisting non-union we were not able to identify an obvious cause of the failure.

Conclusions
Reconstruction of a destroyed proximal scaphoid pole using a free vascularised 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.
033 Prognostic Factors in the Treatment of Scaphoid Nonunions
F. Schuind, F. Moungondo, W. El Kazzi
Department for Orthopaedics and Traumatology, ULB University Hospital Erasme, Brussels, Belgium

The main negative prognostic factors in the curative treatment of scaphoid non-unions are smoking, the time elapsed since the fracture, and avascular necrosis of the proximal fragment. If the latter is present, the revascularization by a pedicle or microsurgical bone autograft is probably the treatment of choice. In non-unions without evidence of osteonecrosis, vascularized bone grafts are probably not superior to conventional bone grafts, which can presently be performed under arthroscopic control, with minimal morbidity.

034 Effect of Neurodynamic Mobilizations on Fluid Dispersion on Median Nerve at the Level of the Carpal Tunnel: A Cadaveric Study
M. Boudier-Revéret1,5, K.K. Gilbert2, D.R. Allégue3, J-M. Brismée2, V. Feipel3, P-M. Dugailly3,5, S. Sobczak2,5
1Physical Medicine and Rehabilitation Service, Centre Hospitalier de l’Université de Montréal (UdM), Montréal, Québec, Canada; 2Department of Rehabilitation Sciences, Center for Rehabilitation Research, School of Health Professions, Texas Tech University Health Sciences Center (TTUHSC), Lubbock, Texas, USA; 3Research unit in Osteopathy, Faculté des Sciences de la Motricité, Université Libre de Bruxelles (ULB), Bruxelles, Belgique; 4Laboratory of functional anatomy, Faculté des Sciences de la Motricité, Université Libre de Bruxelles (ULB), Bruxelles, Belgique; 5Département d’anatomie, Université du Québec à Trois-Rivières (UQTR), Trois-Rivières, Québec, Canada

Objectives: To evaluate the effect of neurodynamic mobilizations (NDM) on an artificially induced intraneural edema in the median nerve at the level of the carpal tunnel in fresh cadavers, and to assess if tensioning (TT) and sliding (SLT) techniques induce the same effect on fluid dispersion.

Methods: Fourteen upper limbs of seven fresh cadavers were tested in this study. A biomimetic solution was injected directly under the epineurium of the median nerve at the level of the transverse carpal ligament. The initial dye spread was allowed to stabilize before starting the experimental protocol (Figure 1). Once the initial longitudinal dye spread stabilized, a randomized crossover design was applied (side and technique). A blinded draw was performed first for the starting side and then for the first technique to be performed on that side. Tensioning and sliding techniques were applied to each upper extremity and were performed, by the same operator, within five minutes each. Post-intervention caliper measurements of the dye spread were taken after each techniques. A descriptive analysis of the dye diffusion before and after technique applications was presented. A two-way ANOVA for repeated measurements was applied. In function of the ANOVA findings, a post LSD Fisher test was applied. The tests were performed using the software Statistica® with a statistical significance of p<0.05.

Results: The mean experimental post-test longitudinal dye spread measurement (7.51±6.63mm) was significantly greater (p=0.024) compared to the initial stabilized pretest longitudinal dye spread measurement. There was a significant diffusion effect with either TT or SLT (p=0.018 and p=0.016 respectively), with no statistically significant difference between both techniques (p=0.976). The order in which TT and SLT were administered did not influence diffusion in a significant way and there was no difference related to the side (right/left) of the upper limb.

Discussion: Passive NDM in the form of 5-minutes therapy of tensioning or sliding technique induced significant fluid dispersion in the median nerve at the level of the carpal tunnel of human cadavers. Both the tensioning and sliding techniques produced similar intraneural fluid dispersion in the median nerve. These data provide an explanation regarding a potential clinical mechanism of NDM in reducing intraneural edema in the median nerve at the level of carpal tunnel.
Figure 1: Representation of the different steps of the experimental protocol. A: skin incision, B-C: detection of the palmar aponeurosis and the transverse carpal ligament, D: incision of the palmar aponeurosis and the transverse carpal ligament. E-F: access to the median nerve, G: median nerve after dye injection under the perineurium, H: suture of the transverse carpal ligament and soft tissues and I: reopening after mobilizations to measure the dye diffusion. After the first measurement, sutures were redone and the second mobilization was applied.
SESSION 9: CARPAL INSTABILITIES

035 Arthroscopic Classification of Extrinsic Ligaments and Dorsal Capsulo-Scapho-Lunate Septum
L. Van Overstraeten, E. Camus, M. Shahabpour (Brussels, Tournai, Belgium and Maubeuge, France)

036 Place of ECRL Tenodesis for the Treatment of ScaphoLunate Instability
W. El Kazzi (Brussels, Belgium)

037 SLAC and SNAC Treatment's: CarpalFix® Device
A. Andrzejewski, Ph. Etienne (Brussels, Belgium)

038 Complex Wrist Instabilities
G. Bain (Adelaide, Australia)

039 Normal and Pathologic MR Imaging of Extrinsic and MidCarpal Ligaments
M. Shahabpour, A. Milants, L. Van Overstraeten, M. De Maeseneer (Brussels, Tournai, Belgium)

040 MR Arthrography of Secondary Carpal Stabilizers with Arthroscopic Correlation
M. Shahabpour, M. De Maeseneer, B. Staelens, E. Camus, L. Van Overstraeten
(Brussels, Tournai, Belgium and Maubeuge, France)

041 Diagnosis and Ligament Reconstruction for Palmar Mid-Carpal Instability
P.C. Ho (Hong Kong, China)
There is not only one scapholunate instability but a lot of instabilities that depend on the lesional spectrum. Scapholunate instability can be acute or chronic depending on the period since onset of trauma. It may be pre-dynamic, dynamic, static depending on whether there are radiological changes or not. It may be dissociative or non-dissociative according to the presence or not of a scapholunar gap. The scapholunate stability is ensured by a set of ligamentary structures which organize anatomically and biomechanically a scapholunate (SL) complex. The scapholunate interosseous ligament (SLIOL) is the main stabilizer. However, there are capsular, extrinsic, interosseous secondary stabilizers located on the volar, dorsal or distal levels of the carpus. Their isolated or combined lesions will construct the lesional spectrum.

The Dorsal Capsulo-Scapholunate Septum (DCSS) is a frenulum, linking the dorsal capsule, the dorsal radiocarpal crest and the dorsal part of the SLIOL. It probably participates to the stability of the SL space. A cadaveric study shows that the section of DCSS produces an arthroscopic SL predynamic instability (p<.001)

An unstable acute sprain and instability of one year have not to be treated in the same way. Similarly, the treatment of the scapholunate instability will be conditioned by the repair of the various injured elements of the scapholunate complex.

The first step of the treatment is the diagnosis of various and varied lesions of SL complex. The arthroscopeaner seems to be the examination of choice to document a lesion of SLIOL (complete, partial, transfixing). The arthro-MRI gives information about the integrity (or non-integrity) of the capsular and / or extrinsic elements. Arthroscopy makes it possible to evaluate the scapholunate stability according to the shape and the enlargement of the midcarpal scapholunate space. Recently, Messina et al. specified the arthroscopic classification of Geissler and particularly its 3th stage. It seemed important for us to assess arthroscopically the extrinsic ligament status in order to determine the level of instability in the lesional spectrum. Using a four-stage extrinsic ligament lesion classification based on the tension state and fibers continuity, we proposed arthroscopic testing of all capsular and / or extrinsic ligaments accessible by this procedure: the radiocarpal part of the radio-scapho-capitate (RSC), the long radio-lunate, the short radio-lunate, the ulno-lunate, the ulno-triquetral, and the dorsal radio-carpal. Midcarpal arthroscopy enables assessment of the mid part of the RSC, the triquetro-capitate (TC), the scapho-trapezial (ST), and the dorsal inter-carpal (DIC), and finally (with an adaptation of this classification) the DCSS.

The status of DCSS is graded in four stages according to the trampoline aspect and the fiber attachment. (Stage S0: The DCSS presents an intact aspect. It's normally tensed when palpated with a probe. All the fibers are continuous, with a typical aspect of cathedral arches; Stage S1: The DCSS is loosened when palpated with a probe. It presents partial detachments on the distal insertion with more than 50% continuous fibers; Stage S2: The DCSS is loosened when palpated with a probe. It presents partial detachments on distal insertion with less than 50% continuous fibers; Stage S3: The DCSS is totally torn. The scope introduced through MCR can pass directly from midcarpal to radiocarpal spaces.

The lesional stage of the DCSS is correlated with the arthroscopic pre-dynamic scapholunate instability stage (p < .01)

For the chronic predynamic SL instability, a (dorsal/volar/combined) arthroscopic reinforcement can be indicated in the same time and according to this arthroscopic extrinsic testing.
Introduction
Partial wrist arthrodeses result in a painless wrist and a satisfying mobility and strength that allow the patient to continue a professional activity. The principal indication is the treatment of radioscaphoid arthritis resulting from scapholunate dissociation (SLAC – ScaphoLunate Advanced Collapse) or scaphoid nonunion (SNAC – Scaphoid Nonunion Advanced Collapse).
Partial wrist arthrodeses are technically less difficult than the proximal row carpectomy but need a strong fixation in order to avoid pseudoarthroses, which remain the primary complication of this surgery.

CarpalFix® Device
Our team previously used to fix three-corner and four-corner arthrodeses with Herber screws and Kirschner wire in order to reduce the lunatum. However, this surgical technique did not seem entirely satisfactory. Indeed, besides the fact that the wire’s migration can lead to extensor tenosynovitis, the position of the fixation hardware can also decrease the postoperative mobilization possibilities. For two years, we have used a new method of fixation with the CarpalFix® Device. It uses two screws with a given angle between them which will be fixed into the lunatum and the capitatum, and which allows for the application of a uniform compression to a greater surface area. We use it for isolated capitolunar arthrodeses as well as for three-corner and four-corner arthrodeses.

Operative technique
We use a longitudinal dorsal skin incision to expose the carpal bones. After the scaphoid’s removal, the articular surfaces between the lunatum and the capitatum are made bare from their cartilage with a rongeur. The lunatum is then replaced and maintained in its anatomical position with a Kirschner wire, which is removed at the end of the intervention. The first screw is inserted into the capitatum. This screw has a role in its head that allows for the orientation of the second screw, which is then inserted into the lunatum with a given angle chosen by the surgeon.

Benefits of the technique
It optimizes the consolidation through greater compression which allows for a rapid mobilization procedure, from the third postoperative week. Because of its size and position, this hardware poses no problem for the mobilization. It causes no cam effect when the patient’s wrist is in a dorsiflexed position, as opposed to other larger hardware. Soft tissue irritation is minimized. Hardware removal is overall unnecessary.

Results
Since 2015, eleven patients have had a partial wrist arthrodesis with the CarpalFix® Device for the treatment of SLAC and SNAC stage II. Mobilization by a physiotherapist was started after the third week postoperatively. The mobility was similar to the literature results. There was no case of pseudoarthrosis among the ten patients followed after the intervention. One patient could not be followed up before the fusion of the arthrodesis.
SESSION 10: TRAPEZIO-METACARPAL JOINT

042 Dynamic Evaluation of CarpoMetacarpal Instability
F. Stockmans (Kortrijk, Belgium)

043 CarpoMetacarpal Stabilization by only Reconstructing the DorsoRadioLateral Ligament
F. Stockmans (Kortrijk, Belgium)

044 Retrospective Analysis of a Series of Trapezio-Metacarpal Prostheses type ISIS
M. Bazi, S. Boulares, Ph. Everaert (Charleroi, Belgium)

045 Dual Mobility Trapeziometacarpal Implant: Principles and Clinical Series
P. Ledoux, B. Lussiez, C. Falaise (Mons and Valenciennes, Belgium and France)

046 A Cupless CarpoMatacarpal Arthroplasty
F. Stockmans (Kortrijk, Belgium)
Dynamic Evaluation of CarpoMetacarpal Instability
Abstract not received in due time.

CarpoMetacarpal Stabilization by only Reconstructing the DorsoRadioLateral Ligament
Abstract not received in due time.

Retrospective Analysis of a Series of Trapezio-Metacarpal Prostheses type ISIS
M. Bazi, S. Boulares, Ph. Everaert
Department of Orthopedic Surgery and Traumatology, CHU Charleroi, Hospital Civil Marie Curie, Charleroi, Belgium

Introduction
Thumb basal Joint replacement is a well know and clinically effective treatment for trapezo-metacarpal terminal arthritis. Despite of a well know significant rate of asymptomatic radiological failure, this procedure still remain very popular. Indeed, this procedure offers the best compromise between strength preservation and mobility. However, because of multiple variables, origins of failure, even asymptomatic can be very difficult to identify. The aim of this study is to analyze which factors where associated to a failure and more specifically if there were any relationship with the trapezial component position.

Patients and methods
Between 2015 and 2015, 42 ISIS® cementless prostheses where implanted within the CHU de Charleroi hospitals. All data's have been retrospectively retrieved for 36 procedures after a median delay of 42 months (9-79). Clinical data's include key and pulp pinch strength test measurement, Kapandji score, visual analogue score, Quickdash score and subjective satisfactory index assessment. Radiological data’s includes Eaton and Littler and Crosby preoperative classification and trapezial component angle in dorsopalmar (DP) and radioulnar (RU) radiograph view measurement. The median age at the procedure was 60 years (39-79) and the sex ratio was 6/30 (M/F).

Results
Within the 36 procedures, there were 15 complications (41.7%), including 11 trapezial fractures and loosening (30.6%), one metacarpal stem loosening (2.7%) and three De Quervain’s tenosynovitis (8%). Within those, five implants were explanted after a median delay of five months (14%). For patients with the implant still in place, the Quickdash score, visual analogue score and Kapandji score did not revealed any statistical differences between the group without failure and the group with implants failures. The pulp pinch strength test measurement was higher in the non failure group than in failure group (5.4 vs 3.6kg respectively, p<0.05). Measurement of the orientation of the trapezial component in RU view showed that mean angle of the trapezial component was more in radial tilting in the implant failure group than in non failure group (3.7° vs 0.3° respectively, p<0.03)

Conclusions
As already showed in the literature, this study confirms the significant discrepancy between the good functional results and the high radiological failure rate in thumb basal arthroplasty. Furthermore, our implants positioning review seem to demonstrate that the trapezial component should be placed in a neutral position in DP view and avoid radial tilting in the RU view according to the J. Duerinckx and P. Caektebeke radiological study.
045 Dual Mobility Trapeziometacarpal Implant: Principles and Clinical Series
P. Ledoux, B. Lussiez, C. Falaise
Mons and Valenciennes, Belgium and France

We present the results of a study of the first 65 Touch dual-mobility prostheses with a follow-up of more than one year. Articulated prostheses are becoming increasingly popular for the treatment of trapeziometacarpal osteoarthritis because they provide better results in terms of mobility, strength and recovery time than trapeziectomies. Early dislocation rate remains high. An increased radius of curvature and an increased range of motion of the implant are two factors which should help to reduce the dislocation rate. We have conducted prospective follow-up of our patients and present the results of the first 65 cases operated by 3 surgeons with a follow-up of more than 1 year out of a total of 420 implants. The prosthesis was implanted in a context of revision of painful trapeziectomy in two cases. Clinical and radiological data were entered into a review database and were analysed by an independent observer. This series comprised 54 women and 11 men with a mean age 65.2 years and an age-range of 44 to 85 years. Mean follow-up at the time of review was 18.6 months. The level of work or leisure activities was light in 51% of cases, heavy in 10% of cases and limited to housework in 39% of cases. The mean duration of resin immobilization was 28 days. Implants following trapeziectomies were immobilized for 2 months. Physiotherapy was not necessary in 64 out of 65 cases. The mean preoperative quickDASH score was 37.14 and the mean postoperative quickDASH score was 18.8, which corresponds to a significant gain in activities of daily living. The mean pain VAS score decreased from 7.22 to 1.54. Significant gains of mobility were observed, especially for thumb abduction: + 44%, which restored complete opening of the thumb in the majority of cases. Antepulsion was increased by 27%. Flexion-adduction (Kapandji score) was increased by 13%. Strength was improved by 46%. 37% of patients presented metacarpophalangeal hyperextension before the operation versus 17.5% after the operation. There were 10 Z-deformity thumbs before the operation and all were corrected postoperatively, without an associated metacarpophalangeal joint procedure. The Dell stage distribution was: stage 2: 15 cases, stage 3: 20 cases and stage 4: 8 cases. A narrowed trapeziometacarpal joint space was observed in 34 cases. A medial osteophyte was present in 45 cases and a lateral osteophyte was present in 17 cases. Scapho-trapeziotrapezoid osteoarthritis was observed in 11 cases. The M1/M2 ratio was 0.68 before the implant and increased to an average of 0.74 (normal value) immediately after the operation. This ratio was maintained at last follow-up. Restoration of normal length of the thumb accounts for correction of metacarpophalangeal hyperextension in one half of cases as a result of restoration of bone axes and muscle levers. It also contributes to recovery of strength by restoring normal muscle levers. No case of dislocation was observed in this series of 420 prostheses, partly due to the increased radius of curvature of the metacarpal head and partly due to the large range of joint motion of the prosthesis, which compensates for small errors of orientation of the cup, thereby avoiding a cam effect. Our preliminary results are therefore superior to those of all series of non-constrained prostheses in terms of dislocation rate, as no implants needed to be removed because of repeated dislocation. Otherwise, these preliminary clinical results are identical to those observed with conventional articulated prostheses. A longer follow-up will be necessary to confirm the low rate of wear of the implant.

046 A Cupless CarpoMatacarpal Arthroplasty
Abstract not received in due time.
SESSION 11: HAND

047  New Aspects of Treatment of Dupuytren Disease  
     J-P. Moermans, N.Cylits (Brussels, Belgium)

048  Collagenase Treatment in Dupuytren Disease: Enzymatic versus Surgical Fasciectomy  
     I. Degreef, K. Cootjans, M. Van Nuffel (Leuven, Belgium)

049  Percutaneous Sonography-Guided Trigger Finger Release  
     F. Moungondo, F. Schuind (Brussels, Belgium)
Introduction
Dupuytren's contracture is a disease of the palmar fascia and its expansions in the fingers. It causes a thickening of the palmar fascia, the appearance of nodules in the palm and the fingers followed by their progressive retraction.
Almost two centuries after its first detailed description we still don't know its origin and prevalence, the mechanisms implicated in its development and why we observe so many different patterns of evolution. That is why many uncertainties remain about the most appropriate treatment: corticoids and splints are ineffective, radiotherapy has been proposed, forgotten, proposed again recently without any proof of its effectiveness and we have learned that surgery helps in the correction of the contracture but does not cure the disease.

Surgical management
The evolution of the surgical management has always been dominated by the search for a balance between the risks of complications and recurrences: fasciotomies (Dupuytren), radical fasciectomy (McIndoe), limited fasciectomy (Hueston, Skoog, Tubiana), dermofasciectomy (Hueston), segmental fasciectomy (Moermans), needle fasciotomies (Lermusiaux) and recently, collagenase injections.

What do we know about surgical treatments?
• Recurrences are frequent after all types of fasciectomy (68% after 8 years; Tubiana, 1985)
• There exists a direct relationship between the extent of the surgical procedure and the postoperative morbidity (Zachariae 1967, 1990; Gonzales, 1985)
• Complications often lead to unacceptable functional losses that can then exceed the impairment induced by the retraction

How much is enough?
Being persuaded that aggressive surgery has no place in the management of most cases of Dupuytren's contracture and having used segmental fasciectomy as our first choice treatment we were interested we were interested by the possibilities offered by simple collagenase injections.

Collagenase or surgery?
We started a prospective study of the results obtained with this new approach compared with those obtained with the more traditional segmental fasciectomy. The variables we were more interested in were:
• quality of the correction of the contracture
• length of treatment
• number and type of complications
• number and timing of recurrences

All patients consulting for a contracture > 30° at the MP or PIP joints were included in the study even those who presented a first recurrence. Patients who had already been operated two or more times for a recurrence were excluded because we think these a best treated with a dermofasciectomy.
191 injections were performed on 160 hands on 114 patients (81 men, 33 women). 32% of these were performed for recurrences.
All injections were performed by the senior author (JPM) and the results were evaluated independently by the junior author (NC).
No serious complications were observed and the quality of the correction of the contracture was similar to that observed in the control group of segmental fasciectomies.

We were able to review 86 hands with a follow-up of at least one year.
At the moment the recurrence rate seems to be much higher than that observed after segmental fasciectomies.

Further details will be presented at the meeting.
Conclusions
Collagenase injections are easy to perform, do not lead to serious complications and have almost no impact on the normal activities of the patient. The price to pay is probably a higher rate of recurrences but further analysis is required and will be presented at the meeting.

048 Collagenase Treatment in Dupuytren Disease: Enzymatic versus Surgical Fasciectomy
I. Degreest, K. Cootjans, M. Van Nuffel
Orthopaedic Department, KULeuven, Leuven, Belgium

Collagenase treatment is currently a valid alternative to surgical fasciectomy in Dupuytren contractures. To assess medium term outcome, recurrence of contractures is evaluated in a single center 5 year experience and compared to surgical outcome. Different parameters are weighed for their predictive value. The influence of fibrosis diathesis (table 1), extent of the contractures and severity of the extension lack are investigated. An algorithm for the current position of collagenase in the management of Dupuytren disease is proposed.

<table>
<thead>
<tr>
<th>Diathesis score</th>
<th>Pearson Correlation</th>
<th>Recidief</th>
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<td>74</td>
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</table>

Table 1: Correlation of the diathesis score with disease

049 Percutaneous Sonography-Guided Trigger Finger Release
F. Moungondo, F. Schuind
Department for Orthopaedics and Traumatology, ULB University Hospital Erasme, Brussels, Belgium

Trigger finger is a common pathology in which fibro-cartilaginous metaplasia of the A1 pulley generates a mismatch between the pulley and the tendon sliding inside. In case of conservative treatment failure, surgical release is mandatory to restore a free sliding of the flexor tendon. Open release is the classic approach. Blinded percutaneous release has been described for long and give the advantage to shorten the recovery time for the patients. However, this technique present some risks of tendon and neuro-vascular complications. The use of these procedure should then be avoided for the thumb and the fifth finger where the neurovascular bundle path may cross the tendon. Furthermore, incomplete release or additional release of A2 are frequent complications of the blind technique. The use of sonography to guide percutaneous release give to the surgeon the possibility to accurately identify structures at risk and to proceed to a very selective release of the A1 pulley. The use of sonography could then decrease the complication rate of the percutaneous technique keeping the advantage of early recovery of the percutaneous technique. This procedure was described first in 2005 by Tchern et al. these authors was using some anatomical bony landmarks to well define the A1 pulley limitations and the release was performed in an extra-sheath manner. Now a day the high definition of new sonography probes allows to define well the pulleys and other fine anatomical structures then the use of bony landmarks is useless. Thank to this high quality of the image, the use of sonography allows to perform safe percutaneous procedures at all finger. Furthermore, the intra-sheath technique to release A1 seems to be less aggressive for the tendon behind it.