Distal Radioulnar Joint Instability
"The distal radioulnar joint (DRUJ) provides not only supination and pronation of the forearm, but also is crucial to the grip strength and lifting capabilities of individuals. Two forces act in the forearm: axial loading, which is created by the muscles to produce gripping, and transverse force, which runs from the hand to the radius to the ulnar head and is the force of gravity against which the arm has to lift."

The Distal Radioulnar Joint

- Diarthrodial, trochoid articulation that provides the distal link between the radius and ulna
  - pivot for pronation-supination
- Incongruent articulation requires soft tissue
DRUJ and Motion

- During forearm motion, the DRUJ moves synchronously with the proximal radioulnar joint
  - any injury or deformity involving the radius or ulna can alter the function of both joints

Courtesy of Thomas E. Trumble, MD http://www.youtube.com/watch?v=LG9gwWt4sTU
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DRUJ and Motion

- **Normal**
  - 70 degrees of pronation
  - 85 degrees of supination
- **Discrepancy in arcs of curvature**
  - volar-dorsal translation
  - proximal-distal translation of ulnar head relative to radius

- **Supination**
  - Deep portions of the **palmar** radioulnar ligament and superficial portion of the DRUL become taut
- **Pronation**
  - Deep portions of the **dorsal** radioulnar ligament and superficial portions of the PRUL are under tension

The DRUJ

- DRUJ and ulnocarpal joints are anatomically and functionally integrated
  - both are affected by traumatic and arthritic conditions
Physical Exam

- Differential Diagnosis
  - TFCC tear
  - DRUJ arthritis
  - DRUJ instability
  - ECU subluxation
  - Carpal arthritis
  - CMC arthritis
  - Fracture/necrosis
Physical Exam

- Tenderness in the soft depression between FCU tendon, ulnar styloid & triquetrum = TFCC injury
- Decreased motion & crepitus during pronation/supination = DRUJ arthritis
  - Stress test
- Increased AP translation of ulna on radius with passive movement = DRUJ instability
  - Defined by position of ulna relative to radius
  - Always check in neutral, and full pronation/supination
  - Always compare to other extremity
Physical Exam

- ECU subluxation is most apparent in supination and ulnar deviation
- LT joint is assessed with the shear or ballottement test
  - Stabilizes the lunate between the thumb and index finger of one hand
  - Manually shear triquetrum against lunate dorsopalmar direction with the thumb and index finger of the other hand
- Pressing and manipulating the pisiform will elicit pain and crepitus in pisotriquetral arthritis
PE – Ulnocarpal stress test

- First described by Friedman and Palmer in 1991
- Provocative test for ulnocarpal abutment syndrome
- Shown to reliably reproduces ulnar wrist pain
- Differentiates ulnar wrist pain due to ulnocarpal pathology from wrist pain of other etiologies

FIGURE 7. Examination of the ulnar wrist. (A) Palpation of the ulnar snuff box. (B) Lunotriquetral shuck. (C) TFCC grind. (D) Push-off test.
Imaging

- PA & lateral radiographs
- Arthrography
- CT
- MRI
- Scintigraphy
- Arthroscopy
X-ray Position

• Zero degree rotation
  – Shoulder 90° abducted, elbow 90° flexed on flat surface
• Firm grip pronation (add 1-2mm ulnar-plus)
• Lateral
  – Shoulder adducted, elbow 90° flexed, forearm neutral
  – Pisiform should align with the distal third of scaphoid
Triple Injection Arthrography

- Diagnose TFCC tears
- Radiocarpal joint injected, 3 hours later DRUJ & midcarpal row injected
- Connection = positive tear
- Downside – degree of false positive and false negative

Picture: http://uwmsk.org/arthrography/
CT

- Both wrists in neutral, pronation & supination – gold standard
- Stress views sometimes needed
- Diagnose
  - Fractures
  - Subluxation
  - Articular surface congruency

MRI

• Accuracy varies widely
• Diagnose
  – Occult fractures
  – Chondromalacia
  – Osteochondral defects
  – TFCC tears

Image: Ketan Naran, MD, Musculoskeletal Radiology Fellow, Thomas Jefferson University Hospital, Philadelphia, PA online: http://onimri.com/default.asp?LINKNAME=CLINCASE06
3 Phase Scintigraphy

- Useful in patients with normal plain x-rays
- Increased activity
  - Fractures
  - Infection
  - Bone bruise
  - Inflammation

DRUJ Instability Problems

- TFCC tears
- Acute Instability
- Chronic Instability
- Arthritis
DRUJ Instability Problems

- TFCC tears
- Acute Instability
- Chronic Instability
- Arthritis
Palmar’s Classification

• Divides lesions of the TFCC into traumatic and degenerative
  – Traumatic: Class 1
  – Degenerative: Class 2
• Traumatic subdivided by location
• Degenerative subdivided by location and severity of degeneration
Class 1A – Central Perforation

- Presents as ulnar sided wrist pain aggravated by power grip
- Produces pain and clicking but not DRUJ instability
- Initial treatment is conservative
- Arthroscopic debridement for refractory lesions

Green’s Operative Hand Surgery, 5th ed. Adams. DRUJ instability
Class 1B – Ulnar Avulsion

- Avulsion of TFCC from its ulnar attachments
- +/- ulnar styloid fracture
- Gross instability can occur in absence of fracture
- Arthroscopic repair possible

Green's Operative Hand Surgery, 5th ed. Adams. DRUJ instability
Class 1B – Ulnar Styloid

- Fracture through base more likely associated with TFCC injury/DRUJ instability
- Pain more ulnar
- Immobilize 4-6 wks
- Surgery for persistent pain or instability
Class 1C – Ulnocarpal ligament tear

- Can occur in combination with 1B or LT injuries
- Reliable healing
- Volar “sag” of carpus relative to ulnar head
- Treatment unclear
Class 1D – Radial Avulsion

• Frequently associated with distal radius fractures
  – Respond to accurate fracture reduction of the radius
• Rare cause of DRUJ instability
• Open vs Arthroscopic
Open repair acute TFCC injury: Class I D tear
Treatment Options
Open repair acute TFCC injury: Class I B tear

**FIGURE 13.** A dorsal approach between the fifth and sixth compartments is used to expose the ulnar head and dorsal portion of the TFCC. This approach is useful for open repair of the TFCC as well as open reduction and internal fixation of the ulnar head.
Arthroscopic Repair: IB lesion
Arthroscopic repair – Tuohy needle technique

Arthroscopic repair – Tuohy needle technique

- Tuohy needle (6 inch, 12 gauge) inserted through existing portal and passed through detached area of TFCC then out of skin volar to ECU
- 2-0 PDS threaded through needle
- Needle retracted back into joint space, passed through TFCC again, then out of skin adjacent to first exit site

Arthroscopic repair technique

- 1.5cm incision over ulnar head
- ECU tendon retracted ulnarly, exposing the floor of the 6th compartment
Arthroscopic repair technique

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Arthroscopic repair technique

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Degenerative TFCC tears

- Chronic, excessive loading
  - Ulnar impaction syndrome
- Natural degeneration common
  - 30 – 70% in cadaveric specimens
- Treatment
  - Debridement of joint
  - Reduction of the load across ulnocarpal joint
Class 2A

- TFCC wear
Class 2B

- TFCC wear
- Lunate and/or ulnar head chondromalacia
Class 2C

- TFCC perforation
- Lunate and/or ulnar head chondromalacia
Class 2D

- TFCC perforation
- Lunate and/or ulnar head chondromalacia
- LT ligament perforation
- 2E adds ulnocarpal arthritis
Ulnar Shortening and TFCC

- The first paper to address ulnar shortening specifically for the treatment of TFCC tears
- 10 consecutive patients had ulnar shortening for TFCC tears documented by arthrography
- Transverse osteotomy removing 2-3mm of bone, 6-hole DCP

Ulnar Shortening and TFCC

- Average 23-month follow-up
- 5 patients with resolution of pain
- 4 patients with mild residual pain only with strenuous activities
- 1 radiocarpal arthritis requiring fusion
- 1 non-union, 1 re-fracture

Ulnar Shortening and TFCC

- 75 wrists in 73 patients underwent arthroscopic examination at the time of ulnar shortening osteotomy
- 32 of these had an isolated articular disc tear (13 radial, 13 central, 6 ulnar)
- These 32 underwent 2nd look arthroscopy at the time of plate removal at a mean of 21.5 months post-op
- Group A: spontaneous repair of TFCC
- Group B: tear remained in same location

<table>
<thead>
<tr>
<th>Localization</th>
<th>Clinical Score*</th>
<th>No. of Wrists (Group A:Group B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFCC dejbridement</td>
<td>82</td>
<td>18 (8:10)</td>
</tr>
<tr>
<td>Radial</td>
<td>80</td>
<td>14 (8:6)</td>
</tr>
<tr>
<td>Central</td>
<td>83</td>
<td>13 (3:10)</td>
</tr>
<tr>
<td>Ulnar</td>
<td>79</td>
<td>13 (8:5)</td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>80</td>
<td>6 (5:1)</td>
</tr>
<tr>
<td>Round</td>
<td>82</td>
<td>12 (1:11&lt;sup&gt;+&lt;/sup&gt;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 (15:5&lt;sup&gt;+&lt;/sup&gt;)</td>
</tr>
</tbody>
</table>

*Modified Green and O’Brien Clinical Scoring System.
<sup>+</sup>p < .01.
Ulnar Shortening and TFCC

• 50% of TFCC tears healed after ulnar shortening
• Healing did not appear to correlate with debridement or clinical symptoms
• Healing did correlate with shape of lesion and (though not statistically significant) with location of lesion

DRUJ Instability Problems

- TFCC tears
- Acute Instability
- Chronic Instability
- Arthritis
Instability

• Defined – Abnormal path of articular contact during or at the end of ROM

• Due to
  – Alteration in joint surface orientation
  – Deficiencies in the main restricting ligaments
  – Both
Mechanism of Injury

- Most isolated DRUJ dislocations are **dorsal**
  - Hyperpronation and wrist extension
  - As seen in FOOSH

- Volar dislocations occur in the supinated forearm
  - Or direct blow to ulnar aspect of forearm
Acute DRUJ Instability

• May occur in association with radial head fracture, distal radius fracture, both bone fractures, or as isolated injury.
• Isolated injury: more subtle presentation with swelling, restricted forearm rotation:

Image: http://www.medsci.org/v05p0292.htm
Evaluation

- Obvious deformity
  - Ulnar head locked over a rim of sigmoid notch

- Tenderness, swelling, limited ROM
  - Dorsal dislocation: blocked supination
  - Volar dislocation: blocked pronation
Evaluation

- **Obvious deformity**
  - Ulnar head locked over a rim of sigmoid notch
- **Tenderness, swelling, limited ROM**
  - Dorsal dislocation: blocked supination
  - Volar dislocation: blocked pronation
Evaluation

- Deep tenderness along IOM
- Pain at PRUJ
- DRUJ stability difficult to assess in the face of an unstable fracture

Imaging
  - Plain films
  - CT rim/notch fxr
Evaluation

- Prognosis poor
  - Initial wide displacement
  - Severe radial shortening
- Radioulnar ligaments tolerate < 5-7mm
- Secondary stabilizers
- Results
  - Fxr reduction
  - Recognition

Simple Dislocations

• Reduced spontaneously or with closed reduction

• Treatment – immobilization 6 weeks
  – Long arm cast x 3-4, short arm cast 2-3
  – Neutral position – bidirectional instability
  – Supination – ulna dorsal dislocation
  – Pronation – ulna volar dislocations
Complex Dislocations

• Irreducible or subluxating cases
• High energy injuries
• Usually due to interposition of
  – Torn TFCC
  – EDM
  – ECU
  – Extensors of ring or small finger
Repair

• Reduction requires open approach
• Unstable after reduction
• Ulnar styloid indications
  – Isolated displaced fracture through base associated with instability
  – Persistent instability after accurate distal radius orif

Green’s Operative Hand Surgery, 5th ed. Adams. DRUJ instability http://www.greenshandsurgery.com/content/default.cfm
Open Repair

ACUTE DRUJ INJURY

Anatomic Reduction of Radius then Assess DRUJ Stability

- **Stable DRUJ**
  - No Immobilization Required

- **Partially Stable DRUJ**
  - Hold in Position of Stability for 4-6 weeks

- **Complex DRUJ Injury**
  - **Irreducible**
    - Open Reduction Required
  - **Unstable in All Directions**
    - **Ulnar Styloid Fracture?**
      - **Large Displaced Ulnar Styloid**
        - Open Reduction and Internal Fixation
      - **No Ulnar Styloid Fracture**
        - Repair of TFCC with transfixed pinning of reduced DRUJ for 4-6 weeks
DRUJ and Galeazzi

- 40 patients with Galeazzi fractures treated over 12 years
- Volar approach to radial shaft with placement of 3.5mm DC plate, ICBG as needed
- If persistent DRUJ instability (n=13) performed CR and k-wire fixation; 3 patients required OR and TFCC repair

### Table 1. Raskin/Rettig Galeazzi Fracture-Dislocation Classification

<table>
<thead>
<tr>
<th>Location of Fracture From the Midarticular Surface of the Distal Radius</th>
<th>DRUJ Fixation</th>
<th>No DRUJ Fixation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I &lt;7.5cm</td>
<td>12 (3 open repair)</td>
<td>10*</td>
<td>22</td>
</tr>
<tr>
<td>Type II &gt;7.5cm</td>
<td>1</td>
<td>17</td>
<td>18</td>
</tr>
</tbody>
</table>

*Two patients with chronic DRUJ subluxation.*
DRUJ Instability Problems

- TFCC tears
- Acute Instability
- **Chronic Instability**
- Arthritis
Chronic DRUJ Instability

- Symptomatic dysfunction not uncommon
  - Especially with distal radius malunion
- Presentation
  - Loss of forearm rotation
  - Prominence of the ulnar head
  - Ulnar-sided wrist pain

Chronic DRUJ Instability

• Mild instability
  – Pain and weakness occur only with powerful rotation of the forearm during hand grip (turning a screwdriver)

• Severe instability
  – Palpable and painful clunk with wrist torsion
  – Loss of rotation from chronic subluxation

• Chronic instability rarely improves spontaneously

Evaluation

• Similar to Acute Dislocation
  – Examine in neutral, pronation, and supination
  – Compare to contralateral side

• Radiographs
  – Most specific radiographic signs: widened DRUJ and prominence of the ulnar head
  – CT: most accurate to evaluate DRUJ for fractures, arthritis, sigmoid notch incongruity, and instability
Treatment

• Nonoperative management of severe, chronic DRUJ instability usually fails

• Low-demand pts with mild instability
  – 4-week trial of forearm splinting or long-arm casting and anti-inflammatory medications

Treatment

- Coexistent conditions, such as ECU tendinitis or ulnar impaction syndrome, should be identified and treated accordingly.

Treatment

- Special consideration is given to patients who have a flat sigmoid notch and bilateral DRUJ hypermobility.
- Less predictable response to reconstructive surgery.

Treatment

• Forearm and wrist strengthening
  – soft brace or supportive taping
• Recurrent dislocations → attenuation of soft tissue restraints
  – Sigmoid notch rim degeneration
• In young patients, it may be appropriate to accept intermittent dislocations
  – Follow these patients regularly until skeletal maturity
  – Avoid the potential for iatrogenic physeal injury with reconstructive surgery

Operative Treatment

• Goals: restoration of stability and a full, painless arc of motion

• Causes
  – bony deformity
  – ligament injury
  – combination
Operative Treatment

- Soft tissue repair or reconstruction in the presence of marked bony deformity will FAIL
Soft tissue reconstruction for Chronic Instability with no malunion

• Must have
  – Congruent DRUJ
  – Stable radiocarpal ligaments
  – Stable ulnocarpal ligaments

2 Reconstruction Techniques

- Extra-articular
- Intra-articular
Extra-articular Reconstruction

- Provides stability without opening joints
- Easier to perform
- Do NOT re-establish the ligament anatomy of DRUJ
Extra-articular Reconstruction Methods

• Radioulnar tether
  – Does not provide balanced forearm rotation
  – May restrict pronation/supination

• Ulnocarpal sling
  – Inherently slack
  – Does not provide stability
Intra-articular Reconstruction

- More demanding
- Restore TFCC anatomically
- May not be possible
Radioulnar ligament reconstruction – Scheker

• Technique for reconstruction of dorsal radioulnar ligaments
• Tendon graft passed into DRUJ via capsulotomy; ends passed through tunnels from sigmoid notch into medullary canal of radius and from fovea into medullary canal of ulna.
• Ends brought out of medullary canals and secured

Radioulnar ligament reconstruction – Scheker

Radioulnar ligament reconstruction – Scheker

- Outcomes of dorsal radioulnar ligament reconstruction:
- 15 patients with DRUJ instability over 4 years
- Average f/u 1.5 yrs in 14 of 15 patients
- Complete pain resolution in 12 of 14 patients with 76% average increase in grip strength from pre-op

Radioulnar ligament reconstruction – Adams

Indication: DRUJ instability with irreparable TFCC without DRUJ arthritis

Radioulnar ligament reconstruction – Adams

Radioulnar ligament reconstruction – Adams

Radioulnar ligament reconstruction – Adams

Radioulnar ligament reconstruction – Adams

- Above-elbow cast x 3 weeks then short-arm for 2-3 weeks
- Therapy with active and gentle passive wrist flexion, extension and pronosupination at 5-6 weeks
- Strengthening started at 3 mos

Outcomes

• Johnston Jones and Sanders
  – 13/14 satisfied @ 26 months
  – 12/14 returned to previous work
  – 2/14 early failure
  – Loss of motion < 10 degrees

• Adams and Berger
  – 12/14 restored stability
  – Resumed previous activities, no restrictions
  – Strength and motion: 85%
DRUJ Instability Problems

- TFCC tears
- Acute Instability
- Chronic Instability
- Arthritis
DRUJ Arthritis

- Degeneration of the DRUJ
  - Post-traumatic arthritis
  - Inflammatory arthritis
  - Osteoarthritis
  - Rarely, long-standing DRUJ instability
Early OA

• Lower 1/3 DRUJ surface involved
• Ulnar shortening osteotomy to change articular contact surfaces
  – Scheker 2001
• Open circumferential surgical resection of the proximal 1/3 of ulnar articular surface 2 to 3 mm deep has also been used
Ulnar Shortening

- Of 92 ulnar shortening procedures of a nine-year period, 32 were for DRUJ OA.
- 2.5mm resection

Established OA

• Ablative Procedures
  – Darrach Procedure
  – Sauve-Kapandji
  – Hemi-resection interposition arthroplasty
  – Matched distal ulna resection

• Implant Arthroplasties
  – Hemi-arthroplasty
  – Total arthroplasty
Darrach Procedure

- Resection of distal ulna through ulnar neck. Ulnar styloid and its attachments can be retained.
- Variety of soft-tissue techniques for stabilization of distal stump
Darrach Procedure

• Initial reports showed >80% success
• However more recent reports show serious disability especially in young patients with unstable forearm, pain, and snapping at ulnar stump

A Problem...
Stabilization of distal ulna stump
Stabilization of distal ulna stump

Comparison

• Analyzed the dynamic effects of the resection of the distal ulna on radioulnar convergence
• Cadaveric study
• Evaluated stabilizing procedures for distal ulnar resection on radioulnar convergence
  – ECU/FCU tenodesis
  – Pronator quadratus advancement flap
  – Implantation of an ulnar head prosthesis (uHead)

Sauerbier (2010) Biomechanical evaluation of the dynamic radioulnar convergence after ulnar head resection Arch Ortho Trauma Surg
uHead

• SBI
• Cobalt-chrome head and stem
• Stem sprayed
  – Press fit
  – Cemented
• Head with provision for fixation of TFCC and ECU subsheath
Fig. 7 Radial-ulnar displacement values for all loading and surgical conditions. Darrach = distal ulnar resection; Johnson = pronator quadratus advancement flap; BreenJup = ECU/FCU tenodesis, Uhead = ulnar head endoprosthesis. *p < 0.05; **p < 0.01
Sauve-Kapandji Procedure

- Fusion of ulna head to distal radius, creating pseudoarthrosis
- Supports ulnocarpus, ECU & TFCC
- >66% pain free ROM
- Potentially better for young pts with high demand wrists & pts with incompetent radiocarpal ligaments (RA)
Sauve-Kapandji Procedure

• Potential complications
  – instability of the ulnar stump
  – Regeneration of the resected segment resulting in loss of motion

Another Problem…
Hemi resection – Interposition arthroplasty

- Resection DRUJ at sigmoid notch
- Portion of ulna retained to maintain TFCC
- Autologous tissue interposed between radius & ulna

Green’s Operative Hand Surgery, 5th ed. Adams. DRUJ instability http://www.greenshandssurgery.com/content/default.cfm
Hemi resection – Interposition arthroplasty

- Success depends on TFCC integrity
- Complications
  - Stylocarpal abutment
  - ECU tendonitis
  - RSD
  - Neuroma of ulnar dorsal sensory branch

Hemi resection – Interposition arthroplasty

- Bowers reported on 38 mostly rheumatoid patients
- Results were generally good for pain relief and motion
- Results were very good in patients with degenerative or post-traumatic arthritis
- Failures from residual ulnocarpal impaction
- Other results variable

Distal Ulnar head implant

• Indications
  – Radioulnar impingement after partial or complete distal ulnar resection
  – Arthritis of the DRUJ

• Complications
  – An unrecognized deficient rim of the sigmoid notch → instability.
  – Overzealous soft tissue attachment → stiffness or joint subluxation

Hemi-Arthroplasty

- Swanson (silicone)
- Berger (cobalt-chrome alloy)
- Herbert & van Schoonhoven (ceramic head fixed to a porous-coated titanium)
Our Problem Revisited

Total DRUJ Arthroplasty

- Semi-constrained modular prosthesis
- Stainless steel & ultra-high molecular weight polyethylene
- Replaces both distal ulna & sigmoid notch
Total DRUJ Arthroplasty

- Semi-constrained ball and socket joint composed of radial and ulnar components

Total DRUJ Arthroplasty

- 2-year follow-up of 31 patients operated over 4 years
- Mean pre-op vs postop pain score
  - 4.2 to 1
- Mean pre-op vs postop grip strength
  - 11kg to 22kg
- 24 of 31 returned to regular activities
- One wound infection, two post-traumatic fractures

Total DRUJ Arthroplasty

- Indication for 19 pts
  - Failed Darrach (10)
  - Failed S-K (7)
  - Trauma (1)
  - DRUJ synovitis (1)

- 7 removed
  - All 5 of one design due to loosening
  - 1 pain
  - 1 at request of patient

Total DRUJ Arthroplasty

- Statistically significant improvements were seen
  - Forearm pronation from 79° to 88°
  - Grip strength from 10 kg to 16 kg
  - Visual analog scale score 5.3 to 3.5

- The distal ulna was clinically stable in all 12 patients who retained the prosthesis