Distal Biceps Repair: Contemporary Options

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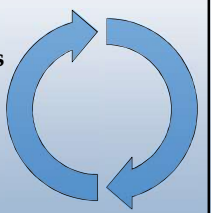
No financial disclosures regarding this topic

123 years ago

Johnson – 1897

- **First report of distal biceps tendon rupture and repair**
- **Single anterior approach**
- **Direct Repair**



23 years ago

Fellow Indiana Hand Center

Indiana Hand to Shoulder Center

Controversies

Three main controversies surrounding distal biceps ruptures

- **Treatment**
  - **Nonoperative v. Operative**
- **Approach**
  - **Single Incision v. Dual Incision**
- **Fixation**
  - **Bone Tunnel, Cortical Button, Anchor**

Biceps Rupture

- **Incidence**
- **Anatomy**
- **Pathophysiology**
- **Mechanism**
- **Diagnostic Studies**
- **Treatment Options**
- **Surgical Techniques**

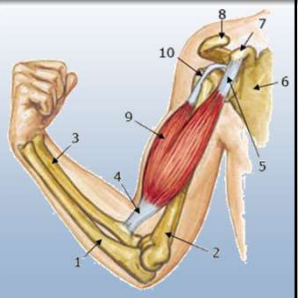
Anatomy

Origin

- Long head
  - Supraglenoid tubercle
- Short head
  - Coracoid process

Insertion

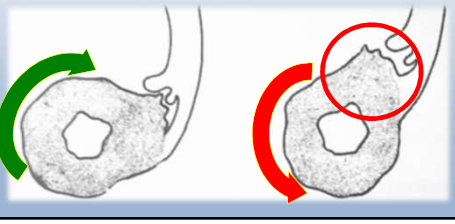
- Radial tuberosity
  - Long/short head
- Medial extension
  - lacertus fibrosis
  - bicipital aponeurosis



Pathophysiology

Yassine and Davis -- JBJS 1956

- Inflammatory and degenerative hypertrophic changes of radial tuberosity



Pathophysiology

Seiler et al, J SE Surg 1995

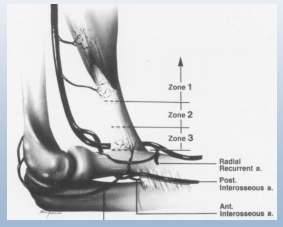
- *Distal Biceps Tendon. Two Potential Mechanisms Involved in its Rupture: Arterial Supply and Mechanical Impingement*

- 30 specimens -- Vascular injection
- 4 specimens -- Light microscopy
- 6 specimens -- Cross sections
- 10 volunteers -- CT scan

Pathophysiology

Seiler et al, J SE Surg 1995

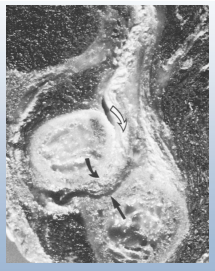
- **Zone 1**
  - **Brachial artery**
- **Zone 2**
  - **hypovascular**
  - **2.14 cm**
- **Zone 3**
  - **Posterior Recurrent**



Pathophysiology

Seiler et al, J SE Surg 1995

- **Cross-sectional anatomy**
  - **Tendon in 85% of space in pronation**
- **CT scan**
  - **48% decrease in space from supination to pronation**



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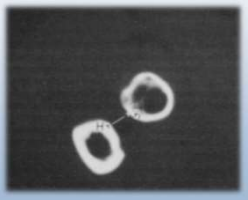

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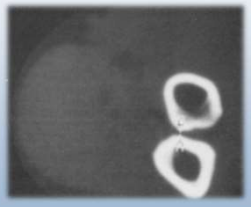
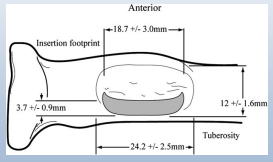


Anatomy

Hutchinson et al, JSES Surg 2008

- **20 cadaver disections**
- **Bicipital tuberosity**
  - **24mm x 12 mm**
  - **Rotational center 45°**
- Tendon insertion
  - Semilunar 80%
  - Axial ridge 40%
  - Osteophytes 15%



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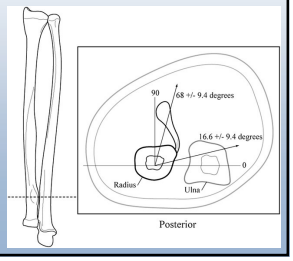


Biomechanics

Effect of Radial Tuberosity Preservation on Supination and Flexion Strength Following a Distal Biceps Repair

Schmidt et al, JSES 2010

- 20 matched elbows
- "Trough" v. "Anatomic" repair
  - 11 mm v. 8 mm (25%Δ)
- 27%⇓ supination moment @ 60º supination
- No difference for flexion force

Biomechanics

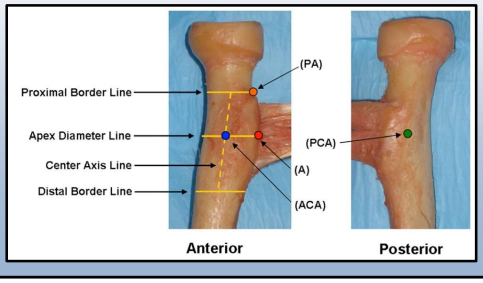
The Effect of Biceps Reattachment Site

Schmidt et al, JSES Surg 2010

- Studied 3 insertion points varying rotation
  - Anatomic, Anterior, Proximal
  - 60º supination, 0º, 60º pronation
- Anterior insertion
  - 97%⇓ in supination
  - 27%⇓ in neutral
  - No difference in pronation

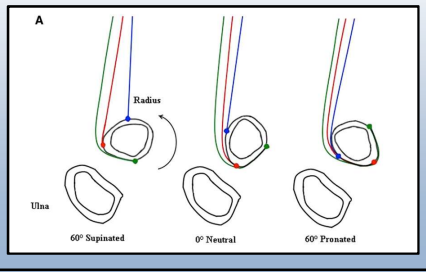
Biomechanics

Schmidt et al, JSES Surg 2010



Biomechanics

Schmidt et al, JSES Surg 2010

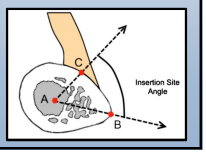


Biomechanics

Repaired Distal Biceps MRI Anatomy Compared with Outcome

Schmidt et al, JSES 2012

- 19 patients randomly selected vs. 10 healthy volunteers
  - Insertion angle 73º more anterior
  - 60º Supination strength 67%
  - 0º 90% and 60º Pronation 101%

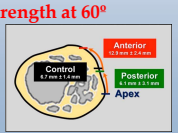


Biomechanics

Factors That Determine Supination Strength Following Distal Biceps Repair

Schmidt et al, JBJS 2016

- 15 prospective posterior vs. 17 random anterior
  - 81% Post vs 67% Ant Supination Strength at 60º
  - 25º Posterior vs 89ºAnterior
  - 6mm Post vs. 13mm Ant
  - Posterior greater supinator fat



Repair Historical Review

Dobbie -- 1941

- 24 prior reported and 51 additional unreported
- Different methods of reattachment
  - 80% to radial tuberosity, 20% to other structure
  - 2 cases of Radial nerve injury (1 permanent)

"The operator was impressed with the numerous important structures identified and confined in this anatomical region and was thoroughly convinced that exposure of the tubercle by this exposure was both impractical and unwise."

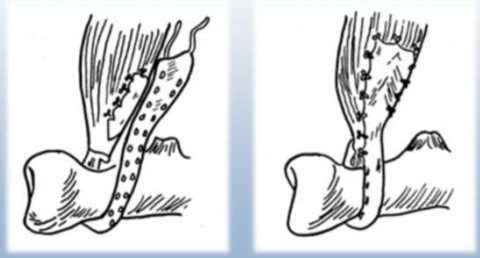
Repair Historical Review

Dobbie -- Conclusions

- "The lesion is disabling and requires operative repair."
- "Loss of power of forearm flexion is the outstanding complaint and disability"
- "supinative power . . . is of secondary importance . . . adequately compensated"

"Direct reattachment of the tendon to the upper radius is difficult to accomplish, time consuming, and not without danger."

Early Repair Techniques



"New" Repair Technique

Boyd and Anderson -- JBJS 1961

- **"different method of insertion"**
  - **3 cases**

"Two-Incision Technique"

- **Tendon approached *anteriorly***
- **Radius approached *posteriorly***
- **Less anterior dissection = Less risk**

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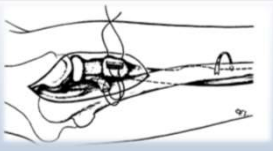


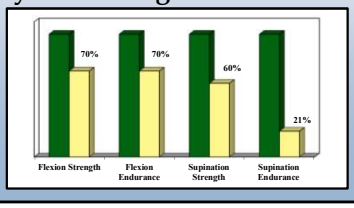
"Two-Incision Technique"

- **Tendon approached *anteriorly***
- **Radius approached *posteriorly***
- **Less anterior dissection = Less risk**

Functional Losses

Baker and Bierwagen -- 1985

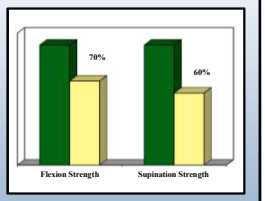
- 13 cases, 10 Operative (Two-Incision Technique)
- Cybex Testing > 15 months later



Functional Losses

Morrey et al – JBJS 1985

- 10 cases, 7 Operative
- Modified Boyd-Anderson Technique
- Strength Testing
- Radioulnar synostosis
  - 2 cases



Comparison Op v Nonop

Nonoperative Treatment of Distal Biceps Tendon Ruptures Compared with a Historical Control Group

Freeman et al, JBJS 2009

- Median supination and elbow flexion strengths for the injured arm were 63% and 93% of contralateral arm
  - compared with values of 92% and 95% for the historical controls that had been treated surgically
    - difference between the mean values was significant for supination strength ($p = 0.002$) but not for flexion strength ($p = 0.164$)
  - Particularly for dominant side
- Patients had satisfactory outcomes overall
  - median scores on the Broberg and Morrey Functional Rating Index, the Mayo Elbow Performance Index, and the Disabilities of the Arm, Shoulder and Hand questionnaire of 85, 95, and 9, respectively

Comparison Op v Nonop

A Comparison of Nonoperative vs. Endobutton Repair of Distal Biceps Ruptures

Legg et al, JSES 2016

- 50 elbows
  - 40 Operative and 10 Nonoperative
- Flexion Strength 93% v 71%
- Supination Strength 88% v 60%
- Functional Scores significantly better
  - Dash, Oxford Elbow, and Mayo

Indications

Nonoperative

- Sedentary
- Elderly
- Individuals not adversly affected by deficit

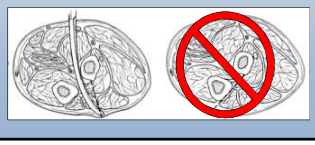
Operative

- Active
- Young
- Laborers
- Maximum function

Radioulnar Synostosis

Failla et al – CORR 1990

- 4 cases proximal radioulnar synostosis
- Attributed to original technique
- "Muscle splitting approach"



Radioulnar Synostosis

- Failla et al – CORR 1990
  - 4 cases proximal radioulnar synostosis
  - Attributed to original technique
  - "Muscle splitting approach"
- Leighton et al -- CORR 1995
  - 1 case of synostosis
  - Using Failla Modification

Single Anterior Approach

- Lintner and Fischer – CORR 1996
  - 5 cases, single anterior approach, Mitek GII
  - Excellent results
  - No cases of nerve injury/synostosis
- Fernandez and Greenberg – ASSH 1997
  - 15 cases, single anterior approach, Endobutton
  - Excellent Results
  - No radial nerve injury/synostosis

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Anchoring Devices

Anterior | Posterior | Interference

Biomechanical BT v SA

Surgical Repair of Distal Biceps Tendon Ruptures: a Biomechanical Comparison of Two Techniques

Pereira et al, Am J Sports Med 2002

- 12 matched pairs, SA v BT
- BT significantly stiffer and greater tensile strength

Biomechanical BT v IS

Distal Biceps Tendon Repair: a Biomechanical Comparison of Intact Tendon and 2 Repair Techniques

Idler et al, Am J Sports Med, 2006

- BT and IS in 9 matched pairs
- Mean failure strength 42% stronger IS
- Maximum strength similar

Comparison BT v CB

Failure Strengths in Distal Biceps Tendon Repair

Kettler et al, Am J Sports Med 2007

- 130 elbows; bone density CT
- 13 different techniques
- CB significantly higher failure load
  - 259N v BT 210N

Comparison BT, CB, SA, IS

Biomechanical Evaluation of 4 Techniques of Distal Biceps Brachii Tendon Repair

Mazzocca et al, Am J Sports Med 2007

- 63 elbows assigned to 4 groups: BT, CB, SA, & IS
- Cyclic loading 0 degrees to 90 degrees at 0.5 Hz 3600 cycles 50-N load
  - pulled to failure120 mm/min.
- No difference in displacement
- Failure load 440N CB, 381N SA, 310N BT, 232N IS

J Shoulder Elbow Surg. 2016 Feb;25(2):e29-37. doi: 10.1016/j.jse.2015.09.004. Epub 2015 Dec 19.

Refixation techniques and approaches for distal biceps tendon ruptures: a systematic review of clinical studies.

Kodde IF[1], Baerveldt RC[2], Mulder PG[3], Eygendaal D[4], van den Bekerom MP[5].

- 40 articles, 1074 patients 4 groups: suture anchors, bone tunnels, interference screws, and cortical buttons
  - outcome measures evaluated were postoperative range of motion, elbow flexion and supination strength, and complication rates and types
- NO significant difference in range of motion and strength between the different approaches and fixation techniques
- Complications were significantly less common after the double-incision approach with bone tunnel fixation (P < .0005)
- double-incision approach had significantly fewer complications than the single-incision anterior approach
- bone tunnel fixation had significantly fewer complications than the other 3 fixation techniques
  - However, as the double-incision approach was used with bone tunnel fixation in 84% of cases, there was a strong interrelationship between these variables.

Arthroscopy. 2017 Sep;33(9):1672-1678. doi: 10.1016/j.arthro.2017.02.008. Epub 2017 Apr 18.

Primary Repair of Traumatic Distal Biceps Ruptures in a Military Population: Clinical Outcomes of Single- Versus 2-Incision Technique.

Waterman BR[1], Navarro-Figueroa I[2], Owens BD[3].

- All military service members primary repair distal biceps rupture through the Military Health System
  - 290 patients average age of 38.9 years
- Single-incision technique 75.4% versus a 2-incision 24.6%
  - Cortical button was the predominant fixation construct 73.4%%
- Reruptures 2.4%
- Overall complication rates 2-incision technique 7.1% was not significantly different from the single-incision repair 16.4%
- Tobacco use was significantly associated with risk of re-rupture
- 96.6% rate of return to preoperative military function without restrictions.

J Hand Surg Am. 2018 Aug 31. pii: S0363-5023(17)31632-5. doi: 10.1016/j.jhsa.2018.07.005. [Epub ahead of print]

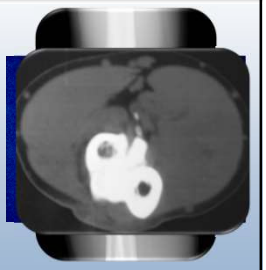
Intramedullary Cortical Button Repair for Distal Biceps Tendon Rupture: A Single-Center Experience.

Siebenlist S[1], Schmitt A[1], Imhoff AB[1], Lenich A[2], Sandmann GH[3], Braun KF[4], Kirchhoff C[4], Biberthaler P[4], Buchholz A[5].

- retrospective study 28 patients intramedullary cortical button repair
  - mean follow-up of 28 months were included in the study
    - Twenty patients examined clinically and maximum isometric strength testing in flexion (at 90°) and supination
    - Twenty-four patients completed functional scores Mayo Elbow Performance Score (MEPS), the Andrews-Carson-Score (ACS) and QuickDASH
- Active range of motion (ROM) was the same
- Strength for flexion was 100
- Strength for supination supination 93%
  - mean MEPS 95, ACS 194 and QuickDASH 3.8
- Heterotopic ossification (HO) seen on radiographs in 46% of patients
  - symptomatic in only 1 patient

Complications

- Technical problems
- Nerve Injury
  - Lateral antebrachial
  - Posterior interosseous
  - Superficial radial sensory
- Elbow stiffness
- Synostosis
- Re-rupture
- Vascular injury



Complications Two-Incision

Complications of Repair of the Distal Biceps Tendon with the Modified Two-Incision Technique

Kelly et al, JBJS – 2000

- 78 retrospective cases - Complications 31%
  - 3 LABCN; 2 SRN; 1 PIN
  - 4 HO
  - 1 re-rupture
  - 1 CRPS
- Timing
  - Less than 10 days – 24%
  - Greater than 10 days – 38%

Complications Two-Incision

Complications Associated with Repair of a Distal Biceps Rupture Using the Modified Two-Incision Technique

Bisson et al, JSES 2007

- 45 consecutive cases – 27% complications
  - 13% (7) nerve
  - 7% (3) functional radioulnar synostosis
  - 1 Re-rupture
  - 1 CRPS

Complications Single v Dual

Cain et al, JHS – 2012

- LABCN 27% v 10%
- RSN 6% v 0%
- PIN 4% v 0%
- HO 3% v 0%
- Re-rupture 2% v 0%
- Infection 2% v 10%
- 37% v 20% -- no statistical significance

J Bone Joint Surg Am. 2014 Dec 17;96(24):2086-90. doi: 10.2106/JBJS.M.00481.

Repair techniques for acute distal biceps tendon ruptures: a systematic review.

Watson JN[1], Moretti VM[1], Schwindel L[1], Hutchinson MR[1].

- 22 studies met the inclusion criteria -- 498 elbows
- complication rate was 24.5% overall
  - 23.9% for single-incision procedures
  - 25.7% for two-incision procedures
    - 44.8% for intraosseous screws
    - 26.4% for suture anchors
    - 20.4% for bone tunnels,
    - 0% for cortical button fixation
  - most common complication was LABCN neuropraxia 9.6% across all studies
    - 11.6% for one incision and 5.8% for two incisions).
  - Heterotopic ossification 3% in single versus 7% is dual incision (0% and 2% synostosis)
- Complication rate did not differ significantly between one and two-incision distal biceps repairs
  - bone tunnel and cortical button methods had significantly lower complication rates compared with suture anchors and intraosseous screws

J Shoulder Elbow Surg. 2014 Jun;23(6):850-4. doi: 10.1016/j.jse.2014.02.006. Epub 2014 Apr 26.

Re-rupture rate of primarily repaired distal biceps tendon injuries.

Hinchey JW[1], Aronowitz JG[1], Sanchez-Sotelo J[2], Morrey BF[1].

- 190 repairs
  - 90% 2-incision
    - Bilateral 7%
    - Women 3%
      - Partial ruptures more common in women
  - Re-rupture in 1.5%
    - All acute phase of 3 weeks
      - Non-compliance/excessive force

Complication Factors

Bekset al, JSES – 2016

- 373 cases – anterior, posterior, combined
- 22% complications – 18% reoperation
  - Single incision and Obesity associated factors
    - 15% radial numbness
    - 2% heterotopic ossification
    - 1% PIN
    - 1.6% Re-rupture

Orthop J Sports Med. 2016 Oct 7;4(10):2325967116668137. eCollection 2016 Oct.

Complications of Distal Biceps Tendon Repair: A Meta-analysis of Single-Incision Versus Double-Incision Surgical Technique.

Amin NH[1], Volpi A[2], Lynch TS[3], Patel RM[4], Cerynik DL[2], Schickendantz MS[5], Jones MH[6].

- systematic review using the PubMed, Medlin, CINAHL, and the Cochrane Central Register of Controlled Trials databases
  - 87 articles met the inclusion criteria
  - Single incision 28% versus Dual incision 21%
- LABCN neurapraxia most common complication in single-incision group 9.8%
- Heterotopic ossification was the most common complication in the double-incision group 7.2%
- frequencies of re-rupture and nerve complications are both higher for single-incision repairs while the frequency of heterotopic ossification is higher for double-incision repairs

J Shoulder Elbow Surg. 2016 Aug;25(8):1229-34. doi: 10.1016/j.jse.2016.02.032. Epub 2016 Apr 20.

Factors associated with adverse events after distal biceps tendon repair or reconstruction.

Beks RB[1], Claessen FM[1], Oh LS[2], Ring D[3], Chen NC[4].

- 373 distal biceps tendon repairs
  - 22% had an adverse event
  - 5.3% were major adverse events
  - single-incision anterior approach and obesity were associated with a higher rate of adverse events
  - 18% of patients with an adverse event and 4% of all patients had a second surgery after distal biceps tendon surgery
- Patients should be counseled that 1 in 5 patients will have a minor complication and 1 in 20 patients will have a major complication

Am J Sports Med. 2017 Nov;45(13):3020-3029. doi: 10.1177/0363546517720200. Epub 2017 Aug 24.

Surgical Treatment of Distal Biceps Tendon Ruptures: An Analysis of Complications in 784 Surgical Repairs.

Dunphy TR[1], Hudson J[1], Batech M[2], Acevedo DC[3], Mirzayan R[2].

- Retrospective cohort study -- 784 repairs that met the inclusion criteria
  - largest series of within an integrated health care system (Kaiser)
    - 81.5% single-incision approaches.
  - Double incision higher complication rate
    - posterior interosseous nerve palsy 3.4% vs 0.8%
    - heterotopic bone formation 7.6% vs 2.7%
    - reoperation 8.3% vs 2.3%
  - most common nerve complication LABCN
    - more common in single incision 24.4% vs 4.1%
  - Re-rupture rate overall was 1.9%
  - No significant differences in rates of motor neurapraxia, infection, re-rupture, and reoperation with regard to surgeon's years of practice, fellowship training, or case volume.

J Shoulder Elbow Surg. 2018 Aug 20. pii: S1058-2746(18)30499-3. doi: 10.1016/j.jse.2018.06.028. [Epub ahead of print]

Major complications after distal biceps tendon repairs: retrospective cohort analysis of 970 cases.

Ford SE[1], Andersen JS[2], Macknet DM[1], Connor PM[2], Loeffler BJ[3], Gaston RG[4].

- large retrospective cohort study of distal biceps
  - 970 patients primary outcome measure total major complication rate
- single incision in 652 cases and 2-incision exposure in 318 cases
  - 7.5% major complication rate and 4.5% reoperation rate were observed overall
    - proximal radioulnar synostosis, 1.0%
    - heterotopic ossification or loss of range of motion with reoperation 0.9%
    - tendon rerupture 1.6%
    - deep infection 0.5%
    - posterior interosseous nerve palsy 1.9%
    - complex regional pain syndrome, 0.6%
- 2-incision exposure significant risk factor for proximal radioulnar synostosis
  - 2.8% of 2-incision cases
- LABCN neuritis more frequently in single-incision exposure

J Shoulder Elbow Surg. 2017 Feb;26(2):295-298. doi: 10.1016/j.jse.2016.11.011.

The use of indomethacin in the prevention of postoperative radioulnar synostosis after distal biceps repair.

Costopoulos CL[1], Abboud JA[2], Ramsey ML[2], Getz CL[2], Sholder DS[2], Taras JP[2], Huttman D[2], Lazarus MD[2].

- single-center retrospective 112 patients
  - 75 mg, once daily 10 to 42 days
- 7 Single-incision and 105 undergoing a Dual-incision repair
- synostosis rate of 0.96% versus 37.50% for untreated group (P < .001)
  - No statistically significant difference was found between fixation methods and synostosis
- did not have any associated adverse effects, including GI bleeding or re-rupture, despite prolonged use of up to 6 weeks

Postoperative Rehabilitation

Does Immediate Elbow Mobilization after Biceps Tendon Repair Carry the Risk of Wound Breakdown, Failure of Repair, or Patient Dissatisfaction?

Smith al, JSES – 2016

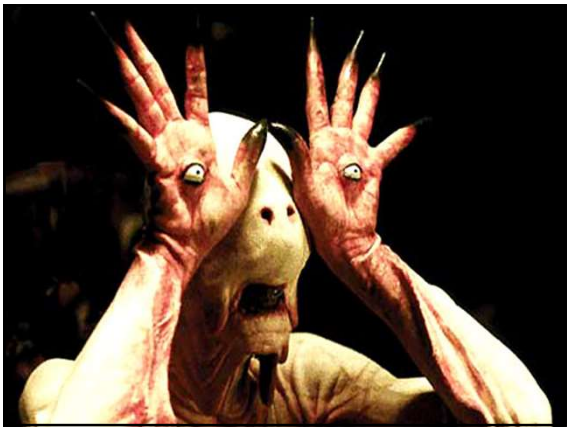
- 22 consecutive CB Repairs
  - No significant differences in tendon re-rupture, wound complications, or patient satisfaction

Postoperative Rehabilitation


- 1-4 weeks: Early active-assist ROM in splint
- 4-8 weeks: 5-10 lbs weight
- 8-12 weeks: progressive strengthening

Biceps Repair Recommendation

- Repair
- Repair early
- Single Incision
- Preserve tuberosity
- Anatomic Site
- Cortical Button
- Protect weeks
- Indomethacin

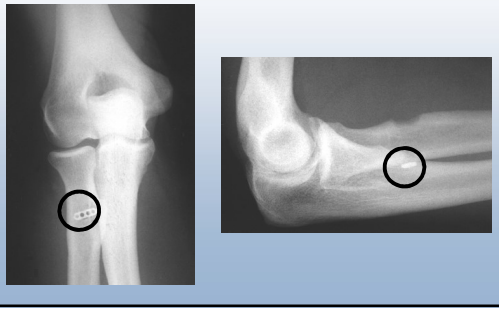


Biceps Rupture

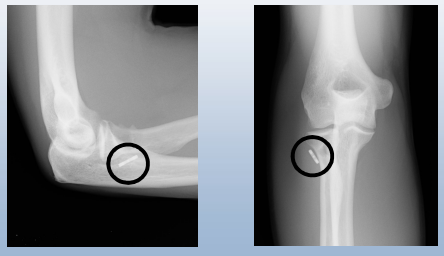
- Incidence
- Anatomy
- Etiology
- Pathophysiology
- Diagnostic Studies
- Treatment Options
- Surgical Techniques

Single-Incision Technique

Radiographs of Endobutton



Radiographs of Endobutton



Two-Incision Technique

Video courtesy M. Cohen, MD