THE MAGNIFICENT DISTAL RADIOULNAR JOINT

Emily Alberman, PT, DPT, CHT, OCS, CLT, WCC
March 11, 2017

Please note:
The following talk is considerably longer than the talk that will be given in Philadelphia on March 11, 2017. However, it was part of a larger presentation, so I have condensed some of the material that will be presented in Philadelphia. Instead, enjoy this extra material as you follow along. Instead, enjoy the extra material as you follow along with the distal radioulnar joint.

Thank You
- For the kind invitation to speak here at this conference
- All therapists, surgeons, researchers who have contributed over the years to the progression of our knowledge base.
  - Scott Wulff, MD
    - Attending Hand Surgeon Hospital for Special Surgery, NYC
  - Arvind Wulff, BS, OTR/L, CHT
    - Mentor, Supportive Colleague, Good Friend
  - Jennifer Rosario
    - Illustrator Extraordinary
  - Hospital For Special Surgery
    - Extraordinary Library
Objectives

- Able to describe the bony congruity of the DRUJ
- Able to describe the arthrokinematics of the DRUJ during pronosupination
- Able to list the soft tissue components of the TFCC
- Able to explain to a co-worker what occurs at the TFCC during a Galeazzi Fracture
- Able to measure ulnar variance on an AP x-ray of the wrist
- Able to openly share your newfound profound respect for the DRUJ

Why This?

- Reputation enhancement
- Respect augmentation
- Increase awareness of recent increases in information available
- Skill enhancing exercise in correlating anatomy with clinical decision making
  - Scrutinize anatomy and biomechanics
  - Apply to what we see in the clinic
    - How to manage and progress with careful thought
Key Unit

One bone + two bone forearm + intercalary carpus + 5 rays

Evolution

- Origins of the structural design of present-day 2-bone forearm
- Transformation of pustules with retraction to dry lend

[Image of fish]

[Image of continental map]
Evolution in Humans

- Brain size (vs) opposable thumb (vs) forearm rotation...
- Three key features
  - Recession of the ulna from the carpus
  - Development of an ulnocarpal meniscus
  - Development of a formal synovial DRU

- All of these animals share a common ancestor that grew limbs with digits
- Descendants of that common ancestor evolved different kinds of limbs adapted for different tasks
- They have never lost the anatomic similarities that revealed their kinship
- Darwin was limited to the tools of the day
Misnomer

Osseous Anatomy

- Triphalangeal joint
- Resultant motion is rotation or spinning
- Cuneo-sigmoid notch/convex ulnar seat
- Sigmoid notch has an extra-articular osteocartilaginous lip
  - Bulges to palmar transgression
  - “Deepens” the sigmoid notch
- Volar ulnar corner of the distal radius
  - Volar projection
  - Ulnar projection

Osseous Anatomy

- **Ulnar notch**
  - Fibrous
    - Medially: capsule
    - Laterally: capsule
  - Attachment site of deep branches of Ulnar artery and PNN ligaments
  - Exit site of flexor carpi ulnaris (FCU) muscle

- **Ulnar styloid**
  - Attachment site of superficial branches of Ulnar artery and PNN ligaments

Just dorsal to the ulnar styloid process is the groove for the extensor carpi ulnaris (ECU) tendon.
The distal ulnar does not articulate directly with the carpus.

Radius of Curvature
Biomechanics and Structure - DRUJ

- Biomechanical function of the DRUJ is forearm rotation
- Motion about a longitudinal axis
  - Radial head – fossae of the ulnar neck
- Third degree of motion to the carpus
- Motion occurs in 3 planes
  - Rotation
  - Proximal – Distal
  - Dorsal – Palmar

Anatomic Geometry and Measures

Ulnar Variance
Ligamentous Restraints - DRUJ

- Ligaments of the TFCC provide the primary intrinsic stability of the DRUJ;
- Supplemental stability
  - IOM
  - Extensor retinaculum
  - Muscles/tendons that cross the longitudinal axis of rotation of the forearm
TFCC

- Complex 3-D structure
  - Restraint
  - Control
  - Load transmission
- Articular disc, PNL, DRUJ, ECU sublimis, ULC ligament, Ulnar styloid, multangular bursa

The IOM

- Broad ligamentous structure that connects the radius and ulna along entire length
- Stabilizes the relationship of the radius and ulna through the arc of pronosupination


Dynamic Stabilizers - DRUJ

- Extensor Carpi Ulnaris (ECU)
- Pronator Quadratus (PQ)
  - Superficial Head - transverse fibers
  - Deep Head - oblique fibers
Dynamic Force - DRUJ

- Four muscles drive motion at the DRUJ
  - Two pronators
    - PQ and PI, median innervated, 1 trikneu, 1 median
  - Two supinators
    - Bicep Brachii and flexor
    - Brach: median/ulnare nerve, extensor
    - Supinator: radial nerve, extensor

Distal Radius Fractures

- Multiple ways to impact the DRUJ
  - Extension into the articular surface of the sigmoid notch
    - Joint function compromised, risk for arthritis (SROA)
  - 55% of intraarticular distal radius fractures have fracture lines extending into the sigmoid notch (Stewart 2013)
  - Fracture causes a change in the position of the distal end of the radius
    - DRUJ congruency and function will be compromised
      - Radial shortening
      - Dorsal angulation of the distal radius
      - Ulnar offset
  - Ulnar styloid fracture
    - Compromises DRUJ stability
- TFCC injury occurs in 45-85% of unstable distal radius fractures (Lincoln T, 2000)
- 5%-10% of patients sustain TFCC problems after distal radius fractures (May MM, 2002)
Radial Head Fractures

- PRU and DRUJ are mechanically linked
  - Shape of radial head
  - Angle of union
  - Length
- Persistent clicking

Radial Head Replacement

- Implant replacement
- Too large:
  - Limit rotation and flexion
- Incorrect angle relative to long axis of the radius
  - Clicking, clunking
- Subluxation of radiocapitellar joint
  (Van Geelbeek F. 2009)
Radial Head Resection

- Load transfer from caput to forearm
  - 80% to the radius, 20% to the ulna (Palmer AK 1982)
- Force transferred via the central band of the IOM to ulna and proximally to axial skeleton
  - Radial head/capitellum articulation prevents proximal migration of radius
- Radial head excision
  - Increased reliance on the intact IOM to prevent proximal migration of the radius with load
- No need to elevate, grip, and strengthening in therapy
- Proximal migration of radius to a lower positive variance
  - Increased pressure on TFCC and ulnar abutment
- May see loss of supination; radius can no longer get around lengthened ulna

Ulnar Impaction Syndrome
Ulnar Abutment Syndrome

- Ulnar head impingement of the ulnar caput
- Increased load seen across the TFCC
  - Degeneration or damage to the articular disc
- Symptoms more pronounced in pronation than supination

ECU Subluxation

- Incompetence of the ECU subluxation
  - Tendon subluxates or dislocates out of its groove
  - Supination
  - Painful snap over the ulnar/lateral aspect of the wrist with supination
  - Immobilization that restricts supination and ulnar deviation
  - Confusion with clicking experienced during pronosupination of an unstable DRUJ
ECU Subsheath Repair/Reconstruction

- Supination and ulnar deviation will stress the repair
- Acknowledge the ECU's dynamic stabilizing role:
  - Depression of the ulnar head
  - Depression of the ulnar head
  - Tensioning of the TPCL via the subsheath's interaction with the DRUJ
- Postoperative findings may include:
  - Prominent ulnar head
  - Relative varus posturing of the distal radius and carpus
  - C3/4 increased pressure on their palmar during writing
  - Consider a soft orthotic device to address volar/dorsal posturing of the radius on the ulna

Forearm Contracture

- Multiple potential contributors to motion loss of the forearm
- DRUJ and DRUJ are mechanically linked
- Manual techniques to address the roll and glide of the radial head in the lesser sigmoid notch of the ulna:
  - Pronation: Radial head translates posteriorly on the ulna
  - Supination: Radial head translates anteriorly on the ulna
- Soft tissue structures of the forearm

Ulnar Shortening Osteotomy

- Ulnar shortening osteotomy
- Reduce load across the TPCL
- Correct relative length relationship
- Tensioning of the IT and UL ligament and the DBB of the ECU
  - Increasing TPCL stability
  - Decreasing joint reaction force across the DRUJ
- Risk of delayed or non-union
- Removal of hardware
  - Leaves the DRUJ and TPCL intact
- Osteotomy is in diaphyseal bone, time to heal
- No need to rush bolus application
- Up to 6 weeks to return to full activity
Galeazzi Fracture

- Junction of distal third and middle third of the radius
- DRU dislocation
  - Significant damage to TFCC structure
- Surgical fixation required
- Oftentimes positioned in supination postoperatively
  for maximum DRU stability
- Restoration and protection of DRU stability is mandatory

Monteggia Fracture

- Shaft fracture of the ulna
- Radiolunate dislocation
- DRU usually not involved
- Lateral collateral ligament complex typically preserved
- Mode 1
  - Apex anterior
  - Anterolateral dislocation of radial head
Essex-Lopresti Lesion

- High energy fracture dislocation of the forearm
  - Radial head fracture
  - Complete TFCC disruption
  - DRUJ dislocation

- Complete longitudinal dislocation of the forearm
- Must not excise the radial head
- Significant elbow and forearm ROM deficits

Chronic DRUJ Instability

No associated arthrosis

- Ligamentous restraint of the DRUJ are not able to control ulnocarpal translation
- Forces are not effectively transmitted from the hand to the forearm
- History of an ununited TFCC traumatic injury
- Pain, weakness, clicking, loss of forearm rotation
- Most common presentation:
  - Dorsal displacement of the ulna with respect to the radius
  - Loss of congruity most pronounced in pronation
  - Circumferential freezing
Chronic DRUJ Instability

No associated arthrosis

- Surgical reconstruction
  - Soft tissue reconstruction procedures exist
  - Adams/Bueger procedure to reconstruct the palmar and dorsal ligaments with a tendon graft
  - Wrist extensor reconstruction
- Reconstruction is contraindicated in the presence of:
  - DRUJ arthrosis
  - Length discrepancies
  - Uncontrollable ulnarsex deviation
  - Mutilations of DRUJ
  - Collegen abnormalities
  - IRA

Postoperative management:
- Prolonged period of strict limitation of forearm rotation in a sugar tong style orthosis
- Permit soft tissue reconstruction to heal
- Aggressive forearm PROM is contraindicated
- 6 weeks: long arm cast
- 4 weeks: custom forearm ulnare gutter orthosis
- ROM exercise: gradually over 4-6 months

DRUJ Instability/Pain

With arthrosis

- Presence of joint destruction or degeneration limits surgical interventions to:
  - Dorsal resection
  - Fusion
  - Suture Karpnagi reconstruction
  - Arthroplasty

Consider after prolonged conservative management:
- Orthotic immobilization
- Nonsteroidal anti-inflammatory medications
- Corticosteroid injections
Darrach Resection

- Removal of the ulnar head to reduce wrist pain and instability of the DRUJ
- Commonly used in the treatment of RA
- Most successful in the less active patient
- Risk for painful convergence of the distal stump of the ulna against the radius (McKee MD 1996)
- Complete loss of the ulnar counter support
  - Ulnar translocation of the entire carpus
- Complete destruction of the DRUJ and the forearm axis of rotation
  - Result in increased demand on soft tissue for structural support
- Rehabilitation should respect the significantly altered mechanics and functional capacity

Darrach Resection

- Postoperatively
  - Long arm orthosis in neutral rotation x 6 weeks
  - Allow soft tissue to heal
  - Then initiation of gentle ROM and recovery of function (Gawin G, 2012)

Wafer Resection Osteotomy

- Address limitations of the Darrach resection
- Removes only 2-4 mm of the distal ulna
- Treatment of
  - Ulnar impaction syndrome
  - Symptomatic tears of the TFCC
  - TFCC and ulnar styloid remain intact
- Contraindicated in the presence of DRUJ instability
Wafer Resection Osteotomy
Postoperative

- Forearm immobilized in neutral rotation x 3 weeks
- Gentle motion at 3 weeks postop
- 3-6 months for maximal pain relief
  (Falkson R, 1992)

Sauve-Kapandji Procedure

- Damaged, painful, post-traumatic DRU with arthritis
- RA
- DRU is surgically fused
- Pseudarthrosis is avoided: ulnar osteotomy
- Ulnocarpal buttons are preserved
- Preserves TPCC
- Preserves ulnocarpal ligaments
- ECU remains in its compartment

Sauve-Kapandji Procedure

- Postop strict immobilization is not indicated
  - Custom wrist orthosis to support wrist as fusion heals local tissue recovers
- Consider an emphasis on PROM over excessive AROM for recovery of pronosupination
  - Inflammatory response at osteotomy site -Pseudarthrosis -Restricted ROM
- Convergence of proximal ulnar stump into radius
- Does not restore normal DRU mechanics
- Can take a long time for postoperative discomfort to resolve and function restored
**DRUJ Arthroplasty**

- Joint replacement is gaining popularity
- Few options for revision of failed arthroplasty
- Two groups:
  - Partial or total ulnar head replacements
  - Total DRUJ arthroplasty

**Ulnar Head Replacement**
*(García-Elias, M. 2007)*

- Unconstrained
- Indicated for arthritic DRUJ with minimal instability
- Degenerative, posttraumatic, and inflammatory DRUJ arthritis
- Contraindicated for DRF malunion and in the presence of infection
- Rely on good quality native supporting soft tissue
- Careful soft tissue reconstruction is critical for stability
- Postoperatively
  - 6 weeks immobilization—soft tissue envelope to form and heal

**Total DRUJ Prosthesis**
*(Scheker LR. 2008)*

- Constrained implants
- Suitable for unstable DRUJ
- Do not require soft tissue support
- Self stabilization, do not require native soft tissue support
- Permit normal proximal/distal translation of radius during forearm rotation
- Provide ulnar column support for the carpus
- Replace function of ulnar head, sigmoid notch, TFCC ligaments
- No postop range of motion limitations
  - ARROM allowed immediately
  - No protection
One-Bone Forearm

- Surgical creation of a 1-bone forearm is the ultimate last resort salvage procedure for DRUJ and forearm pain and instability
- At the midshaft level, a fusion of the distal radius and the proximal ulna is created using a plate
- Digital and radiocarpal interosseous motion are preserved, but function is severely compromised and pain often persists

TFCC Tear

- Symptoms related to degenerative TFCC tears often manifest with immobilization (cast) or ulcer garter enthesal & activity modification
- Acute tears may be candidates for surgical repair or debridement
- Palmar classification describes location and type of tear
- Post surgery
  - Return functional forearm and radiocarpal motion without provoking repeated inflammatory responses
Longitudinal Split Tears of the UT Ligament

- Do not cause instability or the DRUJ or the ulnocarpal articulation
- Significant ulnar wrist pain
- Traumatic event
  - Wrist extension
  - Supination
  - Radial deviation
- It is an injury of the TFCC
- Key clinical test: Ulnar Fossa Sign
- Requires surgical repair
- Immobilized 6 weeks in neutral rotation

---

Organizing DRUJ Pathology

**Pain without Instability**
- TFCC tear
- Nerve, Detachment
- Ulnar coronoid impaction
- Ulnar styloid impaction
- DRUJ impaction

**Pain with Instability**
- Axial load fracture
- Ulnolunate, Unlar scaphoid, UAO
- Ulnar styloid fracture
- Unrecognized axial instability, additional wear, RA

**Pain due to Arthritis**
- Degenerative
degenerative, osteoarthritis, ulno-carpal
- Osteoarthritic conditions
Summary

- The DRUJ is a function multiplier for the human upper limb
- DRUJ delivers the significant evolutionary advantage of forearm rotation
  - Hand in infinite positions in space
  - Predictably transmits forces to the axial skeleton
- Go forth and love the DRUJ

Thank You!

Contact: altmane@hss.edu

I will post this powerpoint on www.handtherapyhub.com