

- 1  **Elbow Tendinopathies**
Orthopaedic Shoulder & Elbow Conference
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February 21, 2017
- 2  **Tendinosis**
 - Defined as non-inflammatory intratendinous collagen degeneration
 - Angiofibroblastic hyperplasia – hypertrophic fibroblasts, vascular hyperplasia, disorganized collagen
 - Areas of focal necrosis, calcification
 - No acute inflammatory cells
- 3  **Tendinosis vs Tendinitis**
 - “Tendinosis” implies an intrinsic degenerative condition, determines therapeutic goals, sets reasonable outcome expectations
 - “Tendinitis” implies an inflammatory condition, is misleading, allows misguided treatment & unreasonable expectations
- 4  **Distal Biceps Rupture – Epidemiology**
 - Male mesomorphs (rare in females)
 - Age range 30–60 years (mean age 47)
 - Dominant extremity (86%)
 - Incidence 1.2 ruptures / 100K / year (rare)
 - Smokers 7.5 times greater risk
- 5  **Bilateral ruptures of the distal biceps brachii tendon**
Schneider et al., JSES 2009; 18: 804–07
 - Retrospective review, 25 pts, non-simultaneous bilateral biceps ruptures
 - All pts male, average age 50 (range 28 to 76)
 - Mean time between ruptures 2.7 yrs (0.5 to 6.3)
 - Pts found to have higher rate of nicotine (50%) and anabolic steroid use (20%)
 - Therapeutic Level IV study (Fondren Orthopaedics – Houston, TX)
- 6  **Distal Biceps Anatomy**
 - Short head and long head
 - Musculocutaneous innervation
 - Elbow flexor, forearm supinator
 - Radial tuberosity insertion
 - Bicipital aponeurosis (lacertus fibrosis)
- 7  **Distal biceps tendon insertion: An anatomic study**
Hutchinson et al., JSES 2008; 17: 342–46
 - 20 cadavers dissected to find biceps footprint
 - Insertion at posteroulnar to middle aspect of the radial tuberosity in all specimens
 - Shape of insertion is semilunar (80%) or oval (20%)
 - Reinsertion should be aimed at the posteroulnar aspect of the radial tuberosity
 - Basic Science study (UTHSC – San Antonio, TX)
- 8  **Proper placement of the distal biceps tendon during repair improves supination strength**
Prud’homme–Foster et al., JSES 2015; 24: 527–32
 - 8 fresh frozen cadavers, biomechanical study
 - Anatomic repair is on ulnar side radial tuberosity
 - Supination torque enhanced by cam effect of the radial tuberosity

- 40% less supination torque w/nonanatomic repair than with anatomic repair
- Basic Science study (Canada)

9 Distal Biceps Tendon Anatomy: A Cadaveric Study

Eames et al., JBS 2007; 89A: 1044–49

- In 10/17 cadavers, long & short heads had distinct insertions on radial tuberosity
- Short head inserted distally, better flexor
- Long head inserted proximally, better supinator
- Bicipital aponeurosis may be stabilizer
- Basic Science study (Australia)

10 Bicipital Aponeurosis (Lacertus Fibrosis)

- Envelops biceps, volar forearm muscles
- Statically, lacertus stabilizes the biceps
- As forearm muscles contract, biceps is pulled medially
- Should lacertus be preserved or released before distal biceps repair?

11 Distal Biceps Potential Mechanisms of Rupture: Arterial Supply, Mechanical Impingement

Seiler et al., JSES 1995; 4: 149–56

- Proximal one-third supplied by brachial artery
- Distal one-third from posterior interosseous recurrent artery
- 2-cm middle-third is a hypovascular zone where blood supply is from paratenon
- Radioulnar space for tendon is 48% less in pronation than in supination
- Basic Science study (Emory University)

12 Clinical History

- Sudden forced extension on flexed elbow
- Eccentric contraction of the biceps
- Tearing sensation anterior elbow, audible pop
- Loss of normal biceps contour, bruising
- Weakness elbow flexion, forearm supination

13 Clinical Exam

- Absence palpable tendon (hook test)
- Bicipital crease interval (bicipital crease ratio)
- Weakness on resisted forearm supination
- Biceps squeeze test
- Passive forearm pronation test
- Bicipital aponeurosis flex test

14 Diagnostics

- Radiographs may show spurs, avulsion fracture
- Ultrasound may confirm complete rupture
- MRI most helpful for partial distal biceps tear
- Best MRI technique for imaging distal biceps is FABS (elbow Flexed, shoulder ABducted, forearm Supinated)

15 Nonoperative Treatment of Distal Biceps Tendon Ruptures

Freeman et al., JBS 2009; 91–A: 2329–34

- 20 cases (18 pts, 16 males), 50 yrs (range 35–74)
- 7 dominant arm, 9 nondominant arm, 2 both
- Mean supination strength 74% +/- 33%, mean flexion strength 88% +/- 16%
- Overall satisfactory outcomes, one unsatisfactory

- Therapeutic Level IV study (Hamot Med Ctr – Erie, PA)
- 16 **Classic Two-Incision Technique – Morrey, 1985 (Mayo Clinic)**
- Anterior incision, deliver tendon, whip stitch
 - Advance large clamp between radius and ulna
 - Posterior approach between EDC and ECU
 - Expose and prepare radial tuberosity, deliver sutures through drill holes and tie
- 17 **Evolution of Single Anterior Incision Repair**
- Savoie, 2001 – Suture anchors
 - Greenberg, 2003 – Endobutton
 - Mazzocca, 2005 – Endobutton and interference screw
 - Murthi, 2007 – Biotenodesis interference screw
 - Mazzocca, 2008 – Cortical button, tension-slide
 - Siebenlist, 2011 – Double intramedullary cortical button
 - Tanner, 2013 – Power-optimizing, cost-effect direct repair
- 18 **Pull-Out Strength Comparison**
- Interference screw – 232 N
 - Direct suture repair – 310 N
 - Suture anchors – 381 N
 - Cortical button – 440 N
- 19 **Single vs Double-Incision Technique Distal Biceps Tendon Repair**
Grewal et al., JBJS 2012; 94-A: 1166–74
- Single incision, two suture anchors (n = 47)
 - Double incision, transosseous drill holes (n = 44)
 - Elbow flexion strength 10% better w/two incisions
 - LABC neurapraxia 40% pts w/one incision
 - Four tendon re-ruptures due to noncompliance
 - Therapeutic Level I study (Canada)
- 20 **Preferred Method – Cortical Button Tension-Slide Method**
- Diagnosis of complete tear is clinical
 - MRI is unnecessary if distal biceps tear is complete
 - Single incision, cortical button w/o interference screw
 - Conservative postop & rehabilitation protocol
- 21 **Conservative Postoperative Protocol**
- Long-arm splint w/forearm neutral rotation
 - Long-arm hinged extension block orthosis at one week, passive flexion, active extension
 - Block extension at 60 degrees 2nd week, then 30 degrees 3rd week, full extension 4th week
 - Active pronosupination during 4th week
 - Full active ROM, biceps isometrics, 7–12 wks
 - Progressive strengthening, 13–26 weeks
- 22 **Does immediate elbow mobilization after distal biceps tendon repair carry risk?**
Smith et al., JSES 2016; 25: 810–15
- 22 distal biceps repairs w/cortical button technique
 - Pts encouraged to begin early elbow ROM on DOS
 - All male pts, mean age 40.6 yrs, mean F/U 16.6 mo

- No wound dehiscence, repair failure, pt complaints
- Therapeutic Level IV study (UK)

23 Distal Biceps Partial Tears

- Anterior elbow pain radiating to biceps often after injury event (lifting, forced extension)
- Tender distal biceps, weak resisted supination
- MRI often diagnostic but may be equivocal
- Nonsurgical treatment including PT does not help
- Surgical options are in situ repair vs take-down and re-attachment

24 Partial Tears of the Distal Biceps Tendon: A Systematic Review of Surgical Outcomes Behun et al., JHS 2016; 41-A: e175–e189

- Meta-analysis 19 studies, 86 partial tears repaired
- 65 pts had failed trial non-surgical treatment
- Surgical repair yielded 94% satisfactory outcome
- LABC paresthesia most common (17%) complication
- Therapeutic Level IV study (Western Michigan Univ)

25 Distal biceps tendon tears in women

Jockel et al., JSES 2010; 19: 645–50

- 15 cases (13 pts), mean age 63 yrs (range 48–79)
- 7 single injury, 8 insidious onset, 6 cystic mass
- 14 partial tears, all did well with surgical repair
- Distal biceps tears rarely occur in women
- Age is older than men, no trauma, associated with cyst, mostly partial tears
- Therapeutic Level IV study (Tufts University – Boston, MA)

26 Chronic Tears

- Primary repair in extreme flexion
- Reconstruction with Achilles tendon allograft
- Lacertus fibrosis local autograft (to extend length of retracted distal biceps)
- Biceps tenodesis to brachialis

27 Surgical Complications

- LABC neurapraxia
- PIN palsy
- Heterotopic ossification
- Radioulnar synostosis
- Tendon re-rupture
- CRPS / RSD
- Wound infection

28 Indomethacin in the prevention of radioulnar synostosis after distal biceps repair

Costopoulos et al., JSES 2017; 26: 295–98

- 124 pts had distal biceps repair 2011–14
- Oral indomethacin (75 mg qd for 10 to 42 days)
- 105 two-incision technique cases, 104 rx w/Indocin
- Rx group had 0.96% rate RU synostosis vs 37.5% rate in untreated group
- No adverse effects from indomethacin
- Therapeutic Level III study (Thomas Jefferson Univ – Philadelphia, PA)

- 29 **Drilling Angle & PIN Safety**
- Position full supination
 - Drill perpendicular to long axis of radius
 - Aim 0 to 30 degrees ulnarly to improve margin of safety
 - Basic Science study (Naval Med Ctr – San Diego, CA)
- 30 **Triceps Tendinopathy – Anatomy Consideration**
- Anconeus expansion of triceps insertion
 - Thick medial border of triceps
 - Dome-shaped insertion at tip of olecranon
- 31 **Review of 150 Acute Triceps Ruptures**
Mirzayan et al., 2014 ASES Meeting
- Average age 49 years (range 15 to 79)
 - Males 93%, dominant side 70%
 - Injury mechanism – fall 51%, weight lifting 20%
 - Bony avulsion on lateral radiograph 58%
 - Complete rupture 77%, at bony insertion 97%
 - Smokers 7%, anabolic steroid use 3%
- 32 **Diagnosis**
- Eccentric load, resisted elbow extension
 - Weight lifters, offensive linemen in football
 - Exam – pain & weakness w/resisted extension, palpable tendon defect, positive squeeze test
 - XR – bony avulsion or olecranon fracture
 - MRI – for confirmation of partial tears and to assess degree of injury
- 33 **Treatment Methods**
- Partial tears < 50% (myotendinous junction or intratendinous) – extension splinting
 - Acute complete tears < 3 wks – anatomic repair by transosseous suture or anchors
 - Chronic tears w/retraction – reconstruction w/tendon autograft or allograft
- 34 **Snapping Medial Triceps**
- May be associated w/ulnar neuropathy
 - Treat medial head by excision or lateralization
 - Treat ulnar nerve by anterior transposition
- 35 **Lateral Epicondylitis (Tennis Elbow) – Epidemiology**
- Affects 1–3% adults per year
 - Age range 30–50 years
 - Men & women equally affected
 - More common on dominant side
 - Risk factors include repetitive lifting, manual labor
- 36 **Anatomy & Histology**
- ECRB most commonly affected
 - EDC involved 35–50% patients
 - No evidence of acute inflammation
 - Angiofibroblastic tendinosis
- 37 **Clinical Diagnosis**
- Insidious onset or lateral elbow trauma
 - Wrist extension activity is provocative
 - PE – tenderness at CEO, positive resisted wrist extension

- XRs – may show CEO calcification 7%, but rarely alter management
- MRI – may quantify tendon involvement

38 Nonsurgical Treatment Options

- Activity modification
- NSAIDs
- Orthoses
- Stretching, ASTYM
- Eccentric strengthening
- Iontophoresis
- Steroid injection
- PRP injection
- Botox injection
- Autologous blood injection
- Extracorporeal shock wave

39 Tennis Elbow: The Surgical Treatment of Lateral Epicondylitis

Nirschl et al., JBS 1979; 61A: 832–39

- 1213 cases of lateral epicondylitis (1971–77)
- 88 elbows in 82 pts had open ECRB debridement
- Results – excellent 66, good 9, fair 11, failed 2
- 98% improved, 85% returned to full activity
- Therapeutic Level IV study (Georgetown Univ – Washington, DC)

40 Arthroscopic classification and treatment of lateral epicondylitis:

Two-year clinical results

Baker et al., JSES 2000; 9: 475–82

- 42 arthroscopic releases on 40 pts, avg age 43 yrs
- 15 type I (intact capsule), 15 type II (linear tear), 12 type III (complete capsular tear)
- 69% had associated pathology including synovitis, bone spurs, loose bodies, arthritis
- ECRB debrided, lateral epicondyle decorticated
- 37 of 39 elbows were “better” or “much better”
- Therapeutic Level IV study (Hughston Clinic – Columbus, GA)

41 Treatment Protocol

- Activity modification, counterforce strap, short-arm splint (night), encourage patience
- OT – stretching, strengthening, ASTYM
- Aggressive needling / trephination w/lidocaine
- If no better after one year, open CEO release, partial epicondylectomy
- Recalcitrant cases – arthroscopic debridement, denervation

42 The Nirschl procedure versus arthroscopic

ECRB débridement for lateral epicondylitis

Kwon et al., JSES 2017; 26: 118–24

- 29 elbows, 26 pts (Nirschl), 30 elbows, 29 pts (scope)
- F/U mean 2.5 yrs, measured DASH, VAS, grip strength
- Both techniques effective, comparable outcomes
- Slightly better pain relief in open group w/hard work
- Therapeutic Level III study (South Korea)

- 43 Arthroscopic vs Open Lateral Release for Lateral Epicondylitis
McDonald et al., 2014 ASES Meeting
- Prospective, randomized, controlled trial
 - Open – 15 women, 19 men (avg age 47.1 yrs)
 - Arthroscopic – 13 women, 21 men (avg age 45.0 yrs)
 - No differences in outcome at 12 months postop
 - Therapeutic Level I study (Canada)
- 44 Medial Epicondylosis (Golfer's Elbow) – Epidemiology
- Overall prevalence < 1%
 - Age range 30–60 years
 - Men and women equally affected
 - Medial-sided pathology in 10–20% pts
 - Occupation-related, military population
- 45 Pathoanatomy
- Mechanism of Injury – repetitive eccentric loading CFO
 - Pronator teres is most commonly injured
 - PT, FCR, FDS and FCU origins may all be injured, but not palmaris longus
 - Angiofibroblastic hyperplasia, fibrosis, calcification
- 46 Clinical Presentation
- Occupational – repetitive forceful grasping, vibration exposure
 - Athletics – overhead throwing, golf, tennis, bowling
 - Late cocking or early acceleration phase of throwing
 - Insidious onset common, trauma to CFO
 - PE – tenderness 5–10 mm anterodistal to medial epicondyle. Pain, weakness on resisted wrist volar flexion, forearm pronation.
- 47 Differential Diagnosis
- Ulnar neuritis, subluxation
 - Cervical radiculopathy
 - Elbow MCL insufficiency
 - Elbow trauma
 - Other elbow tendinopathy
- 48 Additional Diagnostics
- Radiographs – usually normal, but up to 25% show medial calcification
 - Ultrasound – focal tendon lesion, but operator-dependent
 - MRI / MRA – gold standard when ruling out concomitant pathology
- 49 Nonoperative Treatment
- Activity modification
 - Rest from throwing, golfing
 - NSAIDs
 - Counterforce strap, taping
 - Short-term splinting
 - ASTYM, but not ESWT
 - Steroid injection, trephination
 - Flexor-pronator stretching
 - Concentric strengthening
 - Eccentric strengthening

50 Operative Treatment of Medial Epicondylitis:

Influence of Ulnar Neuropathy

Gabel & Morrey, JBJs 1995; 77A: 645–50

- Review 36 elbows, 26 pts, 16 w/ulnar neuropathy
- Pain on resisted forearm pronation in 28 of 36
- Debrided CFO, decompressed or transposed nerve
- Good or excellent – 24 of 25 w/o or w/mild ulnar neuropathy, but only 2 of 5 w/mod or severe sx
- Ulnar neuropathy negative prognostic factor
- Mayo Clinic – Rochester, MN

51 The Results of Operative Treatment of Medial Epicondylitis

Kurvers, JBJs 1995; 77A: 1374–79

- 40 consecutive elbows in 38 pts, mean age 42 yrs
- Concomitant ulnar neuritis in 24 elbows
- Rx w/debridement CFO, ulnar nerve simple decompression in 17 of 24 elbows
- 11 of 16 w/o ulnar neuritis were symptom-free
- Only 3 of 24 w/ulnar neuritis were asymptomatic (Netherlands)

52 Preferred Treatment – Ulnar nerve anterior transmuscular transposition and z-plasty of flexor-pronator fascia addresses both ulnar neuropathy and medial epicondylosis