# TFCC Tears and Repair

Jeffrey Yao, M.D.
Associate Professor
Department of Orthopaedic Surgery
Stanford University Medical Center

STANFORD SCHOOL OF MEDICINE

STANFORD ORTHOPAEDIC SURGERY

# Disclosures

- The following relationships exist:

1. Grants

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2. Royalties and stock options

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3. Consulting income

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4. Research and educational support

   Arthrex

5. Editorial Honoraria

   Elsevier, Lippincott

6. Speakers Bureaus

   Arthrex, Trimed

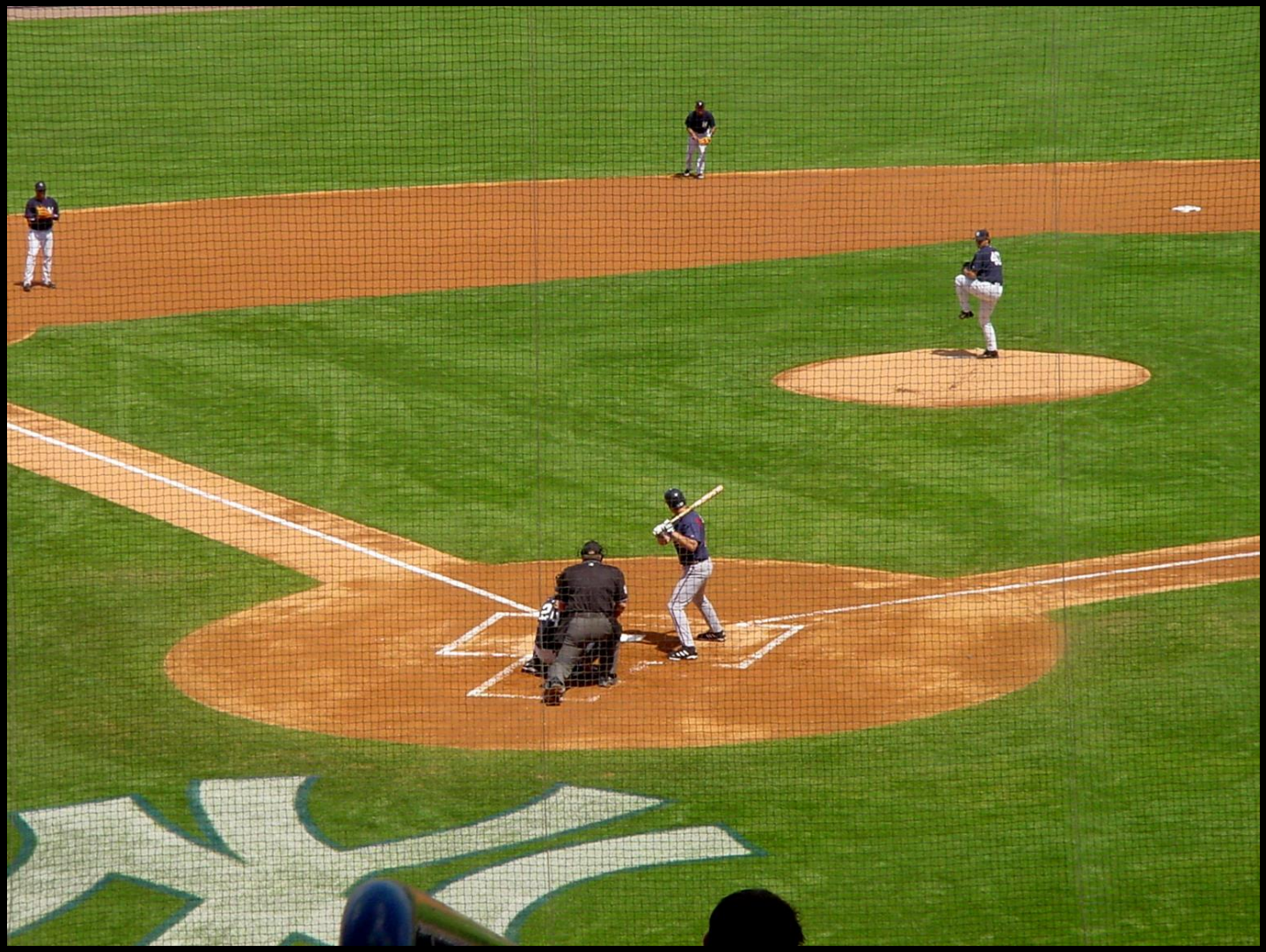
# Introduction

- Tears of the TFCC are a common cause of ulnar-sided wrist pain
- Traumatic tears usually occur with an extension and pronation force to an axially loaded wrist
- Patients typically have pain with ulnar deviation and rotation of the wrist

# Functions of DRUJ

- Distal link between radius and ulna
- Allows radius and attached carpus to pivot smoothly around ulna
- TFCC
  - major stabilizer of the DRUJ
  - provides suspensory mechanism for ulnar carpus
  - central articular disk is the load-bearing component of TFCC
  - allows transmission of axial load from carpus to forearm

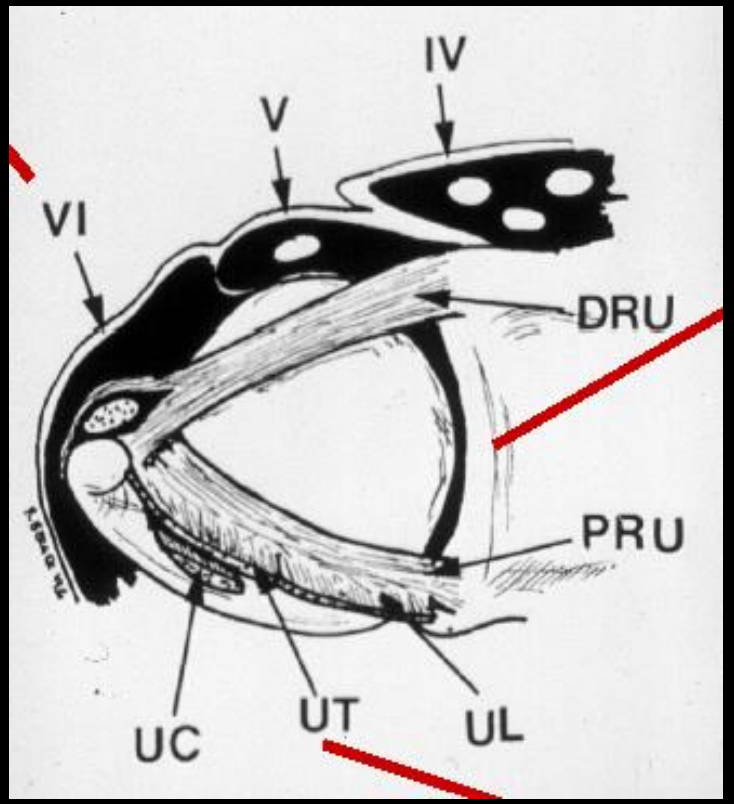
# Anatomy - The TFCC



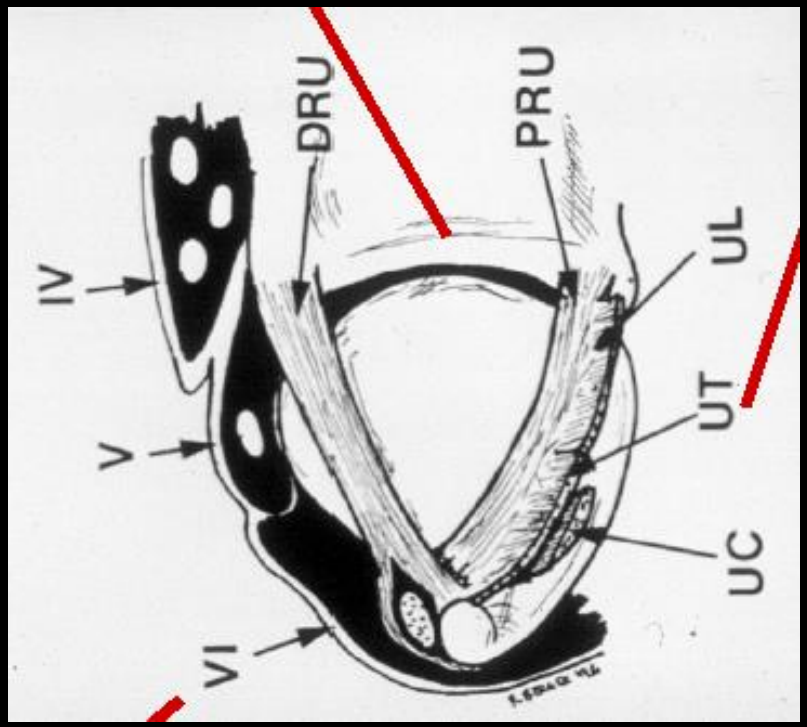
Thanks to Rebecca Yu, MD

# Anatomy - Soft Tissue

- TFCC (Triangular Fibrocartilage Complex)
  - Distal radioulnar ligaments
    - Palmar
    - Dorsal
  - Articular Disk
  - ECU Subsheath
  - Meniscal homologue
  - Ulnar collateral ligament
  - Ulnar extrinsic ligaments

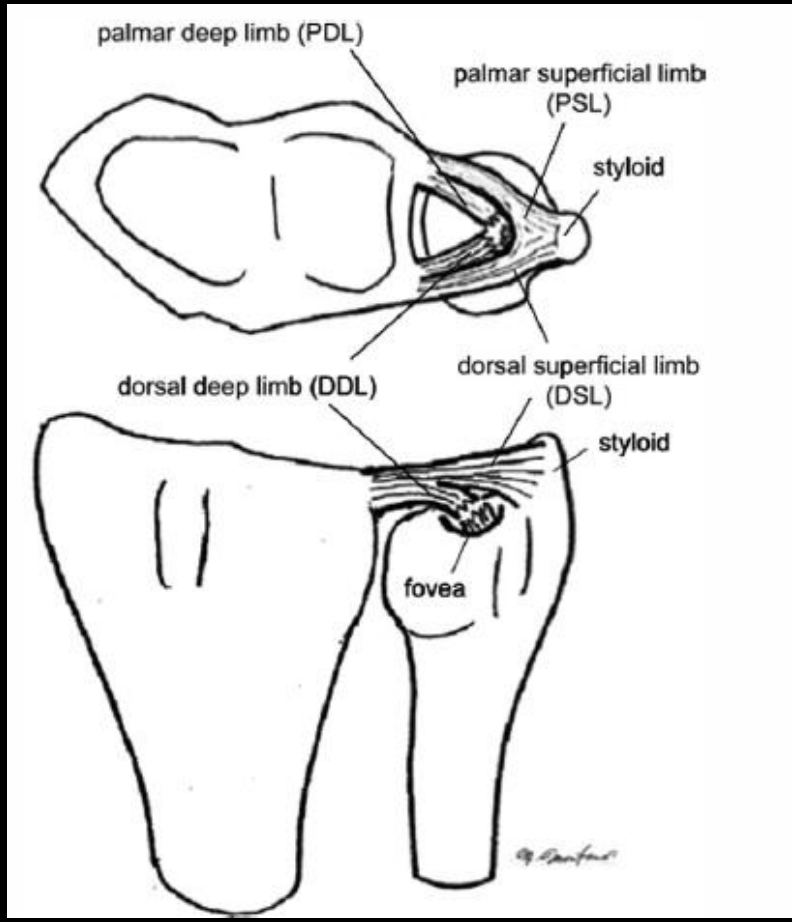


# Anatomy of the TFCC



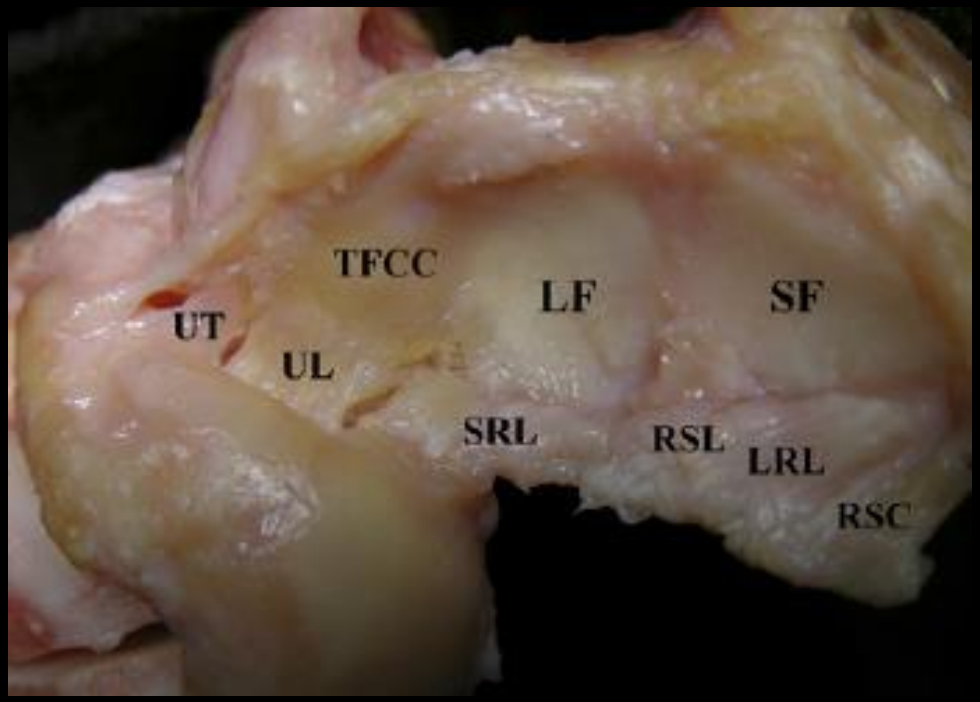

# Anatomy of the TFCC

- Dorsal and palmar radioulnar ligaments
  - Ulna fovea to palmar and dorsal margins of sigmoid notch
  - Ligamentum subcruentum: deep and strong vertical foveal insertion



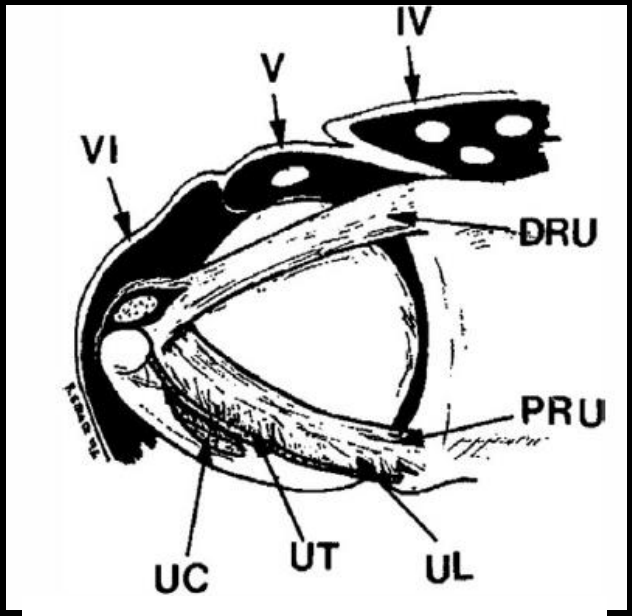
# Anatomy of the TFCC

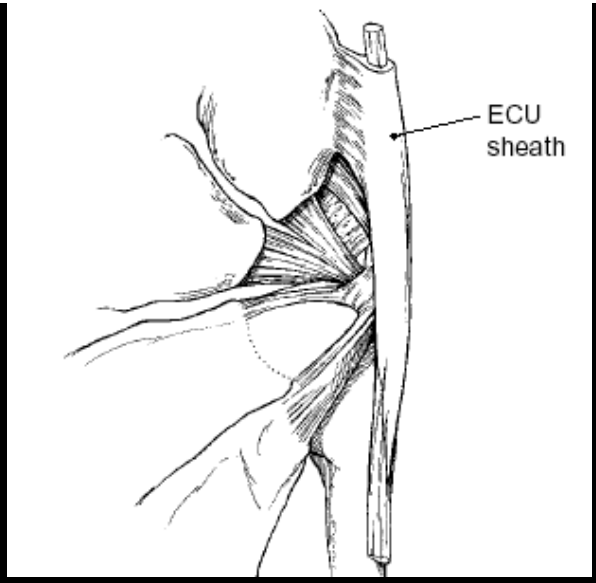
- Fibrocartilaginous articular disk
  - Load transmission
  - Transitions to hyaline cartilage radially, does not insert into distal sigmoid notch



# Anatomy of the TFCC

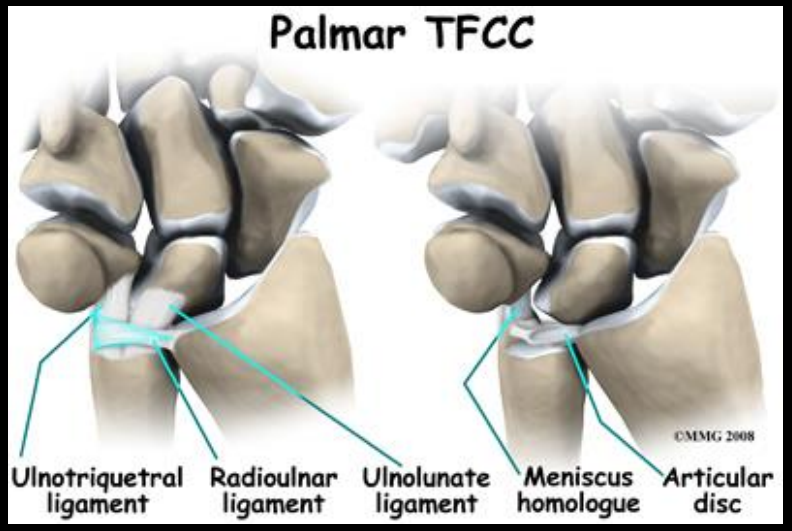
- ECU sheath
  - Arises from dorsal fovea
  - Distal radioulnar ligament splits to form the ECU tendon sheath

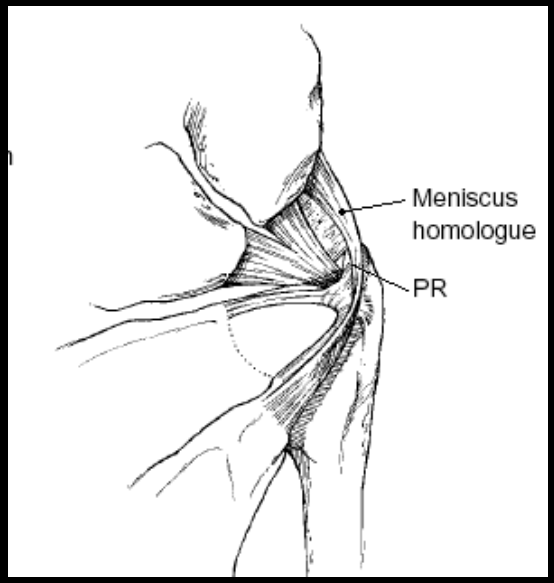


# Anatomy of the TFCC

- Meniscal homologue
  - Ulnar leash of tissue sweeps distally from surface of articular disk to the triquetrum (90%) or triquetrum + lunate (10%)



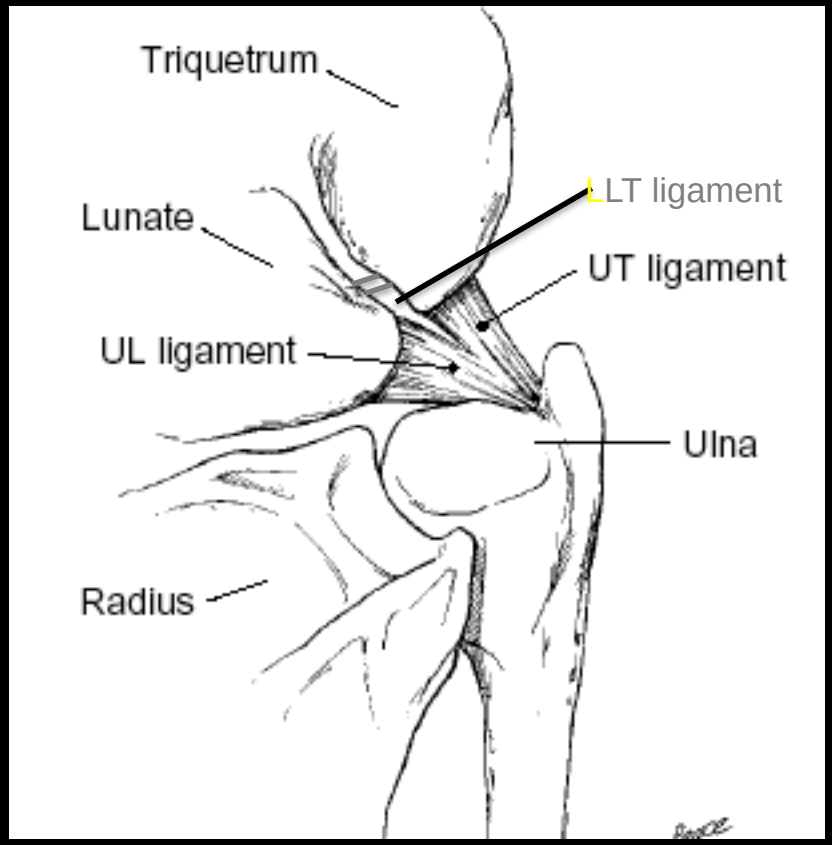



# Anatomy of the TFCC

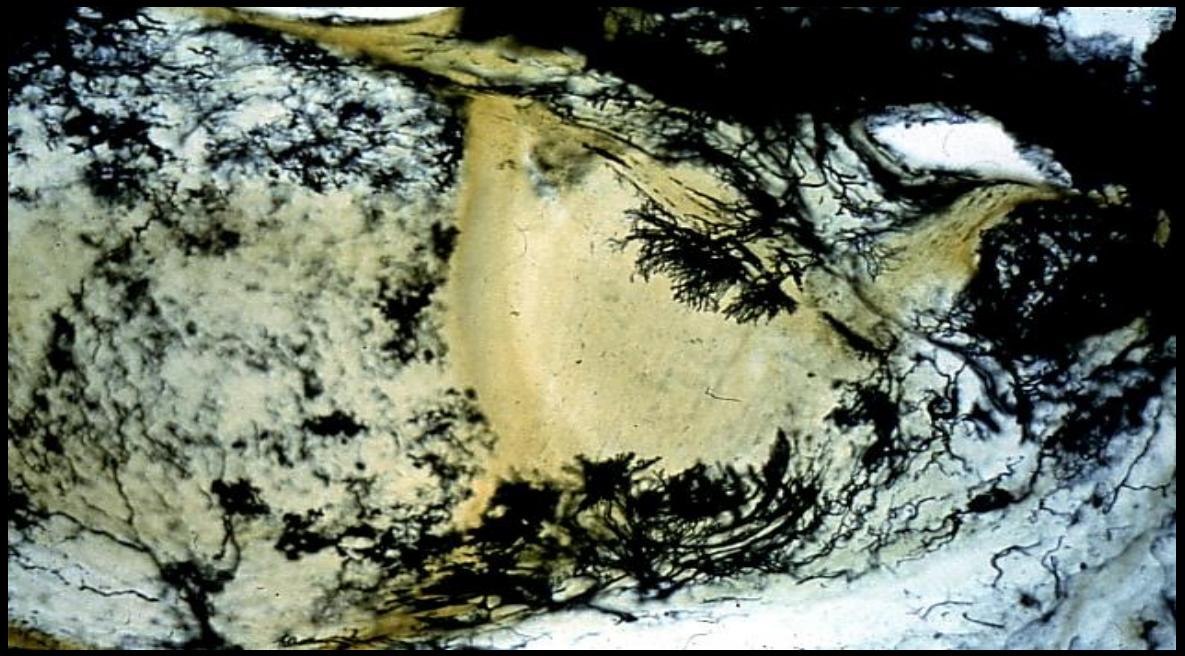
- Ulnar Collateral Ligament
  - loose fibers passing from tip of ulnar styloid to triquetrum, pisiform, and articular disk
  - Resists radial deviation

# Anatomy of the TFCC

- Ulnar extrinsic ligaments and LTIL



# Anatomy - Blood Supply



Only peripheral 10-30% has a blood supply

Bednar, Arnoczky, Weiland, JHS 1991

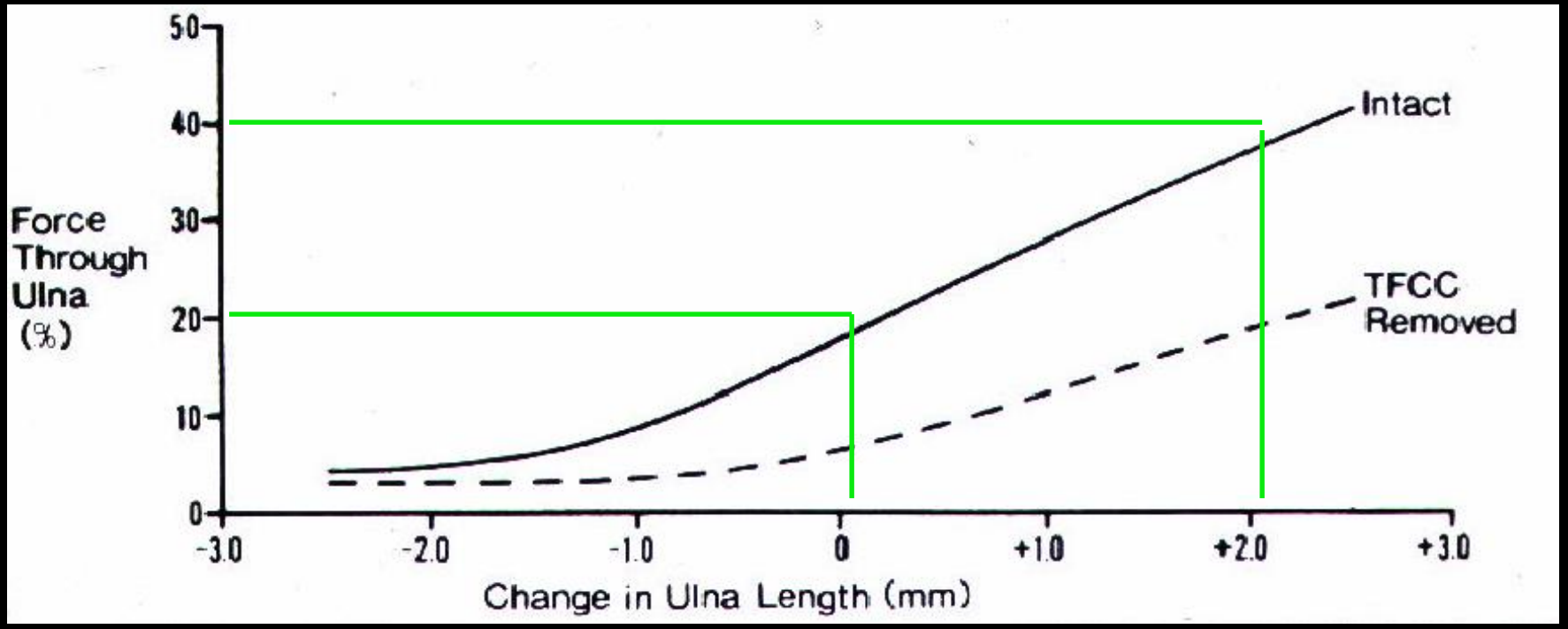
# Biomechanics

- Force Transmission
  - Typically 80% of compressive force from the wrist is borne through distal radius
    - 20% through ulna

# Biomechanics

Force transmission changes with ulnar variance

+2 mm ulnar variance results in increase to 40% through ulna



# Clinical Evaluation

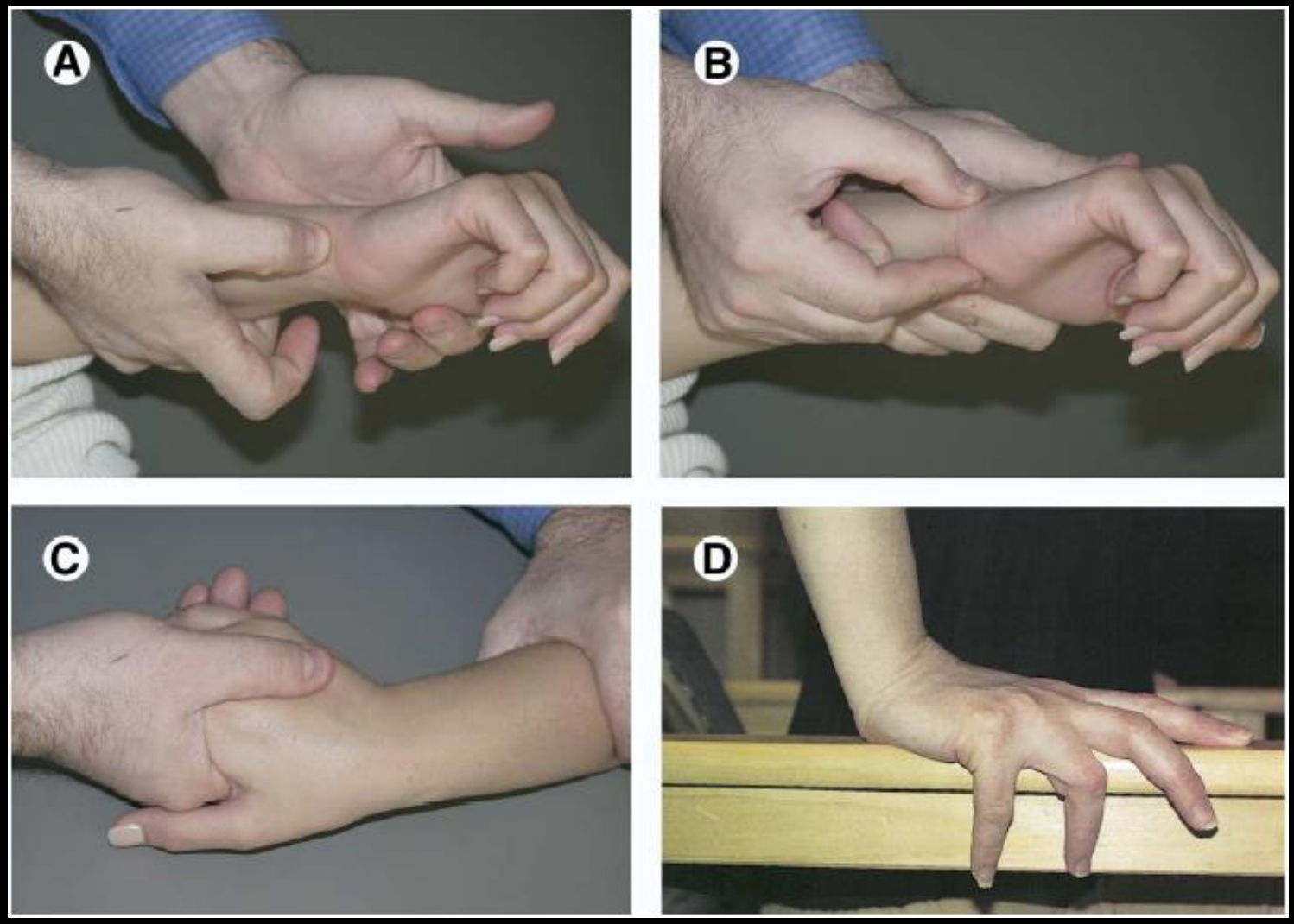
# Clinical Evaluation - History

- Fall on an axially loaded pronated wrist
- Pain with forced pronation or supination
- Pain with gripping in ulnar deviation

# Clinical Evaluation- Physical Exam

- Fovea sign
  - Focal tenderness to palpation at ulnar styloid base
- TFCC stress test
  - Axial load, ulnar deviation, rotation
- Test for DRUJ stability (piano key & shuck test) in all positions - neutral, pronation & supination

# Examination

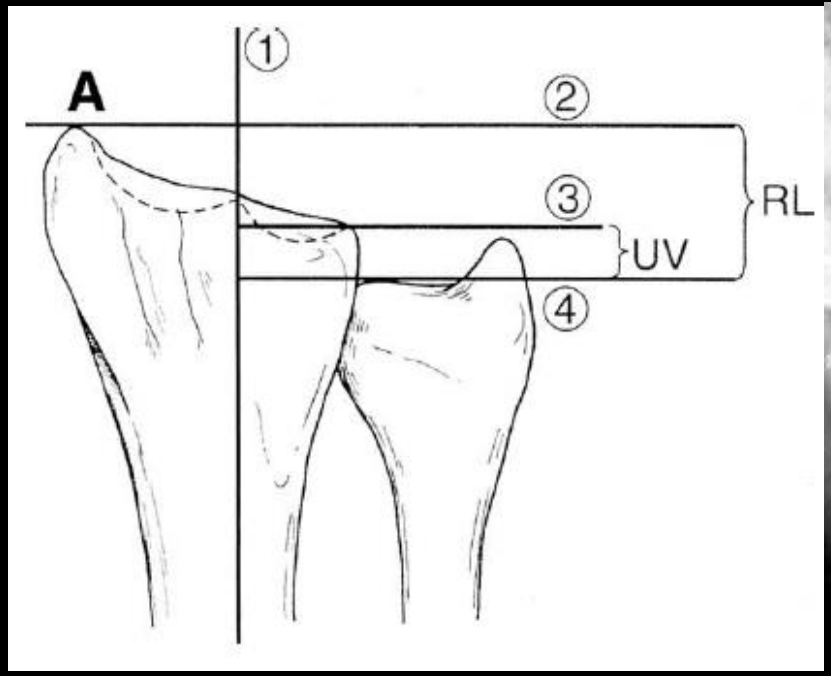


# Imaging

- Standard Radiographs
- “Zero Degree - PA”
  - Elbow flexed to 90°
  - Shoulder abducted to 90°
  - Hand flat on X-ray cassette
  - Standard for measuring ulnar variance

# Imaging

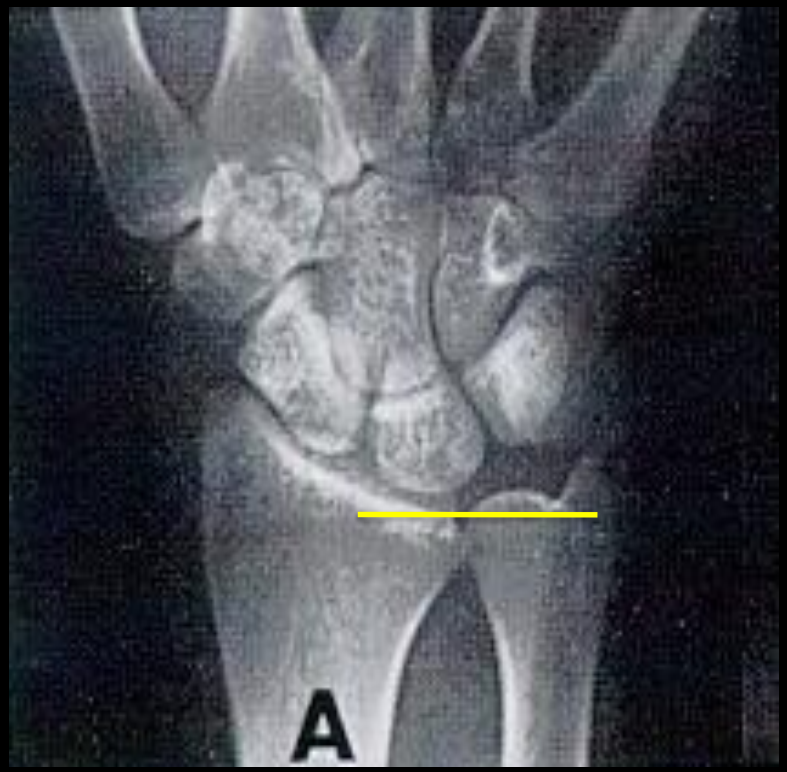
- Ulnar Variance



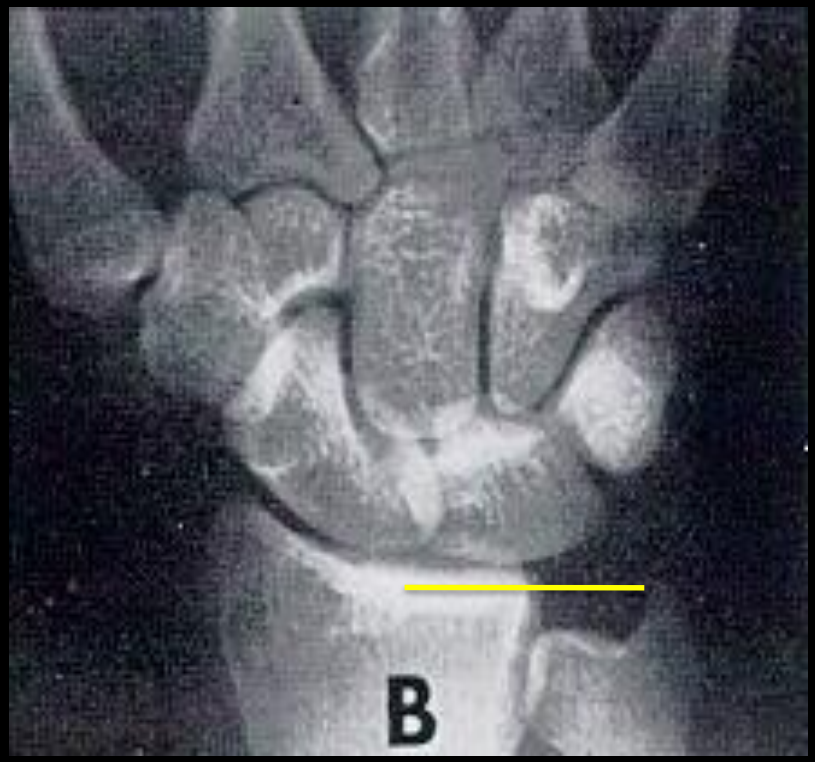

PA

# Ulnar Variance

Ulnar Positive Variance

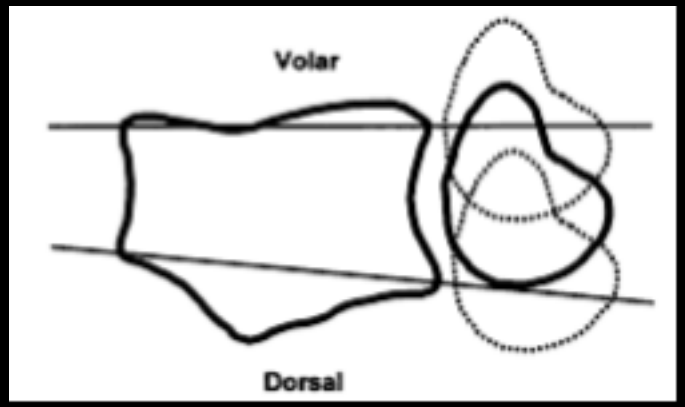


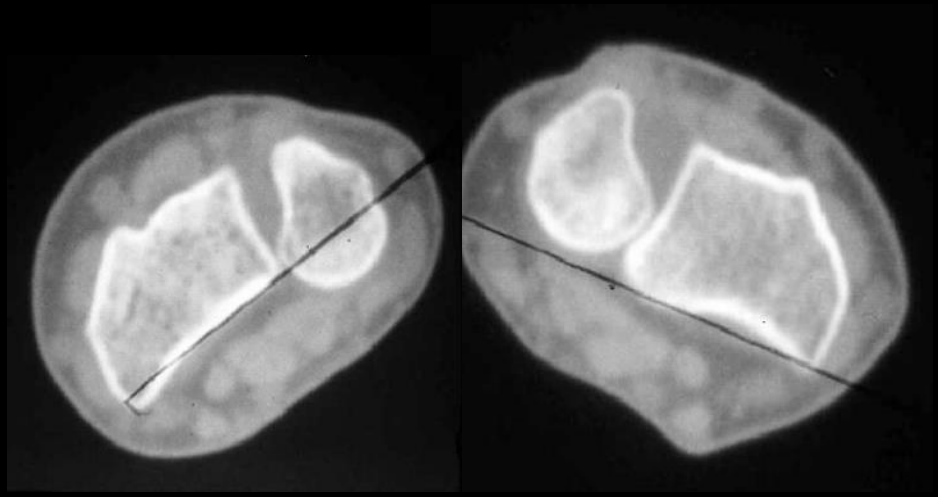

Ulnar Negative Variance



# Imaging - CT

- Visualizes:
  - Sigmoid notch depth
  - Congruency of ulnar head
  - Arthritic changes
- Both wrists should be scanned in
  - Pronation
  - Neutral
  - Supination



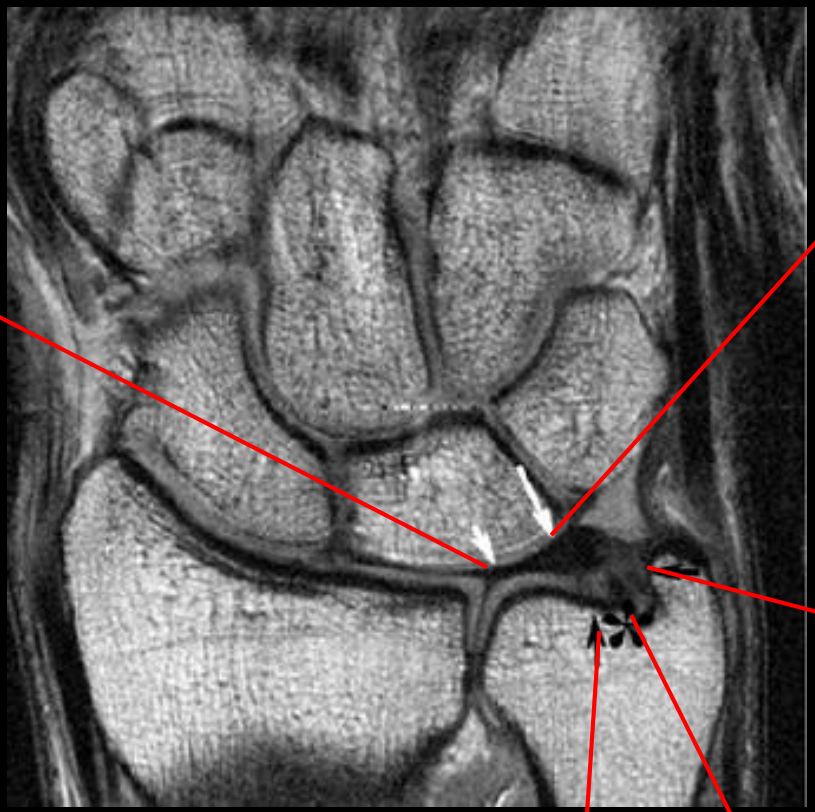



# Imaging - Arthrography

- Triple injection (DRUJ, radiocarpal and midcarpal)
- Useful for evaluating TFCC, SL and LT
  - Specific patterns of leakage observed with specific injuries
- Seldom performed
  - Many asymptomatic patients found to have degenerative tears
    - 42% sensitivity
    - 20% specificity

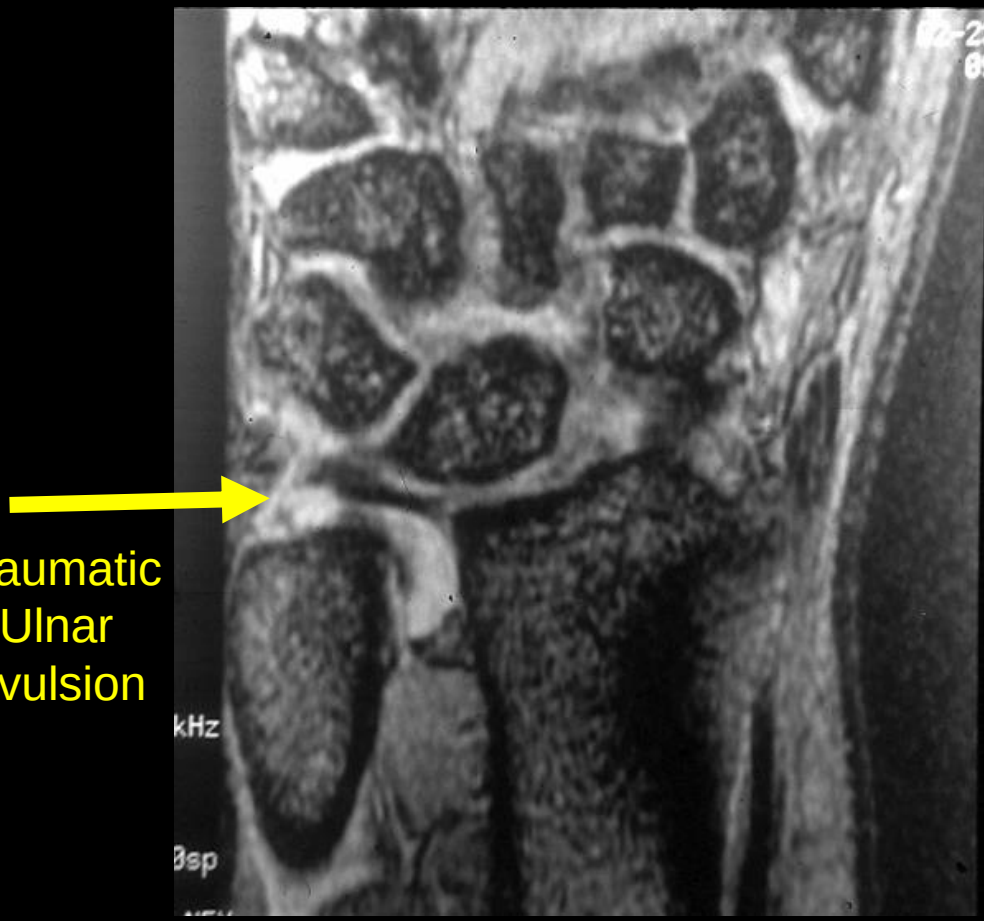

Chung KC, JHS 1996

# Imaging - MRI


Radial attachment of articular disk at sigmoid notch
Articular disk
Styloid insertion
Foveal insertion
Ligamentum subcruentum

# Imaging - MRI

- ± MR Arthrography (Intra-articular injection)
- ± Indirect MR Arthrography (IV contrast)
- 1.5T: 85% sensitive
- 3.0T: 94% sensitive

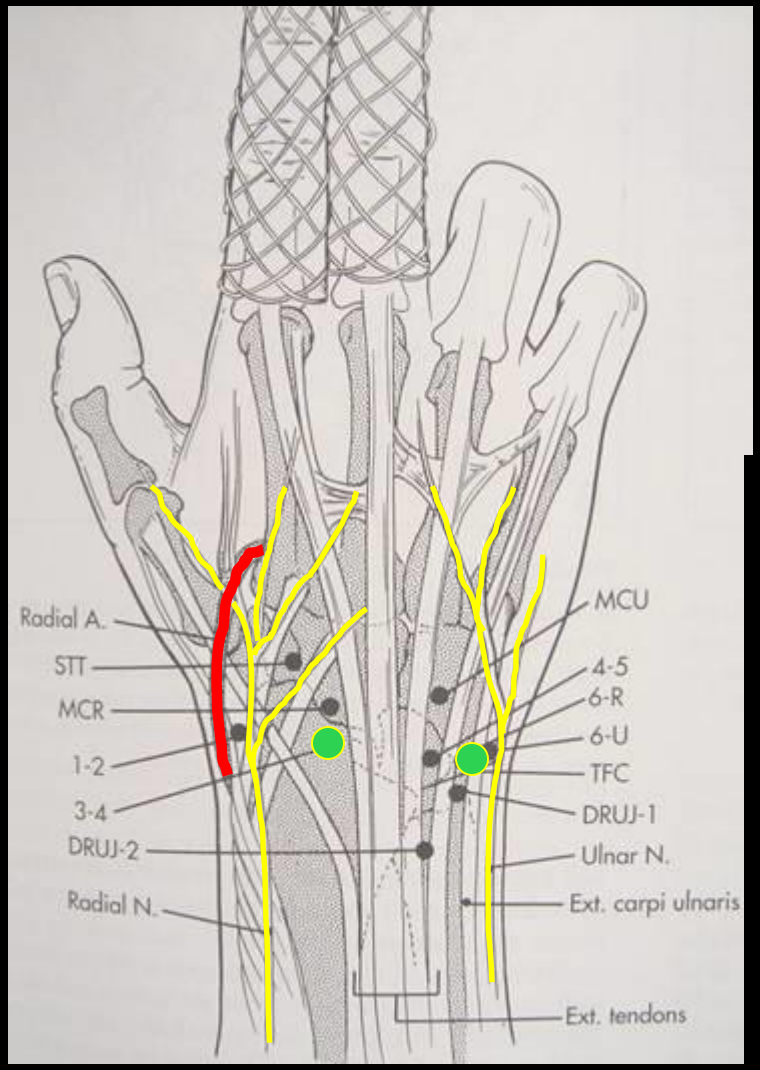


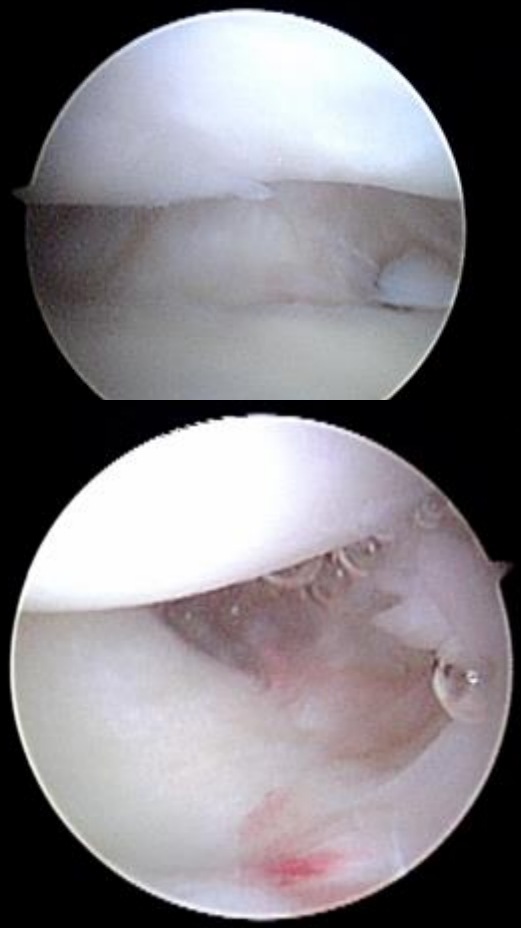

Anderson et al JHS 2008, Faber et al JHS 2010

# Imaging - Arthroscopy

- Gold Standard
- Diagnostic as well as therapeutic
- Can detect TFCC tears as well as other pathology
  - chondral lesions
  - other ligamentous injuries
- TFCC Tears:
  - Loss of resiliency to probing (Trampoline test)
  - Indirect visualization of a peripheral tear
    - Hyperemia along periphery
    - Tears of LT ligament
    - ECU sheath injury

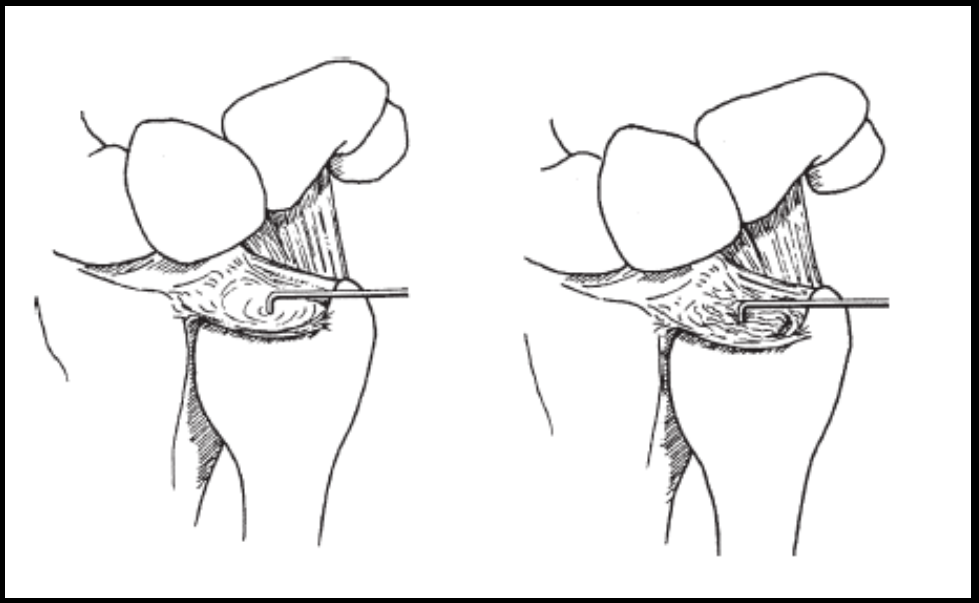
# Imaging - Arthroscopy



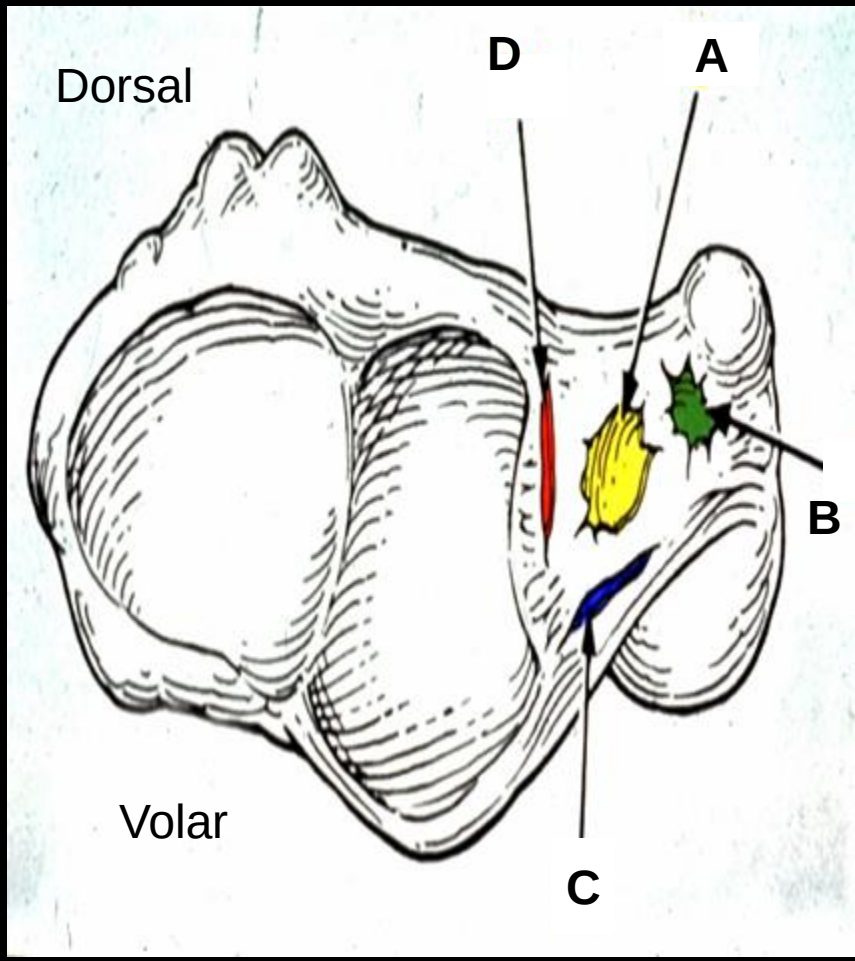
# Imaging - Arthroscopy

- Trampoline Test
  - Ballottment of articular disk



# TFCC Tears

- Classification of TFCC tears
  - Palmer, 1989
  - Traumatic
    - IA – central perforation - DEBRIDE
    - **IB - ulnar/peripheral avulsion - REPAIR**
    - IC – distal/volar avulsion - DEBRIDE
    - ID – radial avulsion - DEBRIDE
  - Degenerative



# TFCC Tears

- Can result in isolated ulnar sided wrist pain as well as DRUJ instability
- Mechanism of injury:
  - Extension with pronation to axially loaded wrist
  - Can also occur with hypersupination
- More common in patients who are ulnar positive or neutral
  - Ulnar negative patients have thicker articular disks

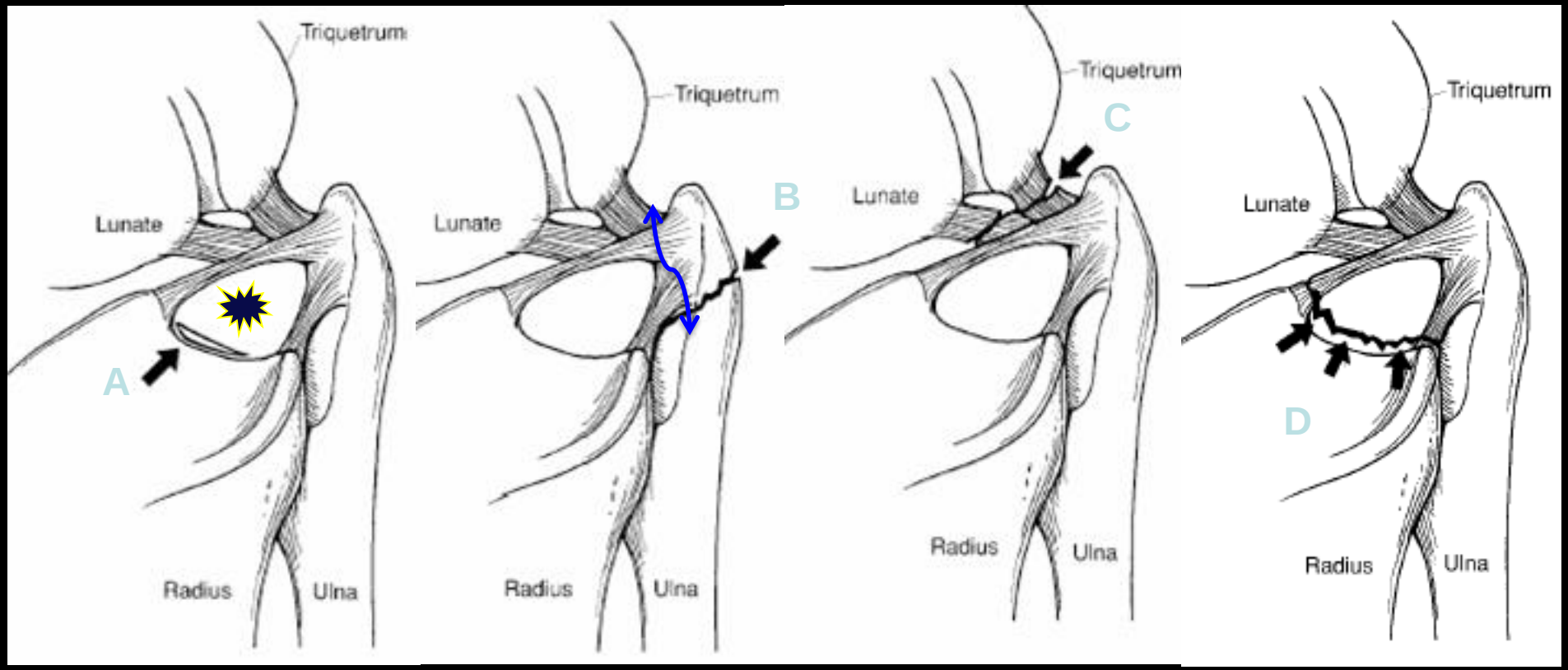
# TFCC Classification

**Palmer's Classification of TFCC Injuries**[3*]

Class 1: Traumatic
- Type A: Central perforation
- Type B: Medial avulsion (ulnar attachment)
  - With distal ulnar fracture
  - Without distal ulnar fracture
- Type C: Distal avulsion (carpal attachment)
- Type D: Lateral avulsion (radial attachment)
  - With sigmoid-notch fracture
  - Without sigmoid-notch fracture

Class 2: Degenerative (ulnocarpal impaction syndrome)
- Stage A: TFCC wear
- Stage B: TFCC wear with lunate and/or ulnar chondromalacia
- Stage C: TFCC perforation with lunate and/or ulnar chondromalacia
- Stage D: TFCC perforation with lunate and/or ulnar chondromalacia and lunotriquetral-ligament perforation
- Stage E: TFCC perforation with lunate and/or ulnar chondromalacia, lunotriquetral-ligament perforation, and ulnocarpal arthritis

*Adapted with permission from Palmer AK: Triangular fibrocartilage complex lesions: A classification. *J Hand Surg [Am]* 1989;14:594-606.

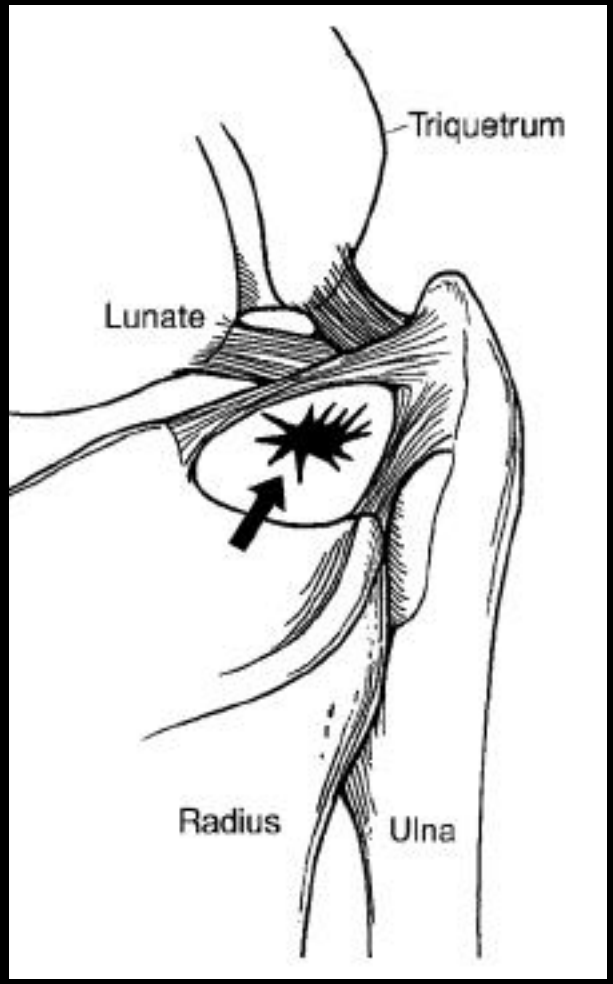

Triquetrum
Lunate
A
Radius
Ulna
Triquetrum
Lunate
B
Radius
Ulna
Triquetrum
C
Lunate
Radius
Ulna
Triquetrum
Lunate
D
Radius
Ulna

# TFCC Treatment

- History, clinical findings, and studies are all used to formulate a plan
- Non-operative management is the initial treatment
  - Unless there is gross instability
  - Immobilization in for 4-6 weeks may allow healing of a TFCC tear
    - 57% versus 43%
    - Acute peripheral tears would be expected to heal given their vascularity
- Otherwise, surgical intervention
  - Debridement vs repair
  - Based on location of tear

# Palmer 1A Tear

- Central tear
- Unlikely to heal (avascular)
- May be debrided
  - up to 2/3 of disk without affecting load transfer
- Typically ulnar positive variance:
  - Consider ulnar recession (wafer) or shortening osteotomy

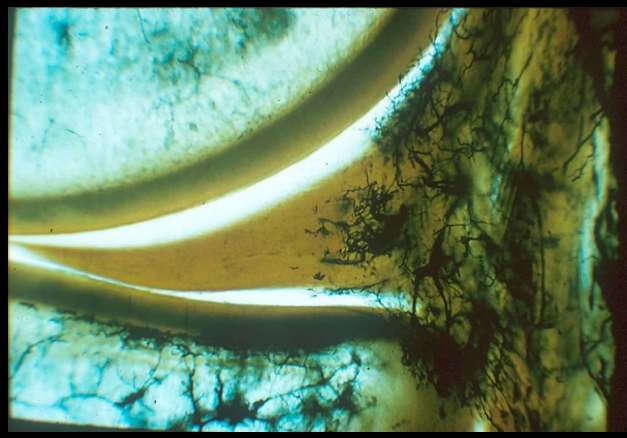


# Palmer 1C Tear

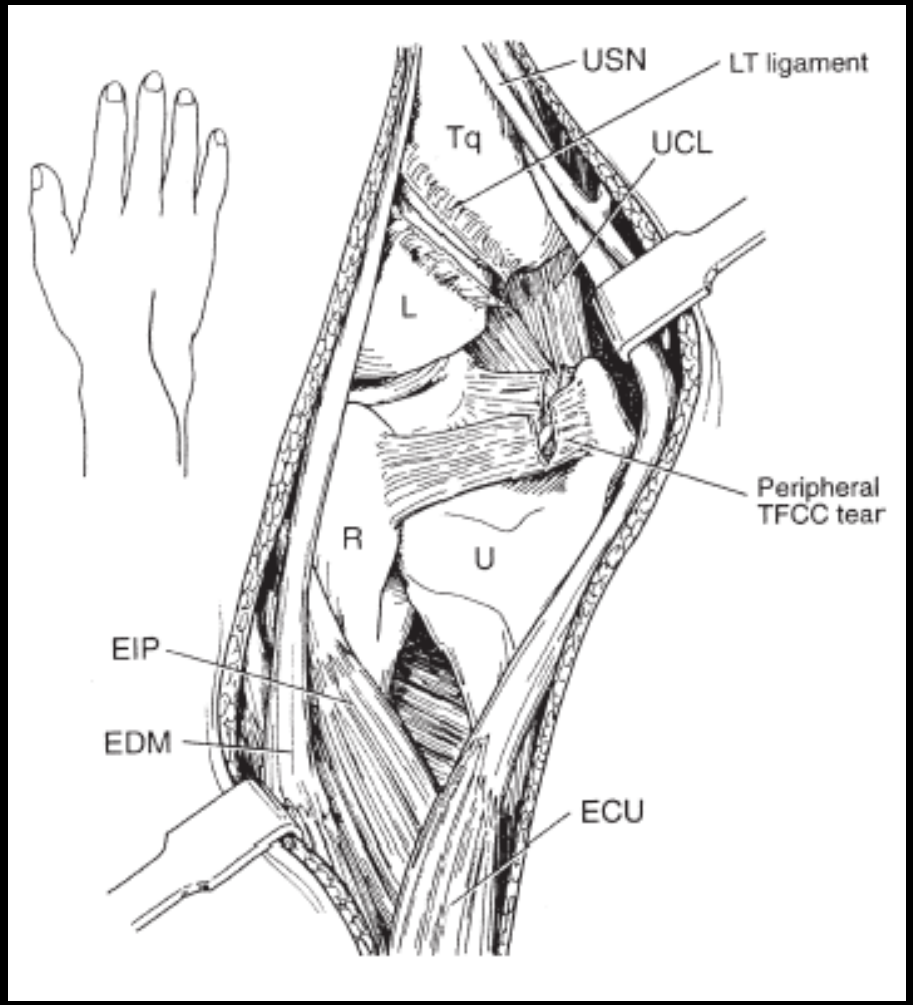
- Usually treated non-operatively or with debridement
- If repair is necessary be mindful of ulnar artery and nerve in region whether repairing through scope or open

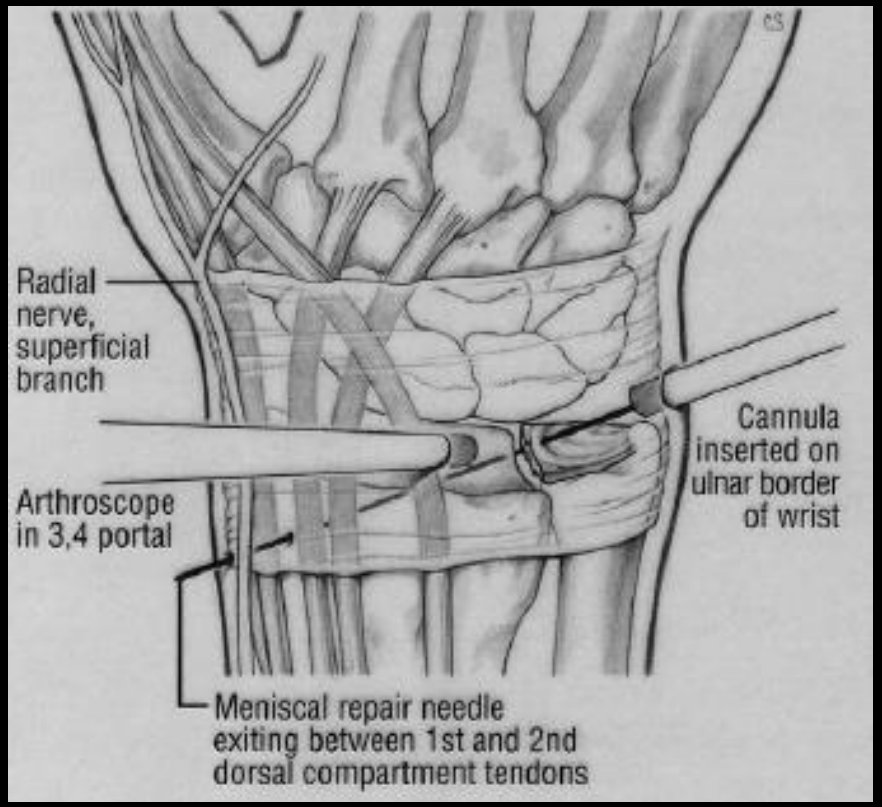
# Palmer 1D Tear

- Controversial
- Little if any vascularity to area
- Open and arthroscopic(difficult) treatments report good outcomes
  - Scope:
    - Meniscal repair sutures used
    - Exit between 1st and 2nd wrist extensor compartments
      (radial sensory nerve)
  - Open :
    - Dorsal approach between 5th and 6th extensor compartments
- Simple debridement has satisfactory results

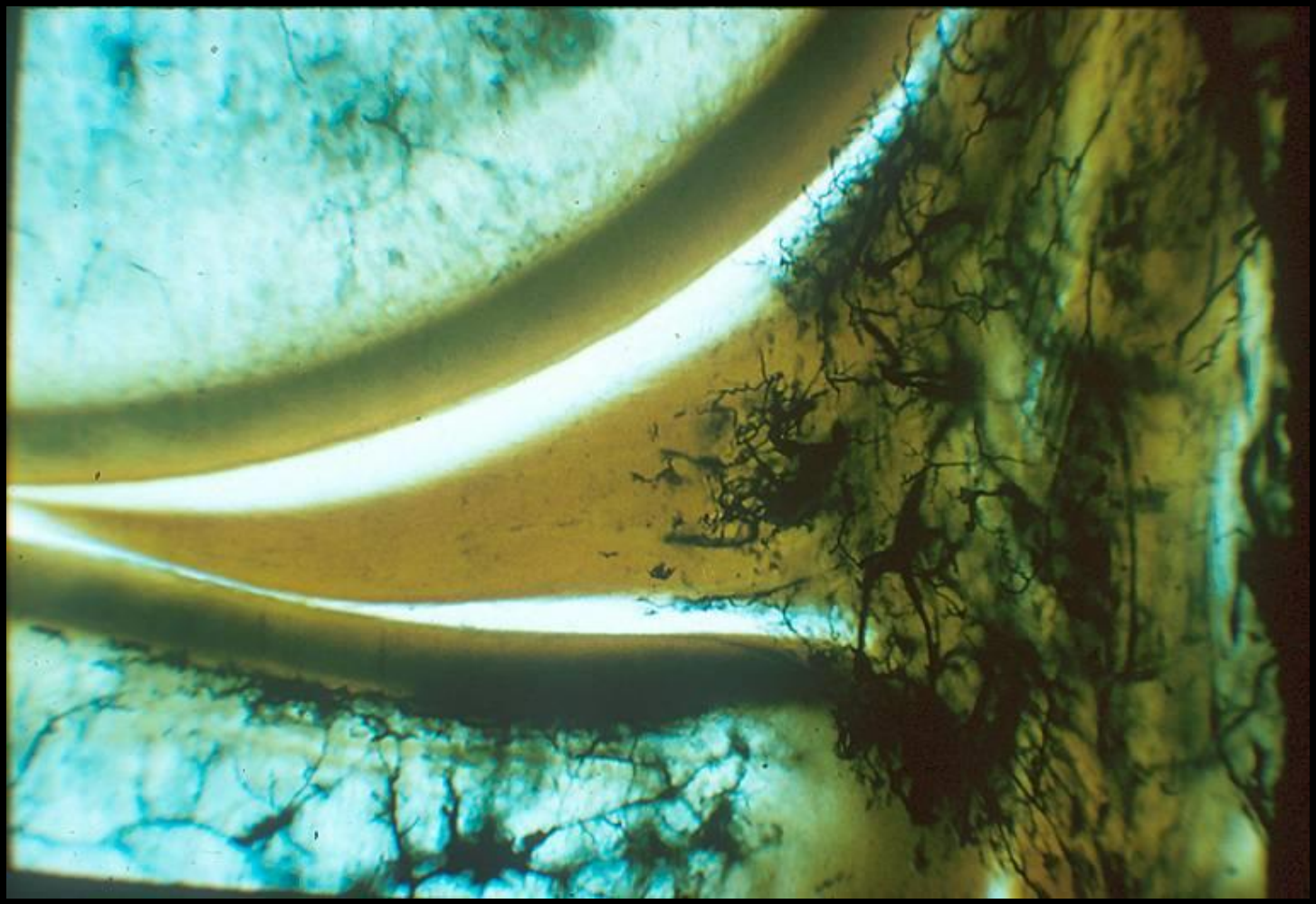


# Palmer 1D Repair



# Palmer 1B (Peripheral) Tear



# Treatment Options for IB Tears

- Conservative
  - If DRUJ is stable
  - Long arm casting x 4-6 weeks
- Surgery
  - Open repair using bone tunnels
  - Mini-open repair using Mitek anchor
    - Chou & Sotereanos (2003)
  - Exogenous fibrin clot
    - Whatley & Arnoczky (2000)

# Open vs Arthroscopic TFCC Repair: What's the Evidence?

- Anderson and Berger, et al. (JHS 2008)
  - 75 patients over 10 years
  - 36 arthroscopic, 39 open
  - Mean f/u: 43 months
  - NO significant differences in objective and subjective outcomes
  - Non-significant trend toward increased ulnar nerve irritation with open repair
  - 17% total reoperation rate for DRUJ instability
    - 8 open, 5 arthroscopic

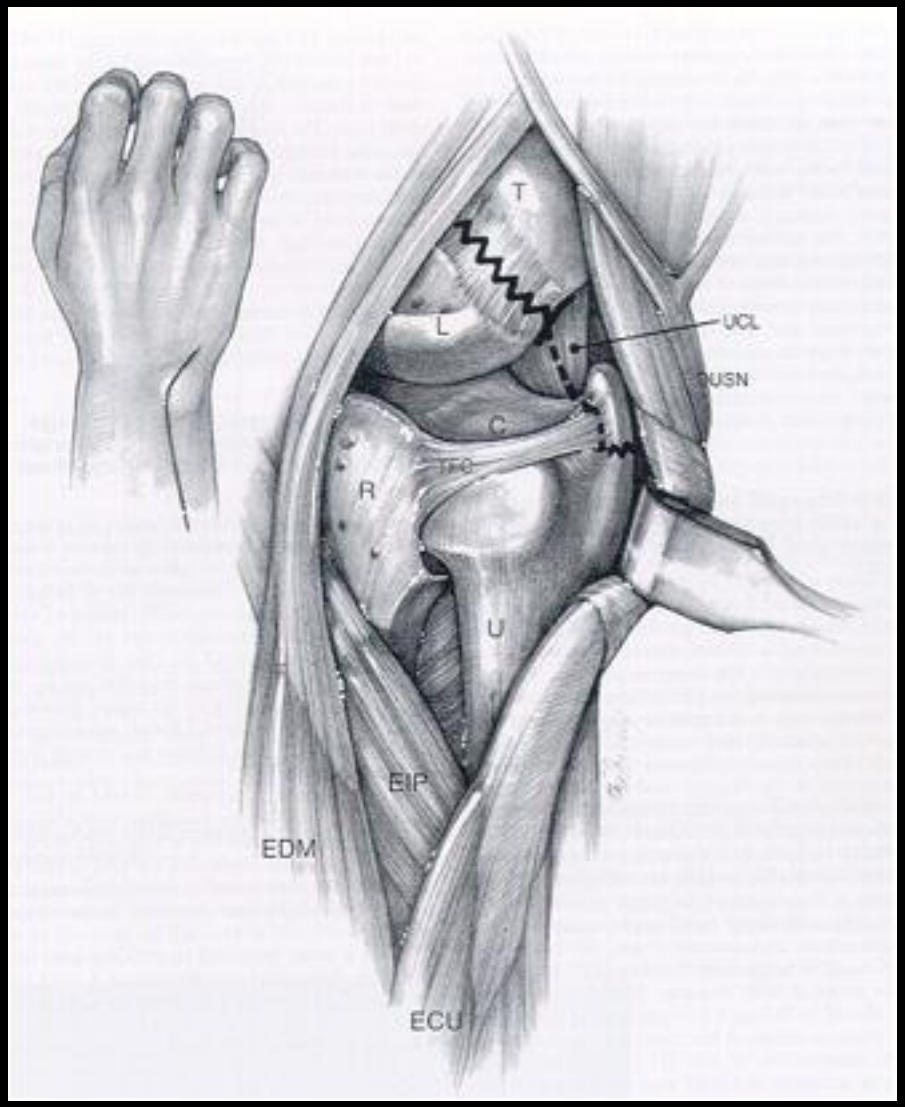
# Atzei and Luchetti, Hand Clinics 2011

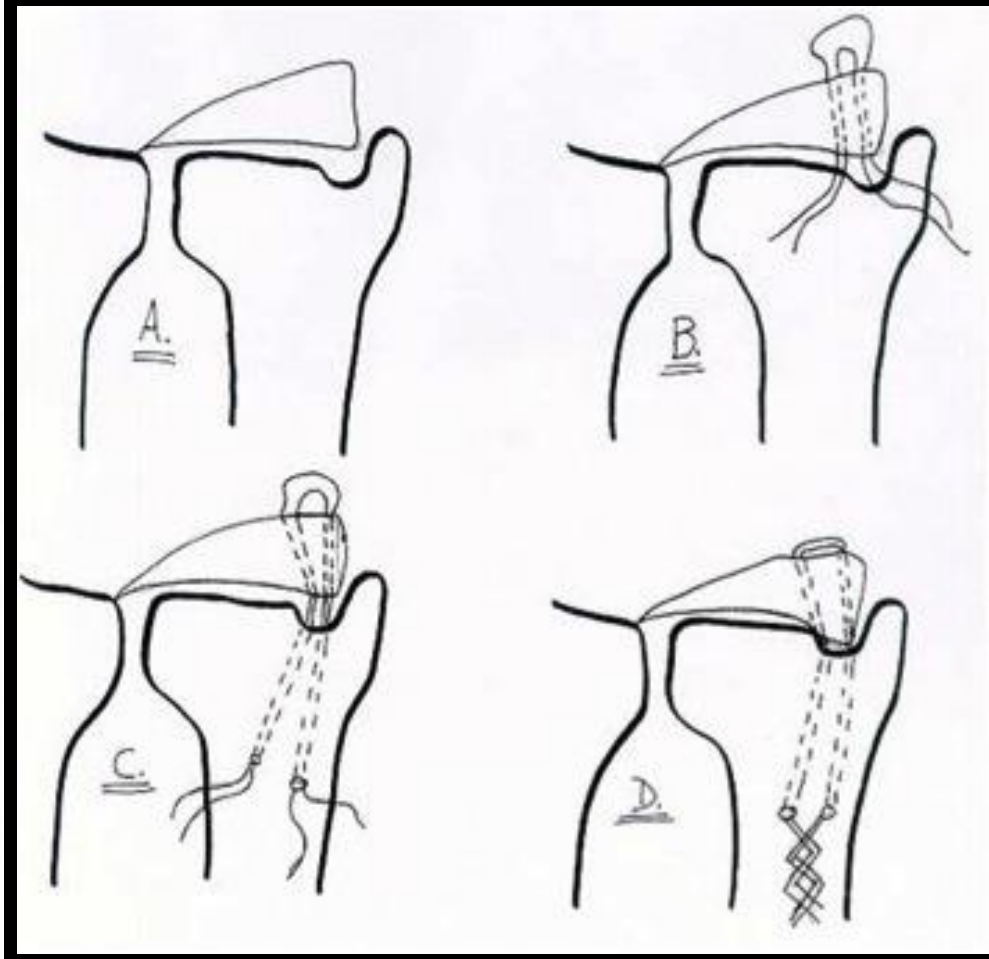
## Comprehensive Classification of TFCC Peripheral Tears

and associated Ulnar Styloid Fractures

| | | CLASS 0<br>Isolated styloid fracture without TFCC Tear | CLASS 1<br>Distal TFCC Tear | CLASS 2<br>Complete TFCC Tear | CLASS 3<br>Proximal TFCC Tear | | CLASS 4<br>NON-repairable TFCC Tear | | CLASS 5<br>DRUJ Arthritis |
|---|---|---|---|---|---|---|---|---|---|
| Clinical Findings | DRUJ Ballottement Test | Negative | Slight Laxity (Hard end-point) | Mild to Severe Laxity (Soft end-point) | | | | | Variable |
| Radiographic Findings | Intact Ulnar Styloid or Tip Fracture of the Ulnar Styloid |  |  |  |  | | | | |
| | Basilar Fracture of the Ulnar Styloid |  |  |  (Floating styloid*) |  |  CLASS 3-A Avvision Fracture of TFCC Insertion |  CLASS 4-A |  CLASS 4-B |  |
| Arthroscopic Findings | Appearance of the Distal TFCC (during RC Arthroscopy) | Normal Appearance (NO tear) | Peripheral Tear | Normal Appearance (NO tear) | | | Massive Tear Degenerated Edges | Frayed Edges Failes Suture | Variable |
| | Tension of the proximal TFCC (Hook Test) | Taut TFCC (Negative Hook Test) | | Loose TFCC (Positive Hook Test) | | | | | |
| | Cartilage status of DRUJ | well preserved Cartilage | | | | | | | Degenerative or Traumatic Cartilage Defect |
| Suggested treatment | | Splinting for pain relief (Fragment removal in chronic painful cases) | TFCC Suture (Splinting of acute cases) | TFCC Forveal Refixation | | Styloid fixation | Tendon Graft Reconstruction | | Arthroplasty |

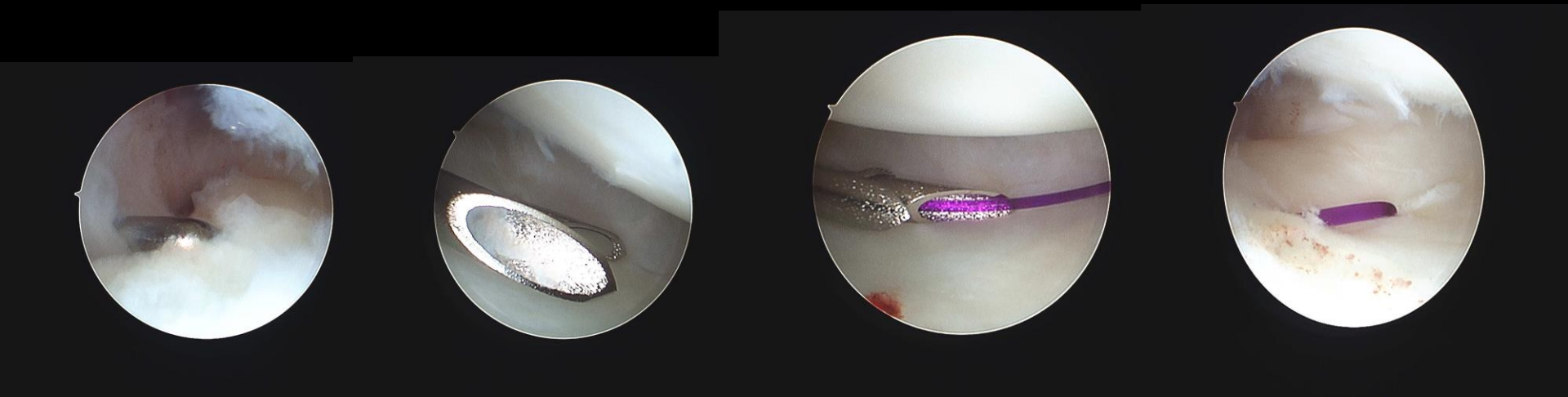
# Open Repair



# Treatment Options for IB Tears

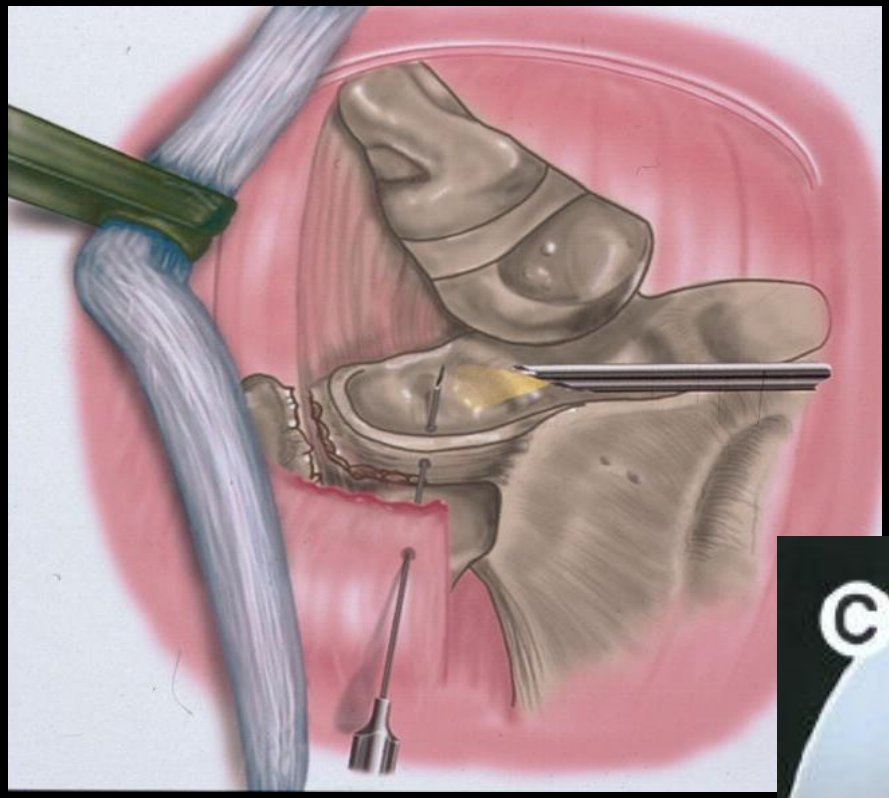
- Arthroscopic repair
  - Outside-inside using meniscal repair needles
    - Whipple & Geissler (1993)
    - Knot tied over a button
    - Knot tied under the dorsal/ulnar skin

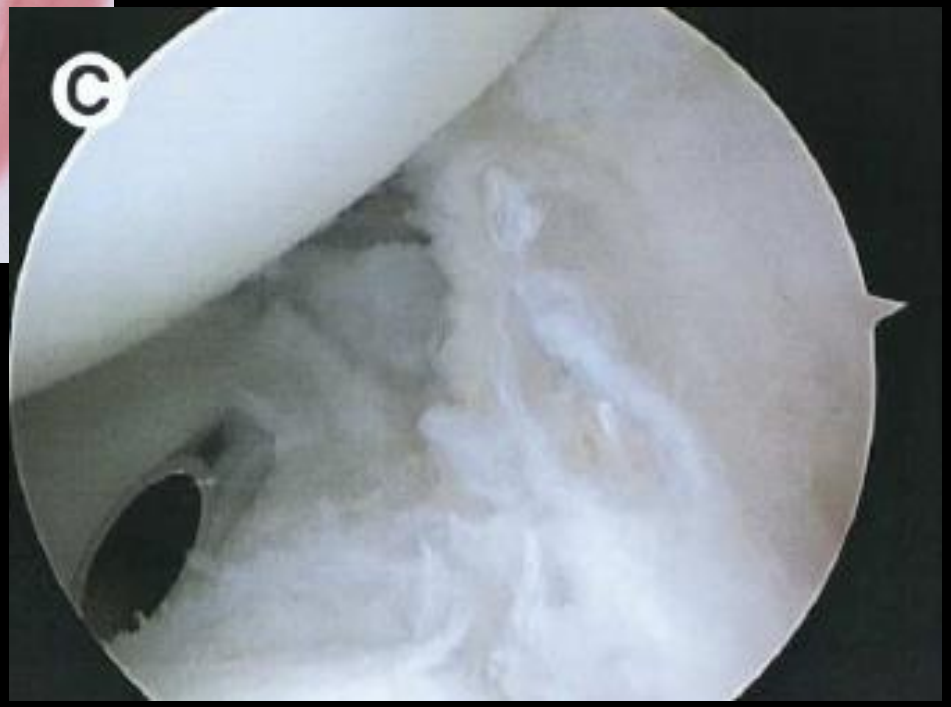


# Treatment Options for IB Tears

- Arthroscopic Repair, cont
  - Inside-outside using meniscal repair needles
    - Trumble (1996)
  - Inside-outside using a Tuohy needle
    - Araujo & Poehling (1996)
  - All-arthroscopic
    - Bohringer et al, Arthroscopy (2002)
    - Conca & Dalla Pria (2004)

# Arthroscopic -Assisted Repair

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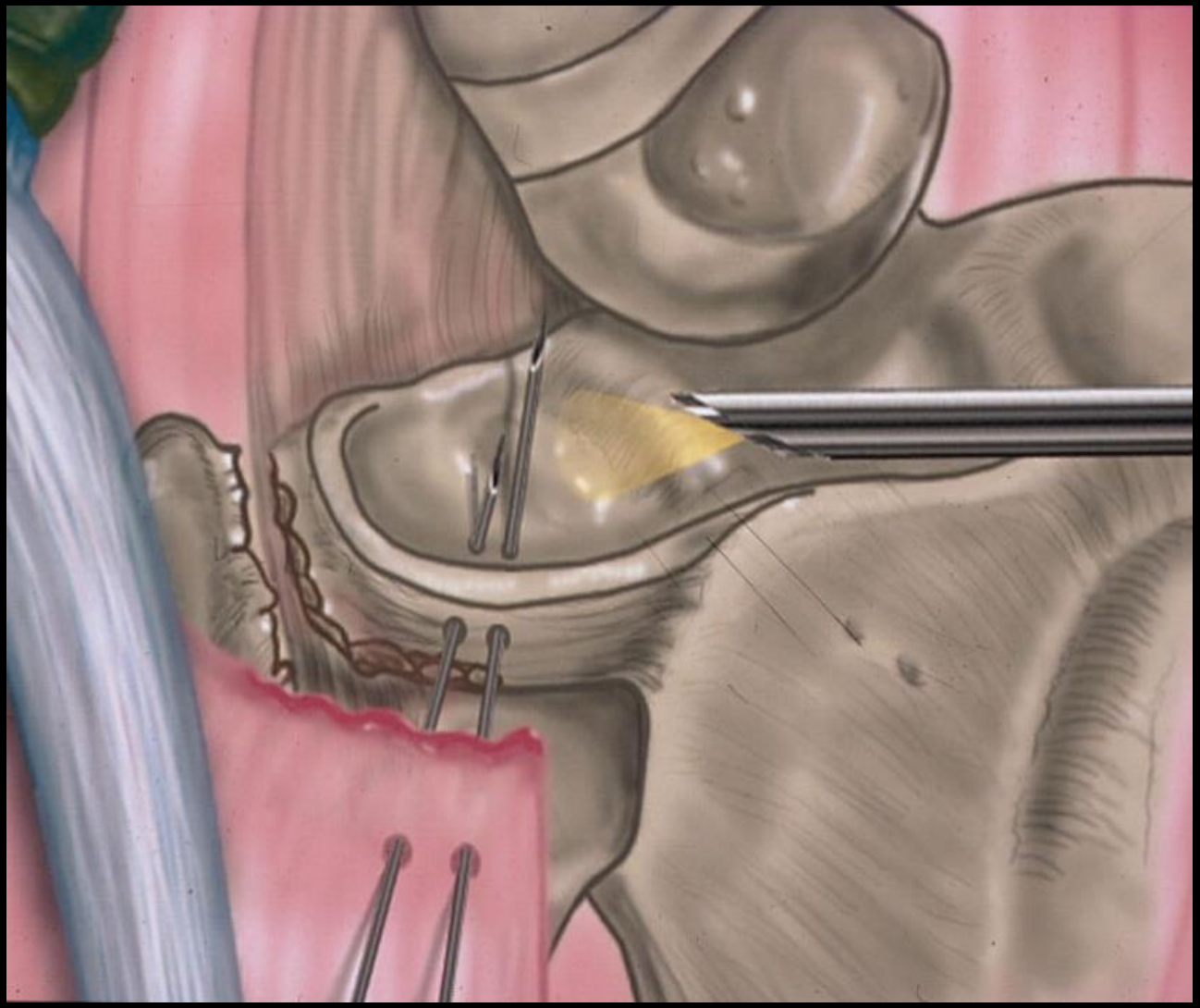

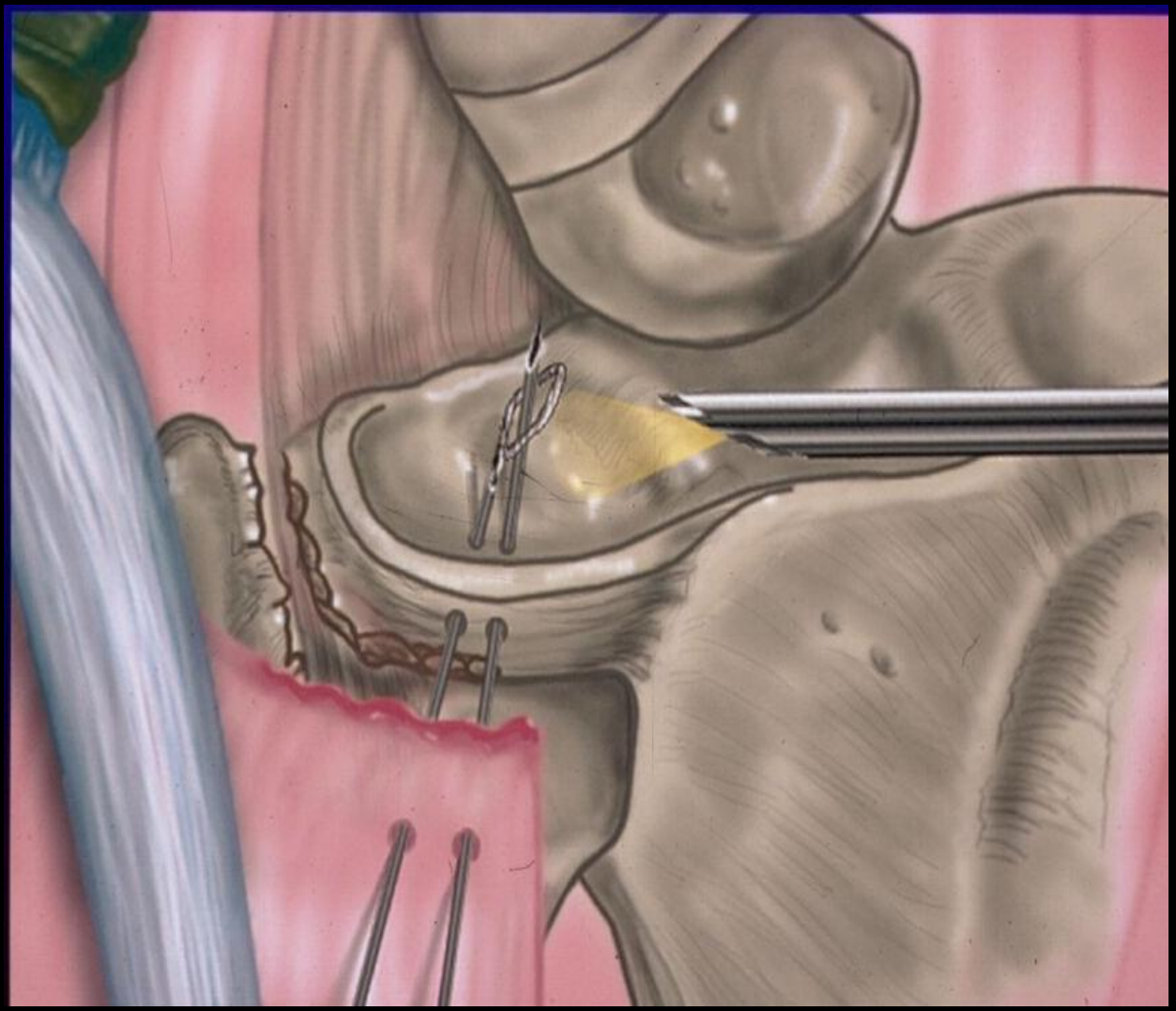

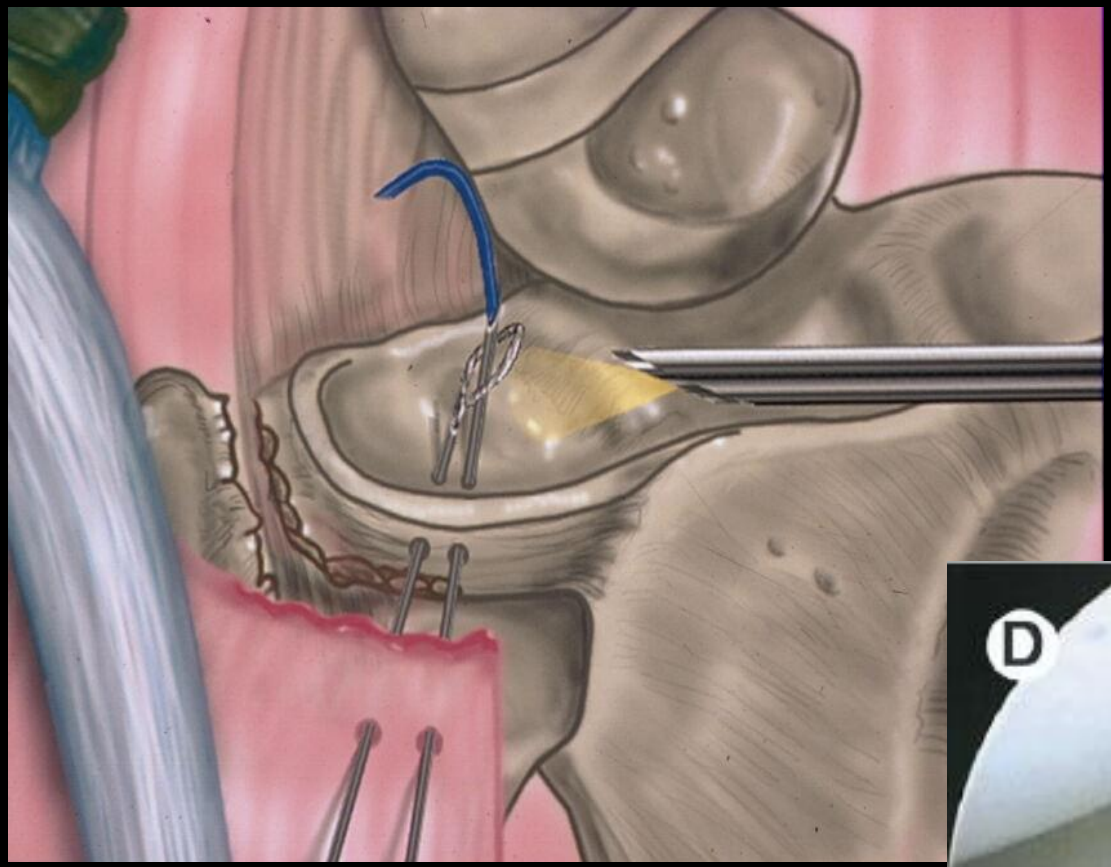


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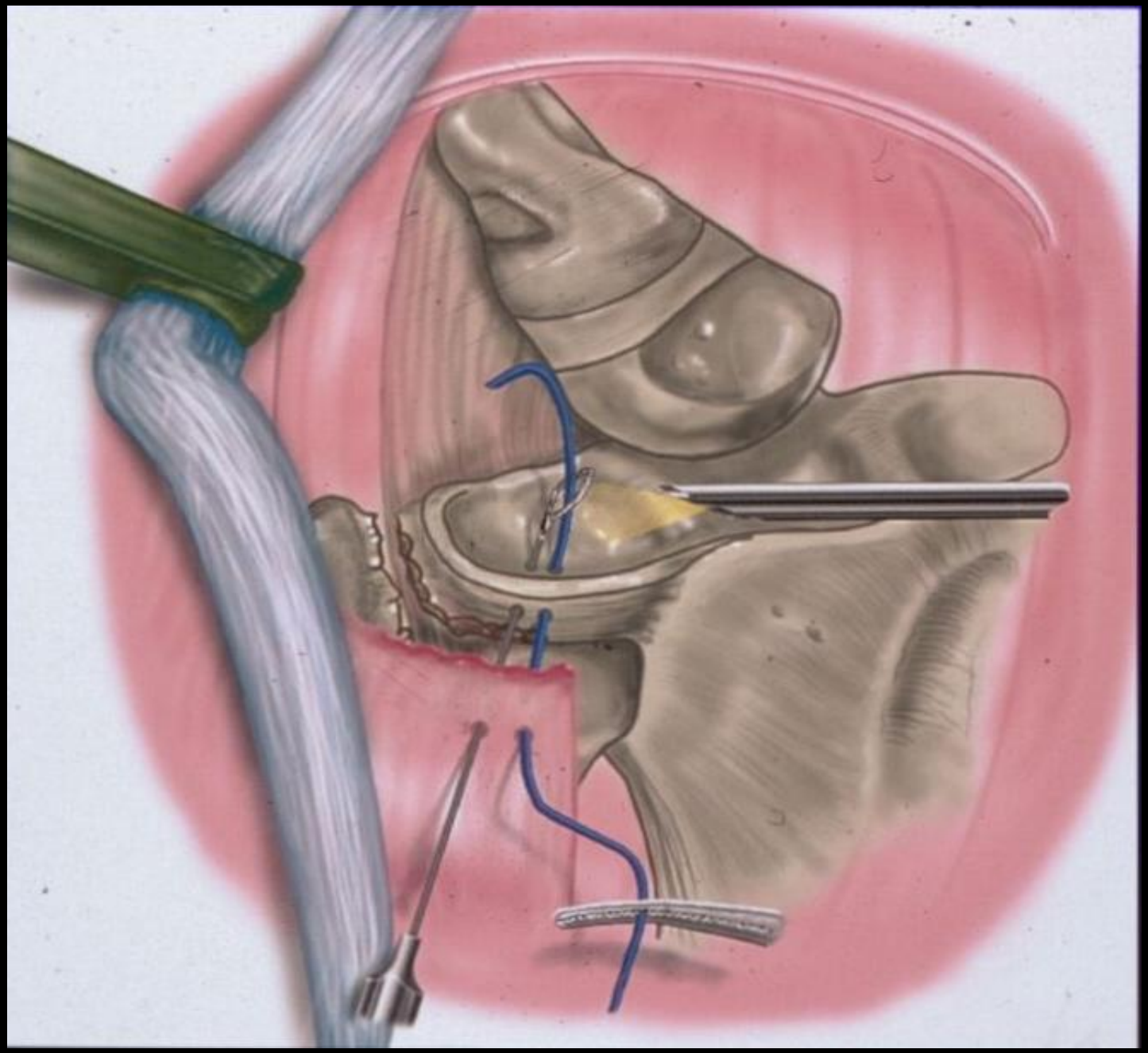

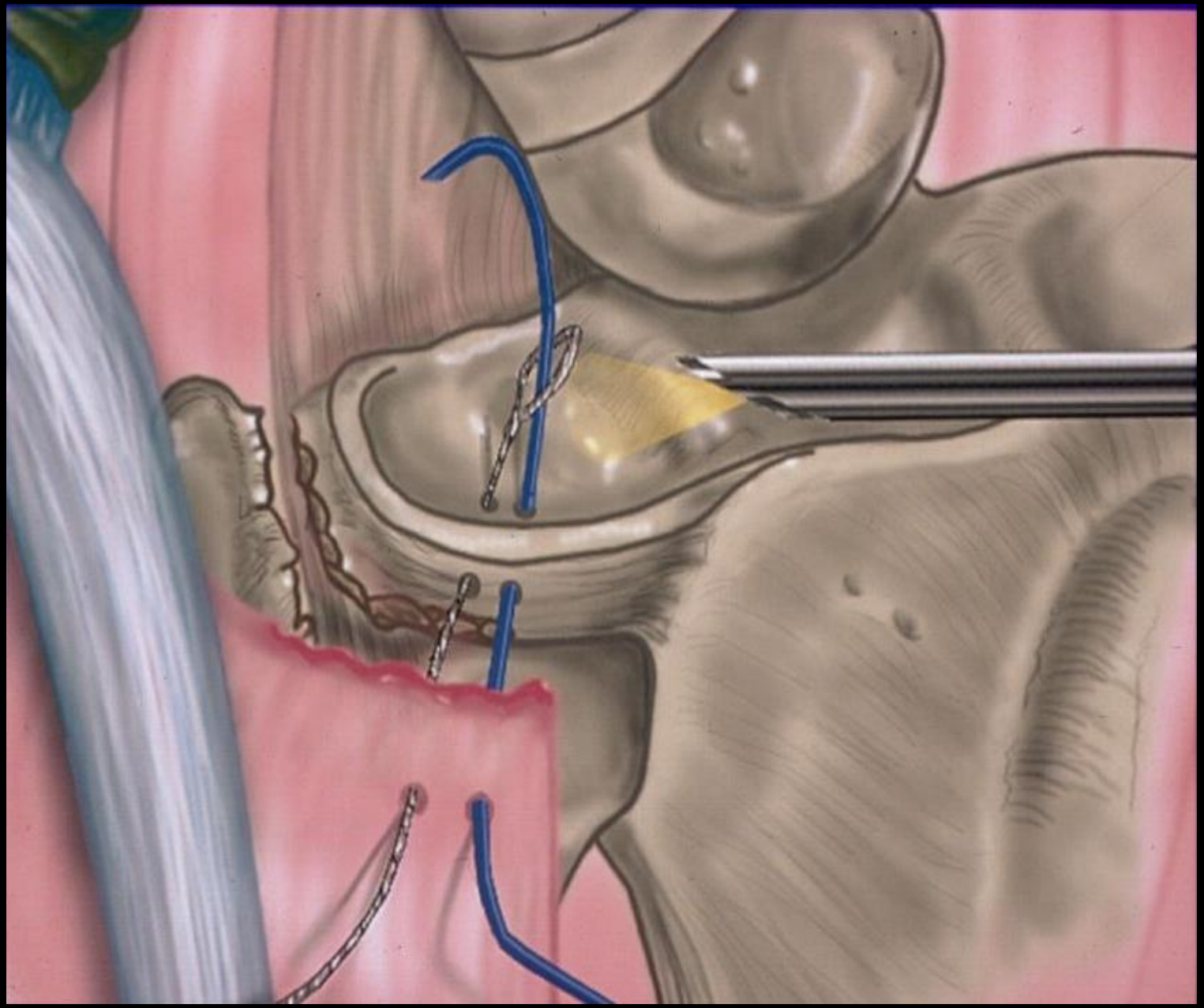

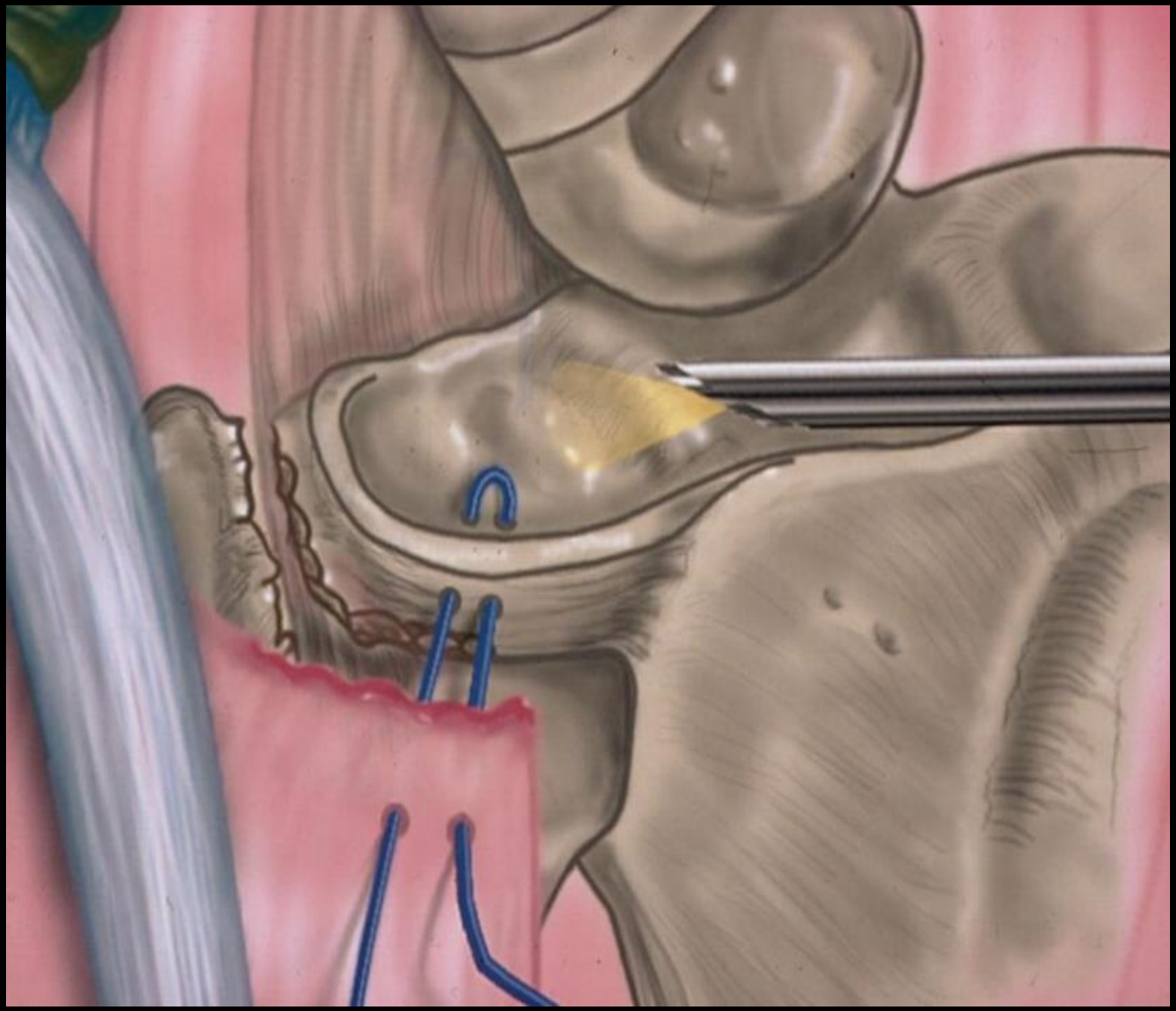

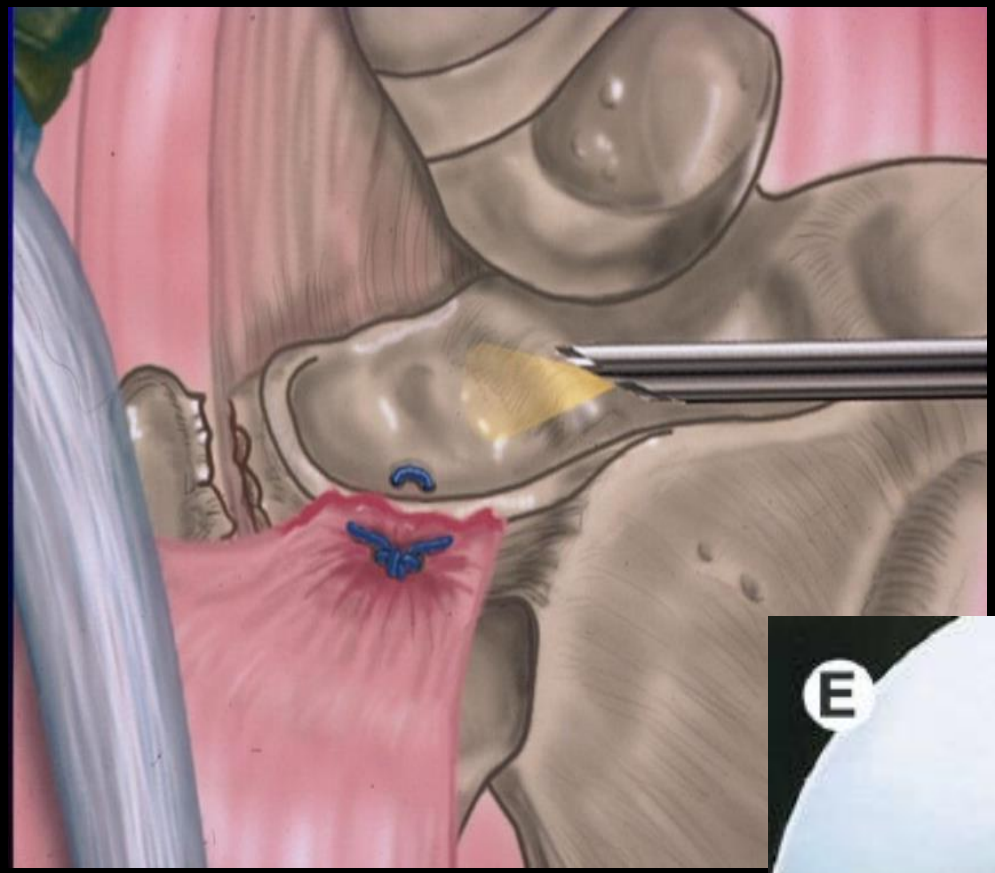


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# Disadvantages of Current Techniques

- Extra/larger incision
- Prominent subcutaneous suture knots
- Patient intolerance of buttons
  - Painful, unsightly, malodorous, skin changes
  - Septic arthritis
- Possible nerve injury

# Introduction

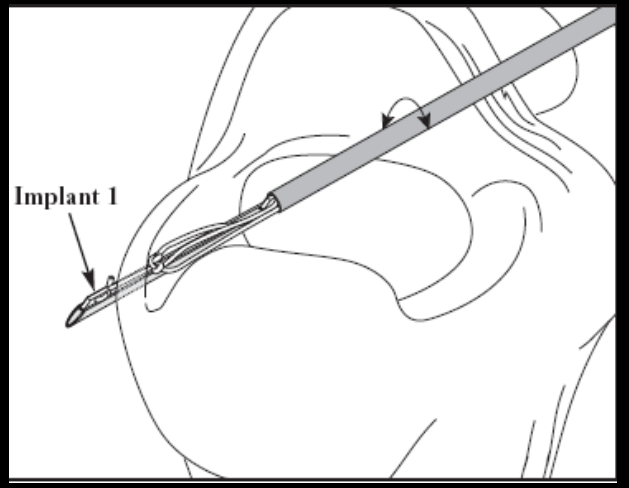
- All-Arthroscopic Method of Repair
  - Yao et al, Arthroscopy, 2007

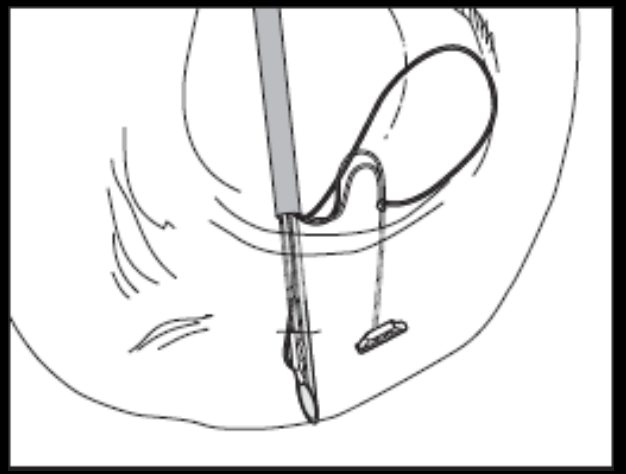
ARTHROSCOPY
THE JOURNAL OF ARTHROSCOPIC AND RELATED SURGERY

A Novel Technique of All-Inside Arthroscopic Triangular Fibrocartilage Complex Repair

# All-Arthroscopic TFC Repair

- Pretied suture device
- Designed for knee meniscal repair
- New technique for the use in TFC repairs
- Potential for Decreased:
  - Operative time
  - Incisions
  - Prominent suture knots
- Increased
  - Efficiency
  - Safety
  - Strength



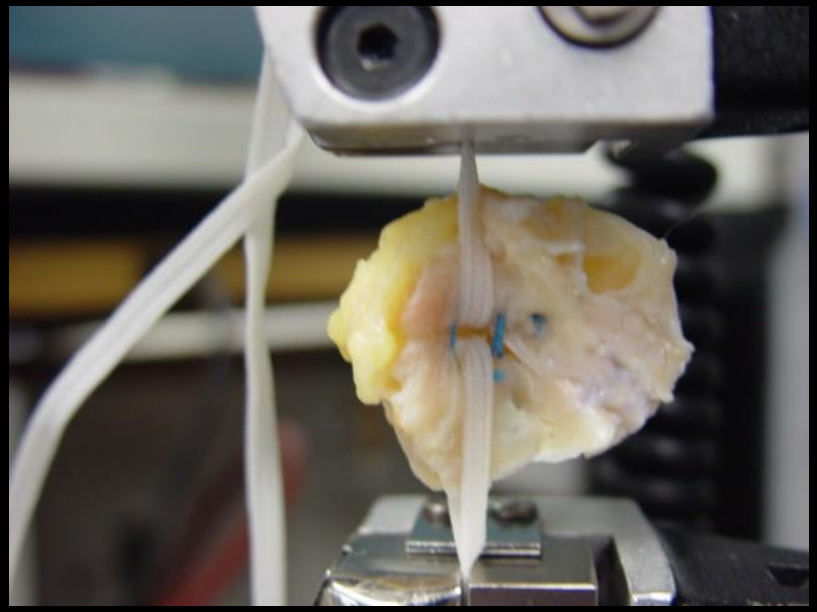
# Biomechanical Strength and Safety Study

- 10 matched fresh-frozen cadaveric wrist specimens
- Iatrogenically produced peripheral TFC tears
- Experimental group:
  - Two pretied suture devices in vertical configuration
- Control group:
  - two outside-in 2-0 PDS sutures in vertical configuration (ala Whipple/Geissler)
- Location of implants relative to the N/V structures
- Instron MTS
  - specimens loaded to failure

# Ulnar Dissection

Whipple/Geissler (PDS)
Distance from UNB:  1.9 cm
Distance from DBUN: 4.6 mm

Suture Device
Distance from UNB:  1.8 cm
Distance from DBUN: 17.1 mm

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# Biomechanical Strength of Repair

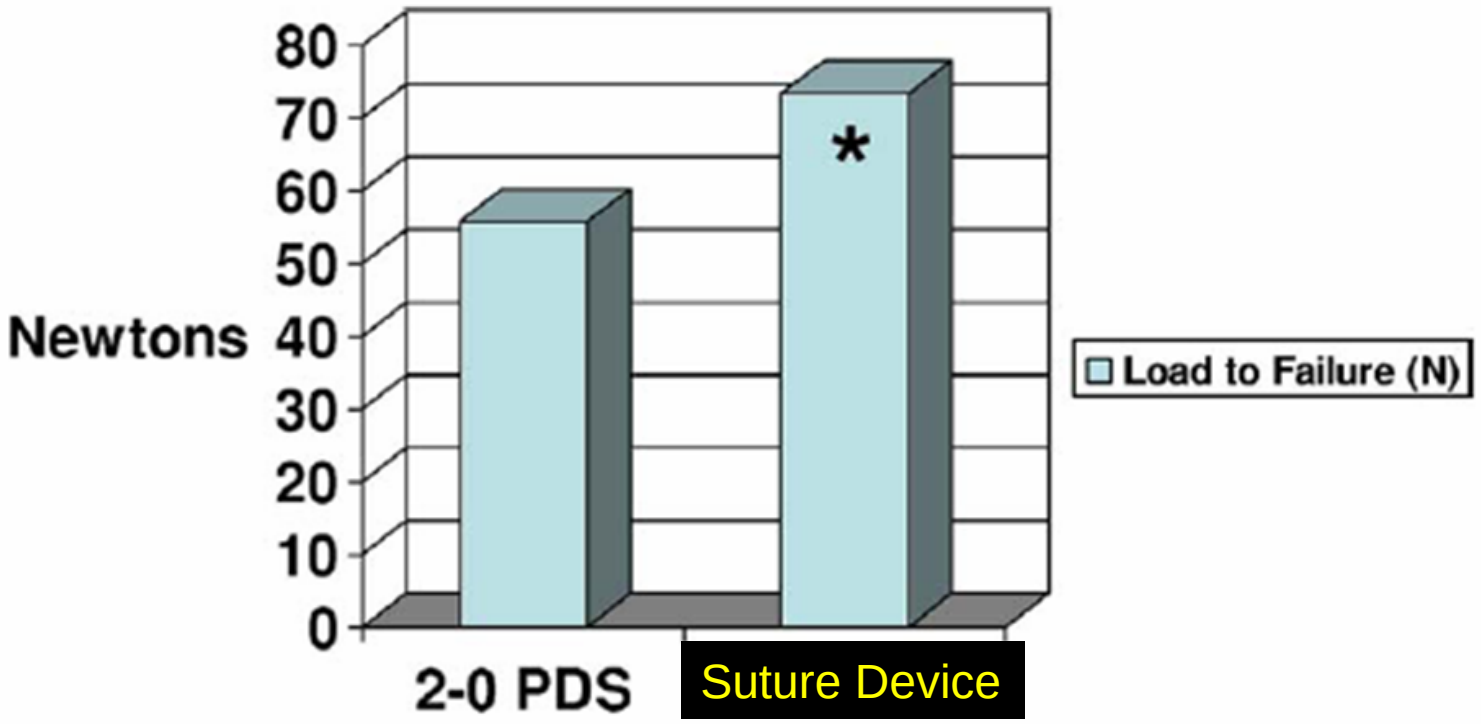
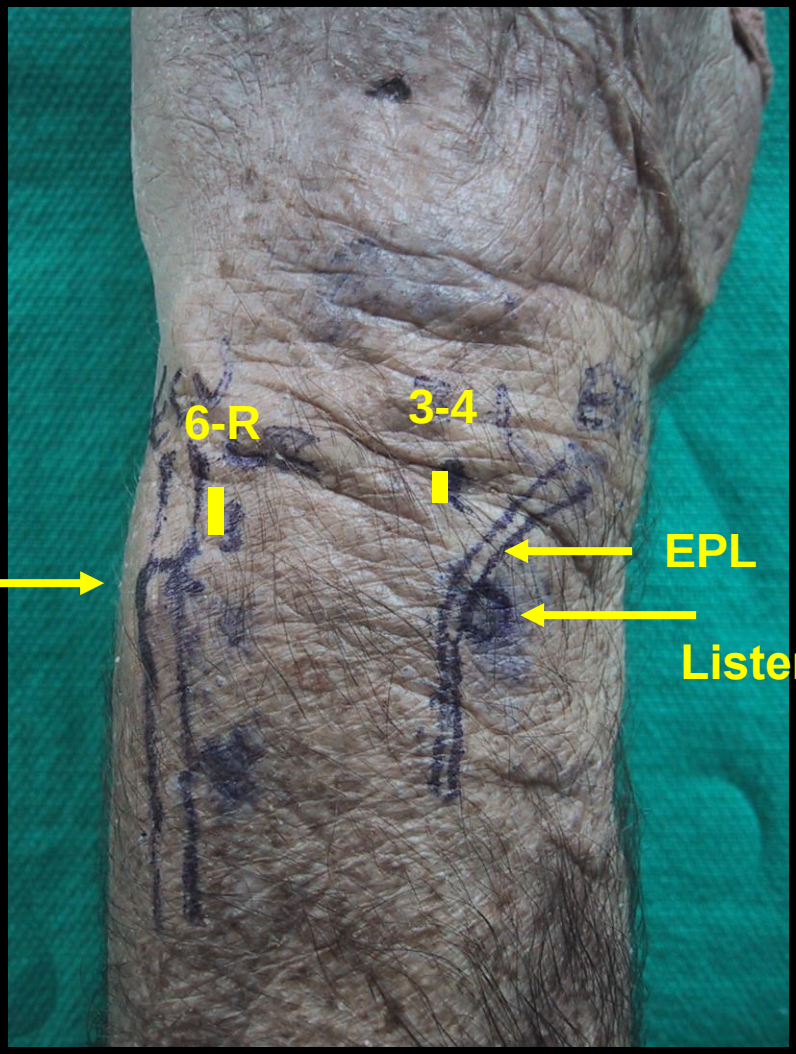



Figure 3: Load to failure of Suture Device versus 2-0 PDS (*p<0.05)

Yao, JHS, 2009

# Arthroscopy Set-Up

# Portals



Arthroscope in 3-4

Probe in 6R

# Insertion of Suture Device


Arthroscope in 6R
Suture device in 3-4

Arthroscope in 3-4

Probe in 6R

Post-Repair

Pre-Repair

# Clinical Experience

- Retrospective Review 2005-2009
  - One hand surgeon
  - Patients with persistent ulnar-sided wrist pain despite immobilization and injections
  - MRI consistent with TFC tear
  - No concomitant DRUJ instability

# Methods

- Objective data:
  - range of motion
  - grip strength
  - return to activity
  - post operative complications
- Subjective data:
  - *quick*DASH
  - PRWE questionnaires

# Results

- 14 patients
- Mean f/u: 16.1 months
- Supination: 81 (+/- 13.1)
- Grip strength: 66% (+/- 13.8)
- *quick*DASH: 10.2 (+/- 11.4)
- PRWE: 18.8 (+/- 13.5)
- Mean time to full activity: 5.2 months
- 0 surgical complications

# Conclusion

- All-arthroscopic repair of peripheral TFC tears show excellent short term results
  - 1 year followup, 93% achieved excellent subjective outcomes based on quickDASH and PRWE
- Benefits of this technique are
  - ease of use
  - lack of prominent suture knots or button
  - no extra incisions
  - safety
  - strength of repair
    - reduced immobilization from long arm Munster cast (6 wks) to short arm cast (4 wks)

# Thank You!