

Triangular Fibro Cartilage Reconstruction

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The distal end of the radius is shaped as a funnel mainly made of cancellous bone.



The ulna is straight, while the radius is shaped as a bow or a modified "S"



*Courtesy of
Professor Makoto Tamai
Kumamoto, Japan*

Radius and ulna are connected at both ends by a bicondylar pivot type joint. Like the knee joint, there are two condyles in the forearm.



*Courtesy of
Professor Makoto Tamai
Kumamoto, Japan*

but unlike the knee, in the forearm each bone has a condyle.



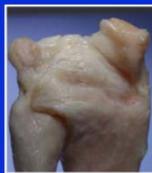
Forearm function



Humero-ulnar joint flexion/extension



Radio-ulnar joint pronation/supination



In 1981, Palmer and Werner introduced the term triangular fibro cartilage complex (TFCC) to describe the ligamentous and cartilaginous structures that suspends the Distal radius and ulnar carpus from the distal ulna.

TFCC Components

Triangular fibro-cartilage
(articular disc)

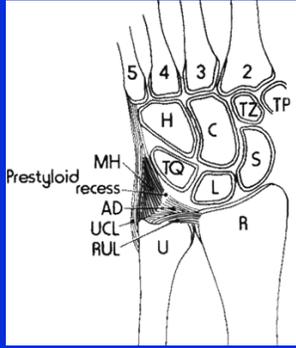
Meniscus homologue

Dorsal radioulnar ligament

Volar radioulnar ligament

Ulnar collateral Ligament

ECU sheath





The dorsopalmar stability of the distal radioulnar joint.

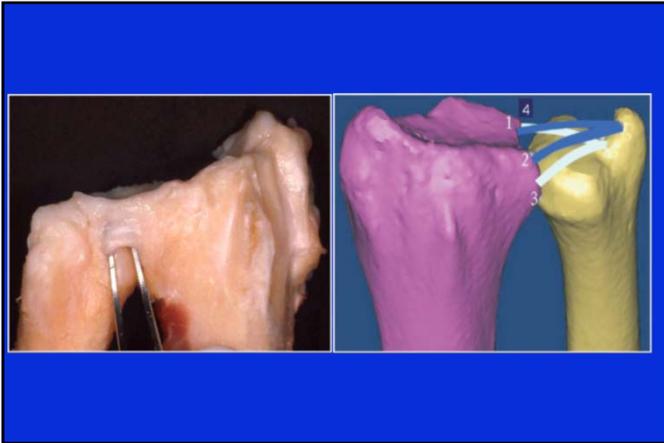
Stuart PR, Berger RA, Linscheid RL, An KN.

Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA.

J Hand Surg Am. 2000 Jul;25(4):689-99.

Sixteen fresh-frozen adult human cadaveric upper extremities were used in a biomechanical analysis of distal radioulnar joint (DRUJ) stability. The relative contribution to stability of the DRUJ by the surrounding anatomic structures presumed to stabilize the joint was analyzed with respect to forearm rotation and wrist flexion and extension using a purpose-built 4-axis materials testing machine. The dominant structures stabilizing the DRUJ were the ligamentous components of the triangular fibrocartilage complex proper. The major constraint to dorsal translation of the distal ulna relative to the radius is the palmar radioulnar ligament. Palmar translation of the distal ulna relative to the radius is constrained primarily by the dorsal radioulnar ligament, with secondary constraint provided by the palmar radioulnar ligament and interosseous membrane. The ulnocarpal ligaments and extensor carpi ulnaris subsheath did not contribute significantly to DRUJ stability; however, approximately 20% of DRUJ constraint is provided by the articular contact of the radius and ulna. These relationships were consistent regardless of wrist position or degree of forearm rotation.









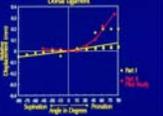
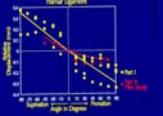

Hall apparatus

10 cadaver hands

Measurements through full range of motion

Findings:
Dorsal lig. Tight in Pron.
Palmar lig. Tight in Sup.

Acosta, Hnat & Scheker
J Hand Surg Br 1993; 18: 502-505



The Distal Radio Ulnar Joint work as an eccentric wheel.
When the points of origin and insertion get far apart the ligament gets tight



Triangular fibrocartilage complex lesions: a classification.

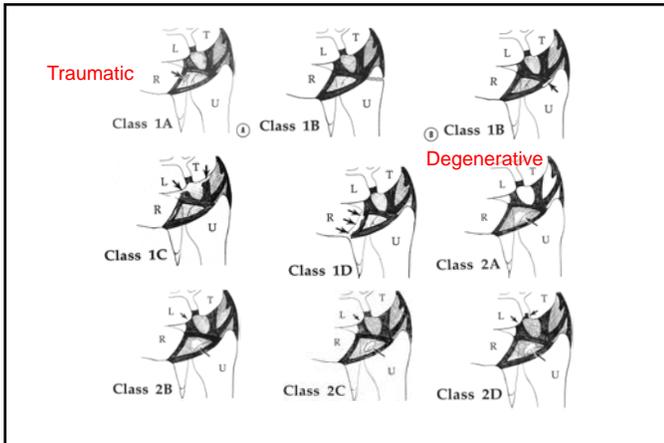
Palmer AK

Department of Orthopaedic Surgery, SUNY Health Science Center, Syracuse NY.

J Hand Surg Am. 1989 Jul;14(4):594-606

Abstract

Based on anatomic and biomechanical studies and review of our clinical experience of the past 10 years, a classification of injuries to the triangular fibrocartilage complex is presented. This classification is based on the clinical examination, routine x-ray films, wrist arthrograms, wrist arthroscopy, and wrist arthrotomy. The classification recognizes both traumatic and degenerative lesions. Traumatic lesions are classified according to their location. Degenerative lesions are classified by the location and severity of degenerative changes of the triangular fibrocartilage complex, ulnar head, ulnocarpal bones and lunotriquetral ligament





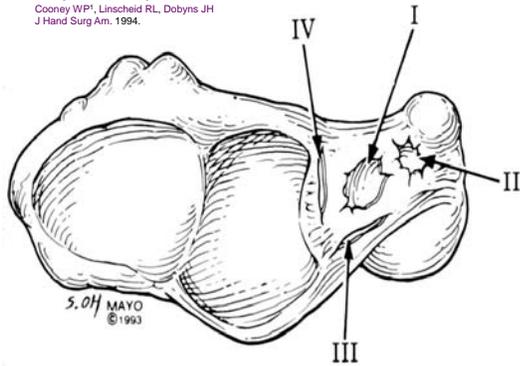
Triangular fibrocartilage tears

Cooney WP, Linscheid RL, Dobyns JH
Department of Orthopedics, Mayo Clinic, Rochester, MN.

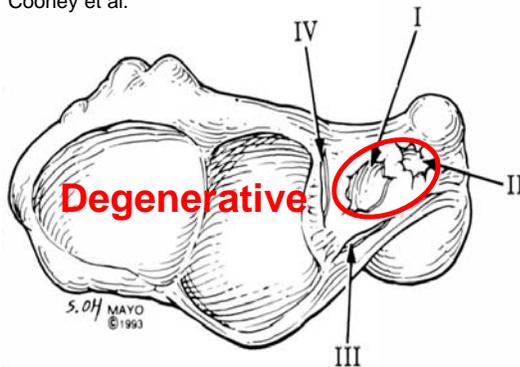
J Hand Surg [Am]. 1994 Jan;19(1):143-54

From a series of 56 patients with triangular fibrocartilage injury, 33 patients with peripheral rim tears not associated with instability of the distal radioulnar joint were identified by arthrography or arthroscopy. Open repair of the peripheral tear produced 11 excellent, 15 good, 6 fair, and 1 poor result (grading based on a Mayo modified Green-O'Brien wrist score). Ulnar recession improved surgical exposure and corrected ulnar variance in 11 patients. A dorsal approach for repair of radial and anterior peripheral rim tears was used in 28 patients. Repair of peripheral tears restored functional integrity to the triangular fibrocartilage, and good to excellent results are reported in 26 of the patients treated.

Triangular fibrocartilage tears.
Cooney WPI, Linscheid RL, Dobyns JH
J Hand Surg Am. 1994.



Cooney et al.



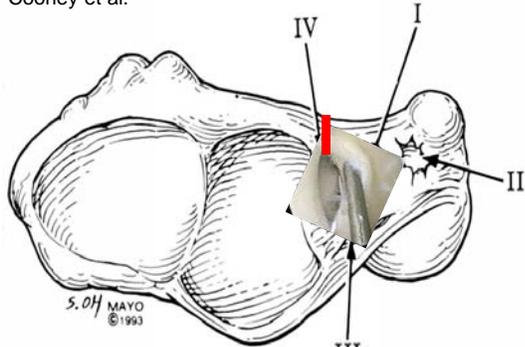
On the basis of a study of 180 wrist joints from 100 fresh cadavers of individuals ranging in age from fetuses to 94 years.

It appears that disc perforation is degenerative and age-related: thus there were no perforations in the first two decades of life; in the third there were 7.6%, in the fourth 18.1%, in the fifth 40.0%, in the sixth 42.8%, and in the over sixties 53.1%.



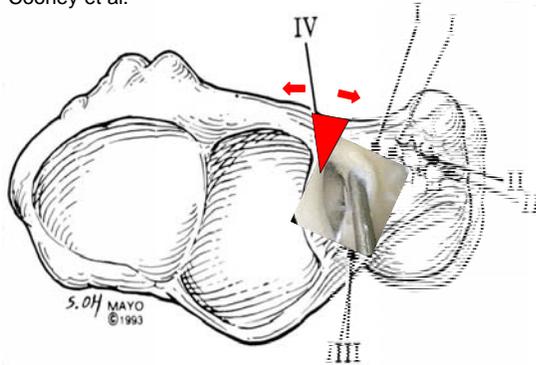
Age changes in the triangular fibrocartilage of the wrist joint.
Mikic ZDJ J Anat 126:367-84, 1978

Cooney et al.



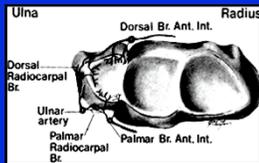
Traumatic tear starts in the periphery

Cooney et al.



The peripheral tear heals in stretch position

Arterial anatomy of the triangular fibrocartilage of the wrist and its surgical significance.



Histologic sections of the TFC reveal vascularity in the outer 15% to 20% of the disc, and the rest is avascular. On the basis of these findings, we feel that tears of the TFC in its vascular zone have the potential to heal if repaired and those in the central avascular zone do not have this potential.

Rama G. Thiru-Pathi, M.D., Donald C. Ferlic, M.D., Mack L. Clayton, M.D., and Donald C. McClure, M.D., J Hand Surg Am. 1986



Instability of the distal radio ulnar joint is defined as an abnormal path of articular contact occurring during or at the end of the range of motion. This is due to either alteration in joint surface orientation or by deficiencies in the main restricting ligaments, or by both.

Bruckner, Alexander, Lichtman 1996.



Distal Radio-Ulnar Joint Instability

Definition:

...the inability to maintain a normal anatomical relationship of the radius to the ulna under physiological loading and within the normal range of motion.

*Mr. John Stanley, FRCS
Chairman of the
Committee on Distal Radio-Ulnar Joint Arthroplasty IFSSH
Sydney, Australia 2007*

Cause of instability

Trauma

- Closed
- Open

Inflammatory disease

- Rheumatoid arthritis

Congenital abnormalities

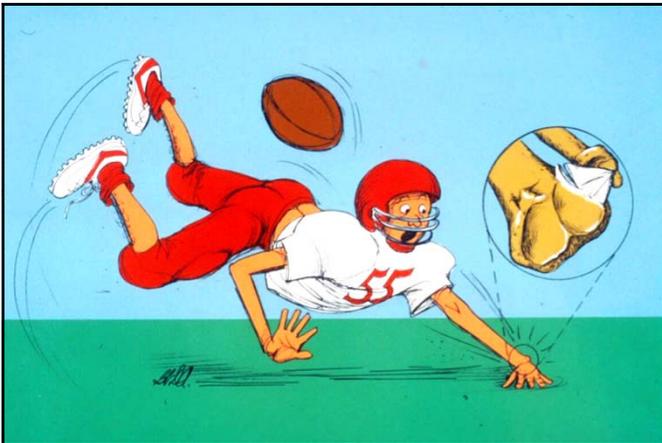
- Ehlers-Danlos syndrome
- Madelung deformity

Cause of instability

- Ligament injury, including ulnar styloid fractures
- Intra- articular abnormalities of DRUJ
- Extra-articular skeletal deformities
- Combinations of these

Traumatic Ligament Injury

- Fall on outstretched, pronated hand
- Acute rotational injury
- Axial load or distraction injury



Etiology

- Ligament injury.
 - Detachment from the radius
 - Detachment from the ulna
 - Intra-ligament injury
- Ulnar styloid fractures

No all styloid fractures seen in x-rays are unstable.

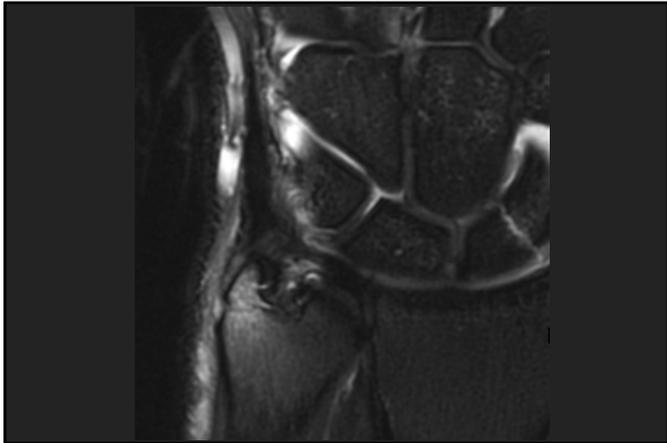
Clinical evaluation is needed.

Most styloid fractures do not need Fixation.



College football quarterback with painful radial and ulnar sided wrist.
Injured one week before this X-rays.
Unstable DRUJ and painful over snuff box.







Treatment of Triangular Fibrocartilage Injuries

- Detachment from the radius
- Detachment from the ulna
- Intra-ligament rupture

Treatment of Triangular Fibrocartilage Injuries

Above elbow cast in neutral position for fresh injuries



Arthroscopic repair of early lesions



Ligament reconstruction of late lesions

Dorsal, palmar or both



Treatment Options for Distal Radioulnar Joint Instability

Type of Instability

Treatment Options

Acute

Simple

Reduction and fixation

Arthroscopic repair

Cast immobilization

Complex

Arthroscopic versus open repair

Cast immobilization

Chronic

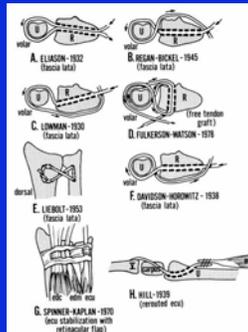
Soft tissue reconstruction

Extra-articular.

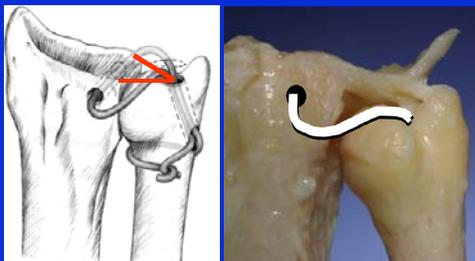
Intra-articular.

Extra anatomical ligament reconstruction of the triangular fibro cartilage

| | | |
|--|------|--------------------------|
| Radioulnar sling | 1926 | Mich H |
| | 1930 | Lowman CL |
| | 1932 | Elkason EL |
| | 1933 | Sauve-Kapandji |
| | 1934 | Regan JM and Bickel WH |
| | 1953 | Liebolt FL |
| Direct repair of triangular fibrocartilage | 1925 | Gibson A |
| | 1925 | Wilson PD and Cochrane W |
| Tenodesis between distal part of ulna and Carpus | 1939 | Taylor JL |
| | 1944 | Bunnell S |
| | 1970 | Spinner M and Kaplan EB |



Most recent extra-anatomical reconstruction



Chronic instability of the distal radioulnar joint

Adams BD and Lawler E
J Am Acad Orthop Surg. 2007



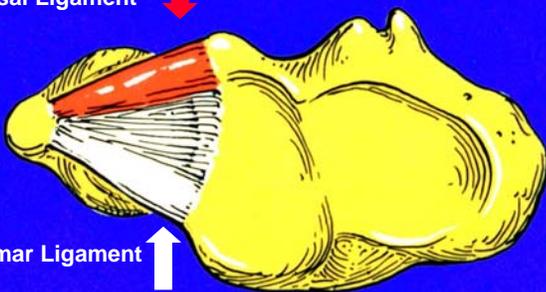
Specimen preparation
Dr. Makoto Tamai
Former Fellow of CMKI

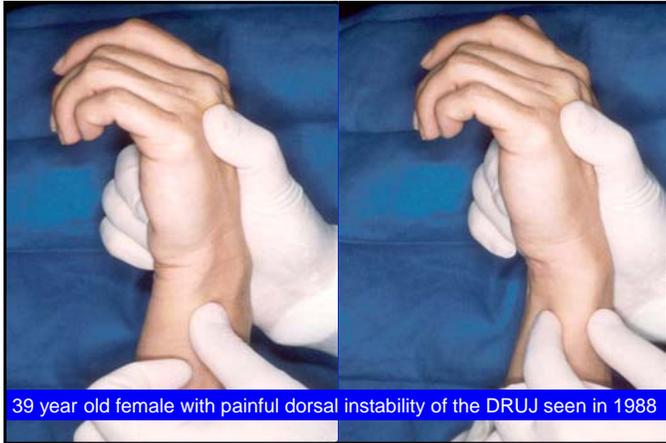
Reconstructed ligaments need to be not longer and running in the same direction as the original

Dorsal Ligament



Palmar Ligament

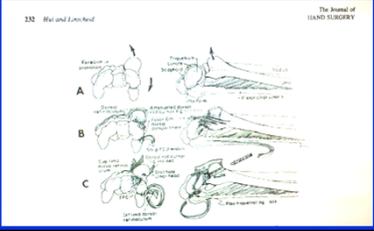


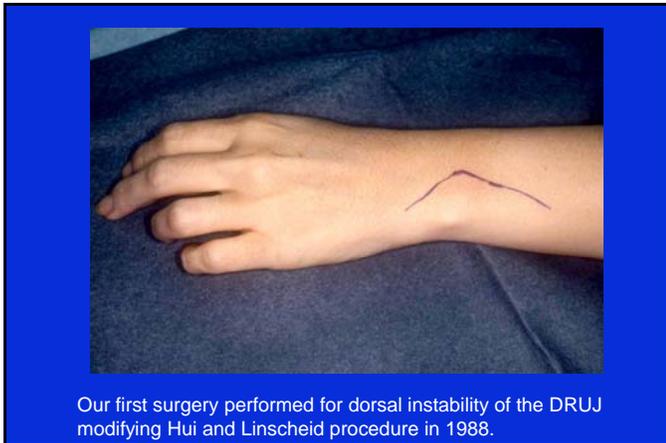


39 year old female with painful dorsal instability of the DRUJ seen in 1988



Ulnotriquetral augmentation tenodesis: A reconstructive Procedure for dorsal subluxation of the distal radioulnar joint
Frank C. Hui, M.D., and Ronald L. Linscheid, M.D.,
Journal of Hand Surgery May 1982





Our first surgery performed for dorsal instability of the DRUJ modifying Hui and Linscheid procedure in 1988.



At four years post op the patient had no pain, full range of motion and Able to lift weights.





Clinical Findings in 31 patients from 1988 to 1991

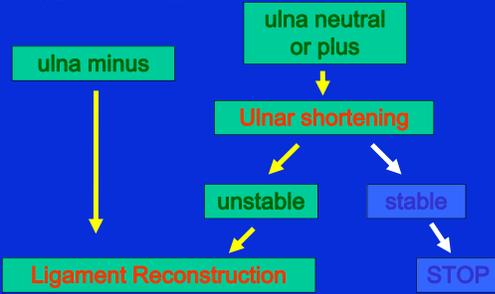
| | |
|--------------|----|
| Pain | 31 |
| Inflammation | 5 |
| Clicking | 4 |
| Paraesthesia | 1 |



The idea is to bring collagen to the damaged ligament while tightening it to its original length

The Unstable DRUJ

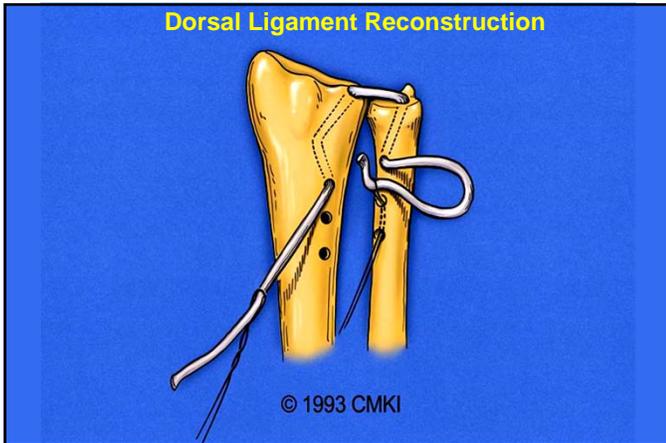
Herbert/Bowers II

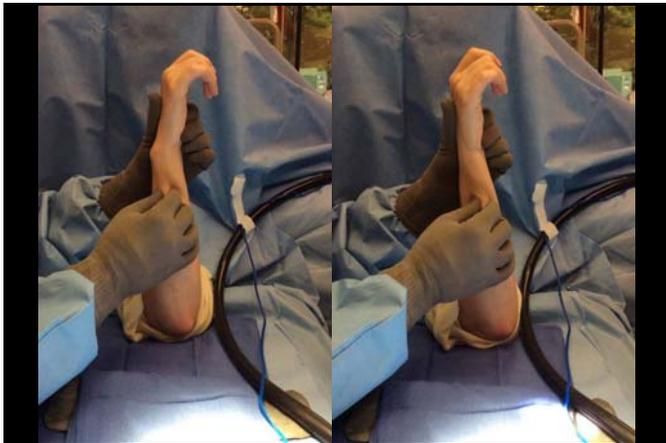


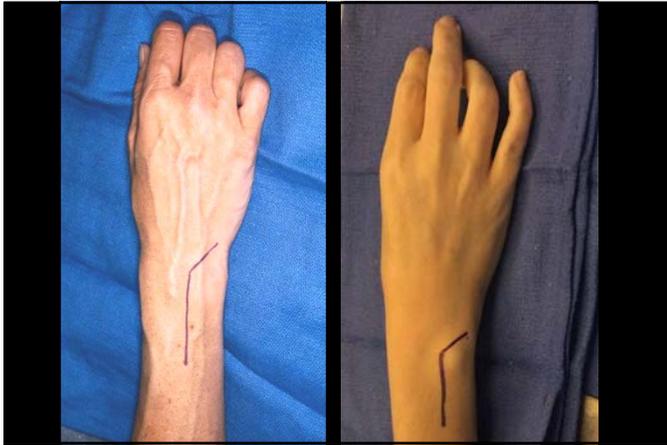
Bowers, WH
Instability of the distal radioulnar articulation. Hand Clin. 1991

Reconstruction of the dorsal ligament of the triangular fibro cartilage









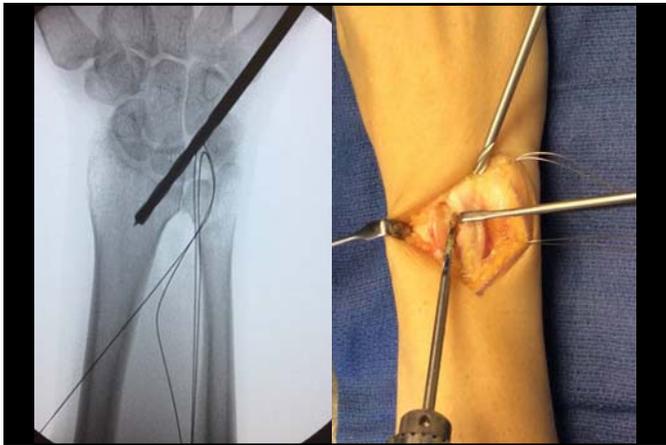


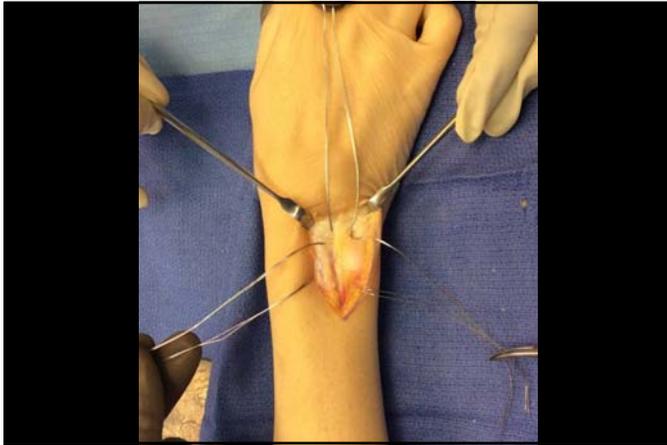






The orientation of the pin is Dorso-palmar, ulna-radial and Distal to proximal to accommodate The shape of the distal radius





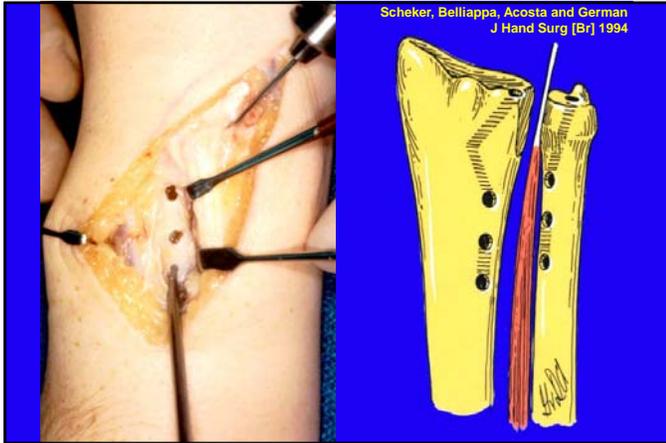


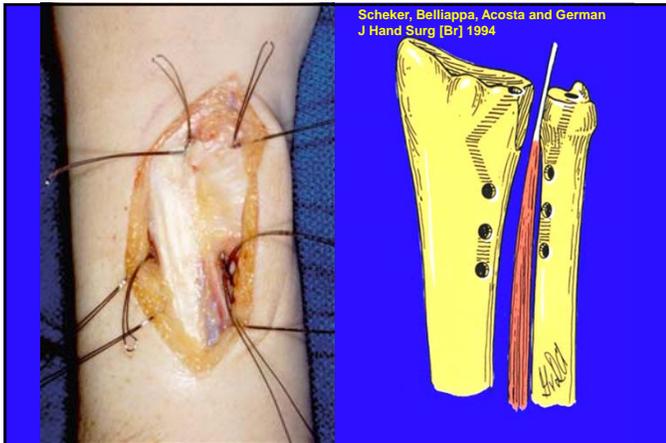




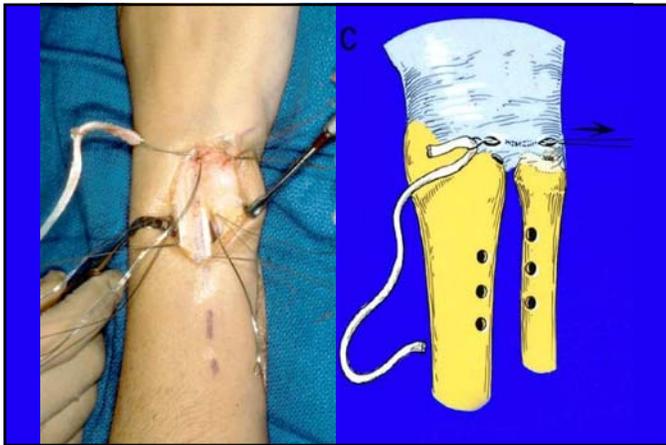


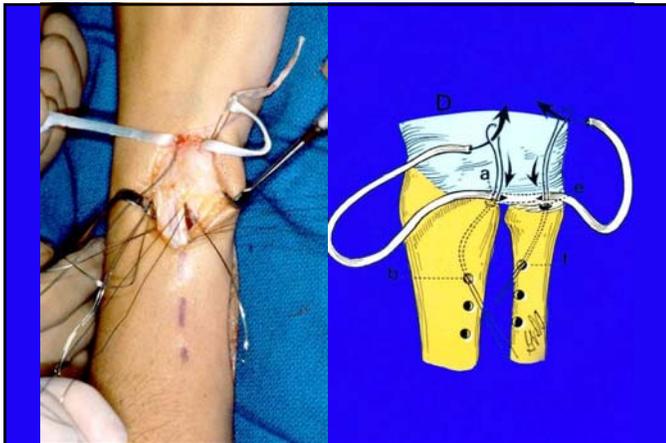


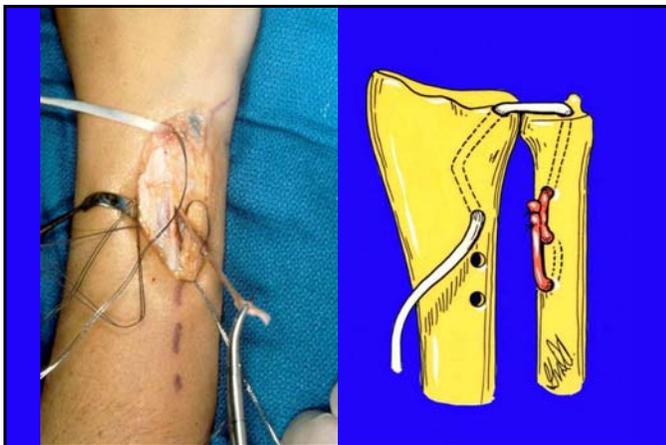


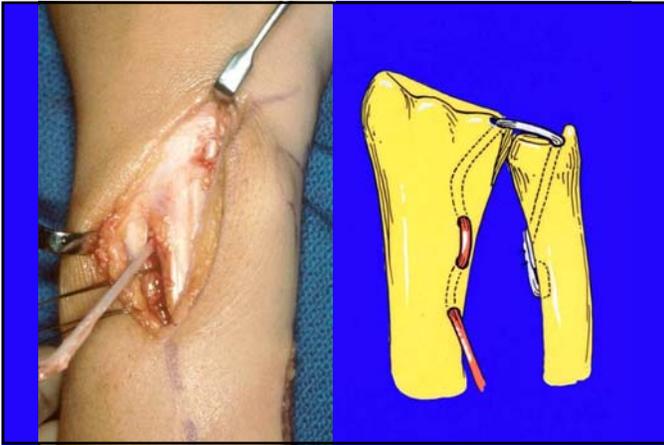


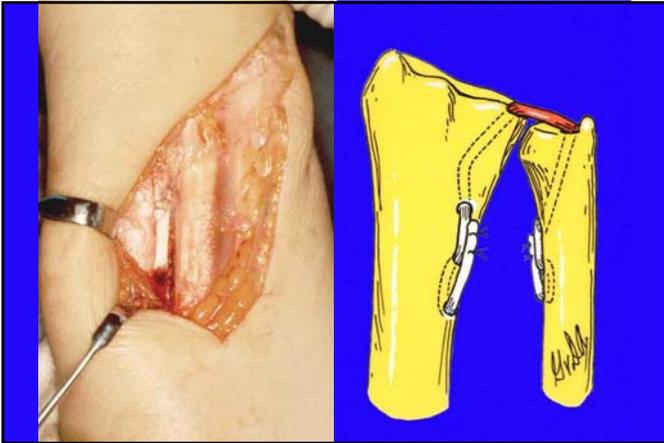






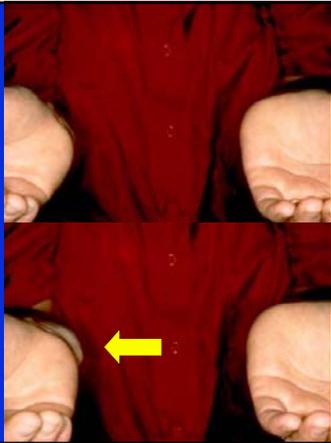






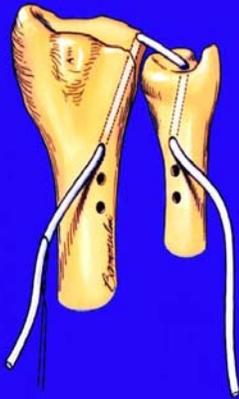


The technique can be adapted for palmar ligament reconstruction or both ligaments together

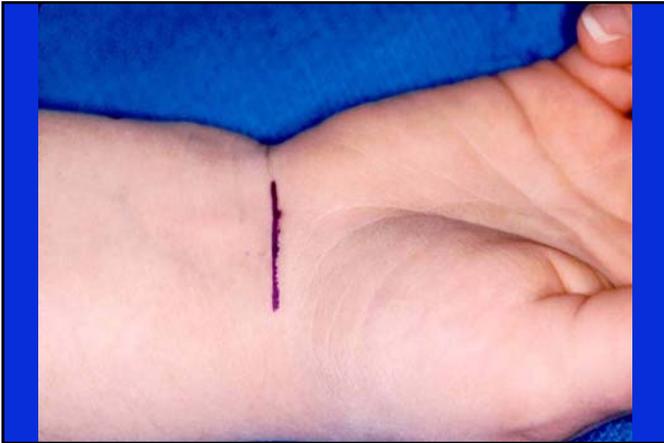


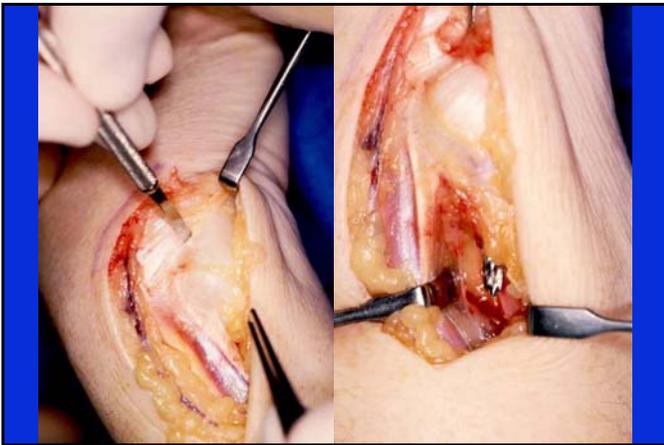


Palmar Ligament Reconstruction



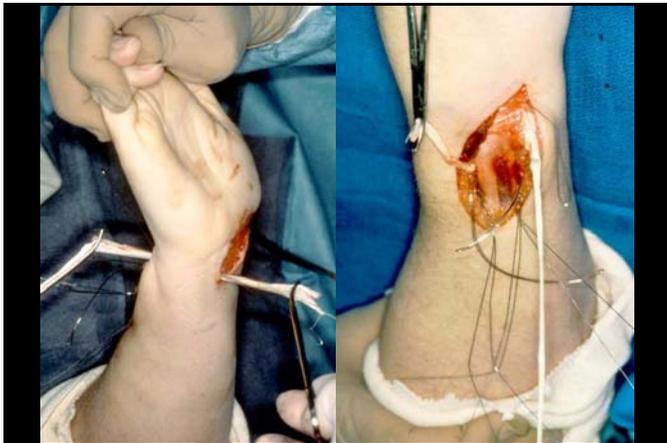










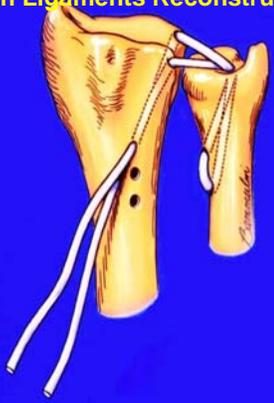






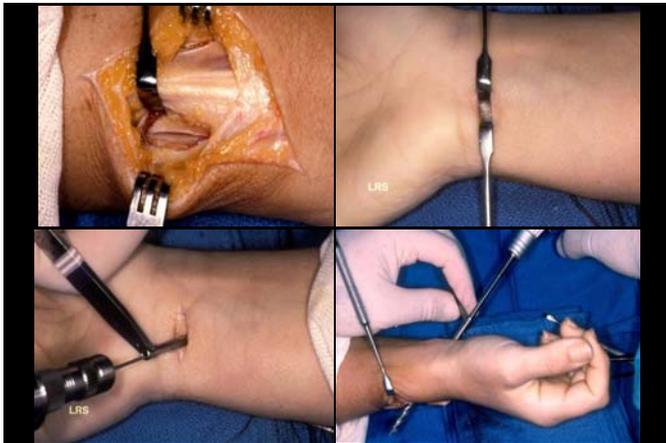


Both Ligaments Reconstruction



25 year old volley ball player with palmar and dorsal instability of the DRUJ.

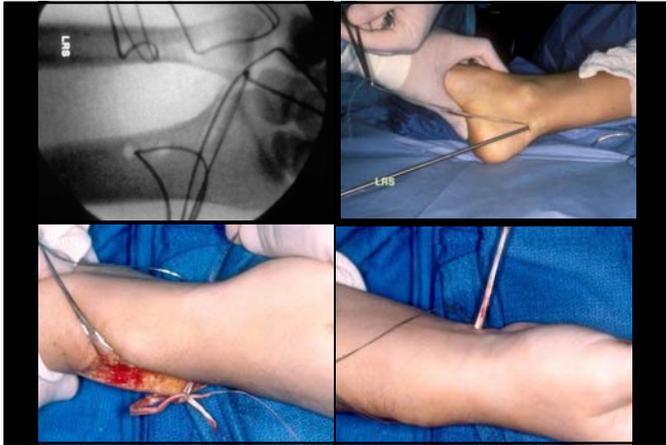


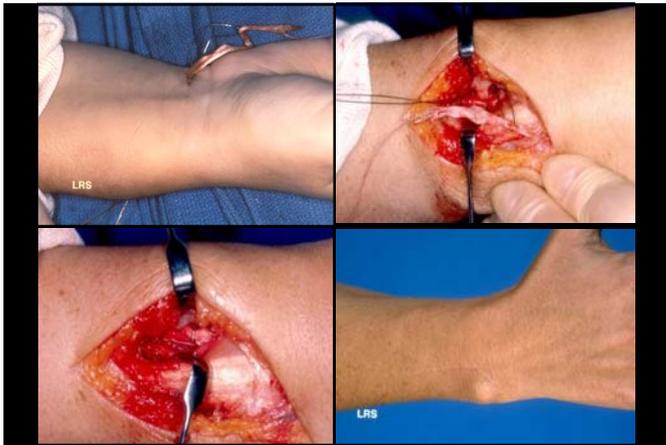








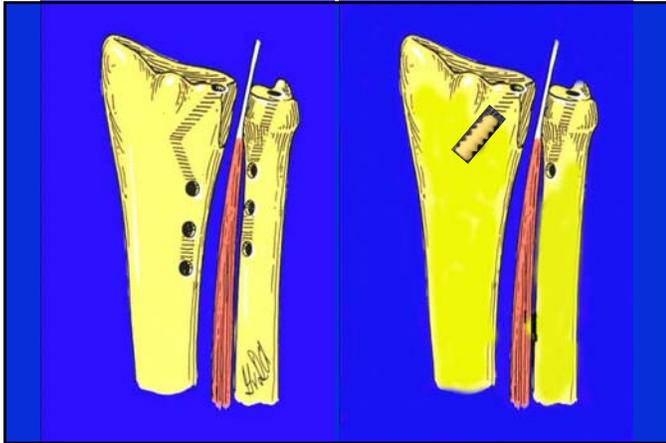


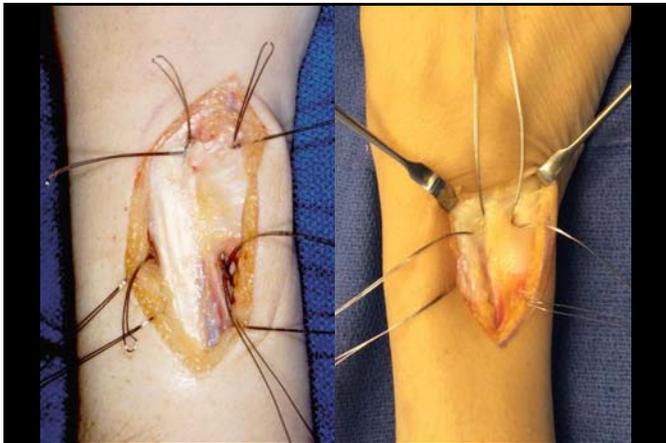






Two years post-operative





Ligaments heal through a distinct sequence of cellular events that occur through three consecutive phases: the acute inflammatory phase, the proliferative or regenerative phase, and the tissue remodeling phase. The whole process can occur over months, and despite advances in therapeutics, many ligaments do not regain their normal tensile strength.

Ligament Injury and Healing: An Overview of Current Clinical Concepts
Ross A. Hauser, MD & Erin E. Dolan, RN
Journal of Prolotherapy. 2011;3(4):836-846

Lundborg demonstrated the capacity of tendons to heal if bathed by synovial fluid.

Experimental intrinsic healing of flexor tendons based upon synovial fluid nutrition

G. Lundborg, M.D., Ph.D. F. Rank, M.D.
The journal of hand Surgery
January 1978,

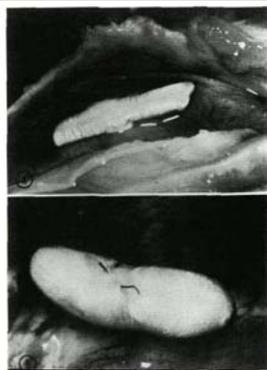
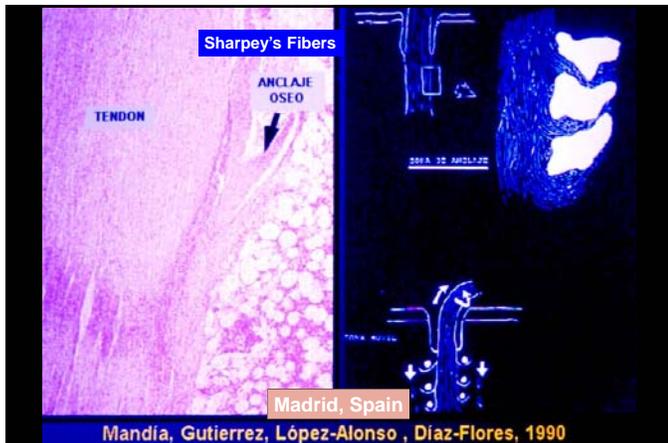


Fig. 4: Photograph of segment of rabbit flexor tendon placed in the synovial cavity of the knee joint demonstrating evidence of healing at both one week (top) and 3 weeks (bottom). (Reprinted by permission from Lundborg: *J Hand Surg* 3:21-31.)



RECONSTRUCTION OF THE DORSAL LIGAMENT OF THE TRIANGULAR FIBROCARILAGE COMPLEX

L. R. SCHEKER, P. P. BELLAPPA, R. ACOSTA and D. S. GERMAN

From the Christine M. Kleiwert Institute for Hand and Micro Surgery and the University of Louisville School of Medicine, Louisville, Kentucky, USA

The distal radio-ulnar ligaments (DRUL) are key components of the triangular fibrocartilage complex (TFCC). The dorsal DRUL tightens during pronation of the forearm and helps to stabilize this motion. 12 women and three men at our clinic have been treated for DRUJ instability secondary to dorsal DRUL rupture or attenuation. Their chief complaint was pain. The dorsal DRUL was reconstructed using a tendon graft, the ends of which were anchored in the bone of the radius and ulna. This technique has been shown to correct dynamic DRUJ instability in carefully selected patients, decreasing or eliminating pain and restoring normal function.

Journal of Hand Surgery (British and European Volume, 1994) 19B: 310-318

The technique can easily be adapted in palmar instability to follow the course of the palmar ligament, with an identical dissection except for the addition of a palmar approach to the palmar lip of the sigmoid notch, as was done in one patient of this series. The selection process, however, must exclude patients with ulnar impaction, positive ulnar variance, and DRUJ arthritis. In patients with DRUJ instability and positive ulnar variance, shortening of the ulna is undertaken first. DRUJ stability is then tested intra-operatively, and ligamentous reconstruction can be done in the same operation if necessary.

Thank you for your attention !!
