**Diagnosis of Proximal Bicep Tendon Pathology:**
Commonly associated with other shoulder problems (SLAP, Supraspinatus and Subscapularis tears)
Tenosynovitis of the LHB tendon may occur with concomitant bursitis, rotator cuff tendinitis, SLAP, rotator cuff tear, and AC joint disorders, frozen shoulder (Neer), impingement or sometimes a combination of these conditions
However, may present as an isolated source of shoulder pain (< 5%).
Diagnosis: combine history of anterior shoulder pain with pain to palpation over the intertubercular groove, and positive provocative biceps tendon tension tests.
Although recognized for >50 years, LBH tendonitis is increasingly recognized as a sole source of shoulder pain, or in combination with one (or more) of the aforementioned disorders

**Anatomy**
Long head of biceps tendon is approximately 9.8 mm to musculotendinous junction
   Widest at its insertion and progressively narrows as it exits the glenohumeral joint deep to the coracohumeral ligament
3.45 cm from biceps origin to sheath
The long head of the biceps makes a 30-45 degree turn into the groove as it exits the glenohumeral joint
Cross-sectional area of the tendon decreases from proximal to distal and is smallest at the exit of the tendon from the intertubercular groove – this will be the area of highest friction between tendon and bone (Refior JSES 1995)

**Pathophysiology**
Commonly regarded as a degenerative rather than inflammatory process of the tendon, although not well substantiated
Blood supply – critical decrease of blood flow as tendon enters the bicipital groove

**Mechanical forces** -As the tendon is fixed to the superior labrum, it is subjected to shear forces, friction, traction, and pressure. Mechanical causes of biceps degeneration probably predominate (Refior JSES 1995)

Continued mechanical stress at narrow sites (distal biceps groove, under acromion, CA ligament, CHL area), and impingement under the CA arch with flexion may cause degeneration.
A thin rotator cuff may increase mechanical stress on the tendon, thus the hypothesis that those with cuff
dysfunction (tendonitis, partial tears, or full tears) have an increased risk for LHB tenosynovitis (Refior JSES 1995)  
Histologically, degenerative changes found most commonly at distal exit of the tendon from the groove (Refior JSES 1995)  
50% of tendons do not have macroscopic evidence of pathology visible by arthroscopy (Murthi, JSES 2000)  
4 / 14 of cadaveric specimens that underwent histologic examination demonstrated tendinopathy in the distal 3 cm of the long head of the biceps (Buck AJR 2009) (perhaps reflects the 12% of patients who fail proximal biceps fixation)

**Innervation** - LHB tendon contains sensory and sympathetic fibers, especially proximally (Alpantaki JBJS 2005), possibly involved in the pathogenesis of shoulder pain. LHB tendons removed during arthroscopic tenodesis demonstrate less axons and less vasularity compared to controls obtained from cadavers. There was a moderate correlation (R=0.5) between LHB vascularity scores and pain scores (Singaraju, JSES 2008).

**Intraarticular pathology into groove** – The “hourglass” biceps has been described – hypertrophy observed and buckling found with elevation of the arm during arthroscopy – incarceration of the tendon. Excision of intraarticular portion (remove all diseased tendon) recommended via tenodesis.(Boileau JSES 2004).

From Boileau et al. JSES 2004, 13:249-57

**Location of tenodesis**

“Tenodesis of the long head of the biceps brachii for chronic bicipital tendonitis. Long-term results.” (Becker JBJS 1989)  
Proximal soft-tissue tenodesis resulted in only 50% improvement in long-term follow up
Conclusion: proximal soft-tissue tenodesis not effective treatment

“Where to tenodese the Biceps: Proximal or Distal” (Lutton COOR 2011)
   Retrospective analysis of 17 patients underwent biceps tenodesis (5 upper half of groove, 12 lower half of groove)
   2 / 5 patients in upper half of groove had persistent pain at one year
   2 / 12 patients in suprapectoral group symptomatic at 6 months, but asymptomatic at 1 year
Conclusion: More distal fixation is better… but did not evaluate subpectoral tenodesis

   188 patients undergoing biceps tenodesis with average 9 month followup
   Revision Rates
      Proximal arthroscopic: 35.7%
      Proximal open: 12.5%
      Subpectoral Open: 2.7% (p < 0.02)
Conclusion: Subpectoral biceps tenodesis allows optimal restoration of resting length leading to good function outcome and cosmetic result

**Subpectoral Biceps Tenodesis Technique**

   50 shoulders subpectoral biceps tenodesis, followed 29 months.
   ASES 81 (89 without RCT vs. 78 with RCT),
   SST 9 (10.6 without RCT vs. 8.8 with RCT), Rowe 86,
   Constant Murley 87, SANE 84.
   1 Failure due to pullout of tendon
Open Subpectoral Tenodesis - preferred choice


Advantages:
Tendon marked arthroscopically and tenotomized at origin
Subpectoral approach is utilized (2 cm incision) near axillary fold longitudinally
Tenodesed with bioabsorbable interference screw fixation deep to pectoralis tendon
Relevant anatomy is clearly identified
Very efficient and reproducible with “easy learning curve”
Removes tendon from confines of intertubicular groove and synovium associated (which may be cause of persistent pain)

Procedure:
Evaluate biceps “dry” upon initial scope to evaluate inflamed tendon
Draw biceps tendon into joint (looks at portion in the groove)
Frazing almost always indicative of pathologic tenosynovitis
Tenotomize at base

Tenotomize at base. Debride SLAP area if necessary. Open incision - 1 cm superior to inferior
border of pectoralis major tendon, continue 2-3 cm below inferior border OR, place in axillary crease for best cosmesis.

Identify inferior border of pectoralis major, dissect below this level, and the sheath needs to be gently incised directly over the tendon. Palpation will identify the longitudinal structure of the biceps. Blunt Chandler is placed medially (watch musculocutaneous n.) External rotation of the arm brings the nerve 11.3 mm further away from tenodesis site (Dickens AJSM 2012). Use right angle to identify tendon and retract out of the wound. Whip-stitch into most proximal 15 mm of the tendon, adjacent to the musculotendinous border (critical for tensioning and cosmesis)

Biotenodesis (Arthrex, Naples, FL) screw system is utilized to fix in place using 8 mm x 12 mm interference screw.
Complications


Over 3 yrs, 8 of 373 Biceps Tenodesis had complications with incidence of 0.71% per year.
- 2 pts (0.18%) with persistent bicipital pain
- 2 pts (0.18%) with failure of fixation with Popeye deformity
- 1 pt (0.09%) with deep wound infection
- 1 pt (0.09%) with temporary musculocutaneous neuropathy
- 1 pt (0.09%) with RSD
- 1 pt (0.09%) with proximal humerus fracture

Postoperative protocol

Sling x 4 weeks during sleep, during work for 2-3 weeks
Discontinue sling completely at 4 weeks (if isolated procedure)

Overall protocol and sling frequently dictated by concomitant procedures
Progress full PROM (x 6 weeks) to active ROM
Start elbow range of motion and grip strength (immediately)
Avoid supination strengthening and active elbow flexion for 4 weeks
May resume light work at 3-4 weeks depending on job, sooner if less demand.


What are the loads on the biceps tendon?

Difficult to fully characterize – in vivo determination of LHB force
To maintain weight of forearm at 90 degrees to hold a 1 kg object is 112 N (Nordin 2001)
Thus, it is generally inferred from biomechanical failure studies.
Almost all have shown failure at the bicipital-labral complex with progressive loads in several models
Force required to cause failure of superior labral complex is 289 +/- 39 N (Arm in ABER, Kuhn 2003)

External/internal rotation with rapid change in position of the humeral head affect magnitude of tension in biceps (Yeh AJSM 2005), deceleration caused the highest stress/load.

Ultimate strength in a simulated biomechanical model was 508 N (+/- 134N) in deceleration, 262 (+/- 88N) in late cocking (Shepard AJSM 2004). All failed by generation of a SLAP II injury.
Kuhn demonstrated failures of 289 N in late cocking, vs. 346 N in deceleration.(Kuhn Arthroscopy ‘03)
(From Yeh, AJSM 2005)


**Interference screw technique:**

- Highest ultimate load to failure (NO Question; you want strong fixation, this is it)
- Least amount of displacement with cyclical loading
- Most rapid healing (increase fixation strength at 3 weeks in sheep model)
- High clinical success in multiple studies (85 – 90%)


- Biceps tenodesis with interference screw is stronger than double suture anchor

Mazzocca *Arthroscopy* 2005:1296-1306

- Interference screw demonstrated least amount of displacement (versus open bone tunnel, suture anchor)

Kilicoglu *AJSM* 2005: 1536-44

- Sheep shoulder study – Fixation improved over time (healing?), tenodesis screw exhibited higher failure at week 3 versus day 0 (419 N versus 164 N). Tenodesis screw fixation improves over time

**Suture anchors:**

- Less fixation strength at time zero and 3 weeks (however, it often is “enough” based on published clinical studies)
- Less resistance to displacement with cyclical loading
Recommended Reading


Zanetti M, Weishaupt D, Gerber C, Hodler J. Tendinopathy and rupture of the tendon of the long head of the biceps brachii

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