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ORIGINAL ARTICLE

# Anatomic landmarks for arthroscopic suprapectoral biceps tenodesis: a cadaveric study

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**Background:** Biceps tenodesis reduces the incidence of Popeye deformity occurring with tenotomy, but pain may occur with tenodesis superior to or within the bicipital groove. Arthroscopic suprapectoral tenodesis is an attractive alternative. The purpose of this study was to establish landmarks for arthroscopic suprapectoral tenodesis and determine the appropriate fixation point to optimize muscle tension.

**Methods:** Twelve fresh cadaveric shoulders were dissected. Urethane polymer was injected into the axillary artery. The position of the anterior branch of the axillary nerve was marked. The transverse humeral ligament was split, exposing the biceps (long head of the biceps [LHB]) from its origin to the pectoralis major tendon (PMT). The intra-articular portion was released. Measurements were taken from the proximal tendon to described landmarks.

**Results:** The mean length of the intra-articular LHB was 2.53 cm (range, 1.72-3.55 cm). The mean distance from the LHB origin to the inferior lesser tuberosity (LT) was 5.58 cm (range, 4.02-6.87 cm), and that to the superior border of the PMT was 8.46 cm (range, 6.46-10.78 cm). The suprapectoral tenodesis zone (inferior LT to superior PMT) was 2.96 cm (range, 1.54-4.40 cm). In all specimens, a branch of the anterior humeral circumflex arose medial to the LHB and distal to the LT and crossed the suprapectoral zone from medial to lateral at 1.49 ± 0.42 cm proximal to the PMT, approximately at the level of the axillary nerve. The musculocutaneous nerve was on average 3.06 cm (range, 1.86-3.76 cm) from the tenodesis zone.

**Conclusion:** A branch of the anterior humeral circumflex is a reliable landmark for identifying the mid-suprapectoral zone. The distance from the proximal LHB tendon to this crossing vessel averaged 6.32 cm in female specimens and 8.28 cm in male specimens. These findings allow appropriate tensioning of the LHB during arthroscopic suprapectoral tenodesis.

**Level of evidence:** Anatomy Study; Cadaveric Dissection



**Keywords:** Biceps tenodesis; arthroscopic tenodesis; suprapectoral tenodesis; axillary nerve; musculocutaneous nerve; anterior circumflex vessels; landmarks; cadaveric study

The long head of the biceps (LHB) tendon is increasingly recognized as a common source of shoulder pain.[18,19,33] Surgical treatment for recalcitrant pain of the LHB or superior labrum injury can be tenotomy or tenodesis.[3,8,9,11,18,27,28,32]

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Tenotomy produces reliable pain relief, but muscle retraction can result in a cosmetic deformity and muscle cramping.[4,11,13,27-29,32] Tenodesis reduces the incidence of this Popeye deformity and pain and is preferred in younger, more active patients. Tenodesis can be performed via an open or arthroscopic approach, with a variety of fixation methods.[1,2,5,7,17,34] Residual postoperative anterior shoulder pain and bicipital groove tenderness have been observed following arthroscopic tenodesis proximal to, or within, the bicipital groove.[24] This pain has been attributed to persistent tenosynovitis extending into the bicipital groove following tenodesis at the proximal aspect.[6,26] Bicipital groove pain has been observed with increased frequency when the transverse humeral ligament is not released.[26] Several studies have suggested that tenodesis distal to the bicipital groove may eliminate this pain.[22-26]

Prior studies have examined the anatomy of the proximal humerus, particularly the relationship of the LHB tendon and the insertion of the pectoralis major.[14,15,20,35] LaFrance et al[20] evaluated the relationship of the musculotendinous junction of the biceps and the longitudinal width of the pectoralis major tendon at its humeral insertion. They identified the most distal aspect of the musculotendinous junction as the optimal tenodesis site for tensioning in a subpectoral tenodesis. Johannsen et al[15] demonstrated that it was possible to consistently perform tenodesis of the biceps tendon distal to the bicipital groove in an arthroscopic technique and demonstrated reliable measurements of bony landmarks from the superior lip of the humeral tenodesis tunnel. We identified only 1 study, by Jarrett et al,[14] that examined anatomic landmarks of the proximal humerus that would be visible during a standard arthroscopic approach, however.

Lo and Burkhart[21] described a technique for arthroscopic suprapectoral tenodesis distal to the inferior tuberosity and the bicipital groove but proximal to the insertion of the pectoralis major tendon. This was later modified by Flatow and colleagues.[22] Multiple studies have shown low rates of revision and a reduced incidence of postoperative pain using this technique.[21,22] Appropriate soft tissue tensioning remains a concern, however. Over-tensioning can lead to tenodesis failure, while under-tensioning of the biceps can produce a pseudo-Popeye deformity.[15,34,35] The purpose of this study was to identify reliable landmarks and anatomic relationships to aid in establishing physiological muscle tension during arthroscopic suprapectoral tenodesis.

## Methods

### Cadaveric study

Twelve fresh cadaveric shoulders were available for the study. One was found to have a large rotator cuff and tear and prior rupture of the LHB tendon; this specimen was excluded from the analysis. A urethane polymer (PMC-780; Smooth-On, Easton, PA, USA), injected into the axillary artery proximal to the branching of the thoracoacromial trunk, was used to define vascular structures as described by Hettrich et al.[12] The brachial artery was ligated distal to the insertion of the pectoralis major tendon. Dissections were completed 12 to 24 hours following the injections to allow the polymer to solidify.

Surgical exposure of the proximal humerus was performed via a standard deltopectoral approach. The anterior motor branch of the axillary nerve was isolated on the undersurface of the deltoid muscle belly, and its craniocaudal position was marked on the humeral shaft. The anterior deltoid was then reflected off the clavicle and acromion. The transverse humeral ligament was split in line with the bicipital groove and into the rotator interval superiorly, exposing the LHB tendon. The biceps was exposed from its intra-articular origin at the superior labrum to the superior margin of the pectoralis major tendon.

One kilogram of tension was placed on the biceps muscle to most accurately represent anatomic measurements and relationships of the biceps with surrounding structures. The location of the musculotendinous junction was confirmed to be physiological and fixed with a suture, per the technique used by Jarrett et al.[14] The intra-articular portion of the tendon was measured, and the LHB tendon was then released from the labrum. Measurements of distances to identifiable anatomic landmarks were made with digital calipers (Absolute Digimatic Caliper Series 500; Mitutoyo, Aurora, IL, USA) (Fig. 1).

## Results

The mean age of the 11 specimens was 65.5 years. There were 7 female and 4 male specimens for analysis, and there were 5 right and 6 left shoulders. The mean age of the female cadavers was 66.4 years, and that of the male cadavers was 64 years. The mean length of the intra-articular segment of the tendon was 2.53 cm (range, 1.72-3.55 cm). The mean distance

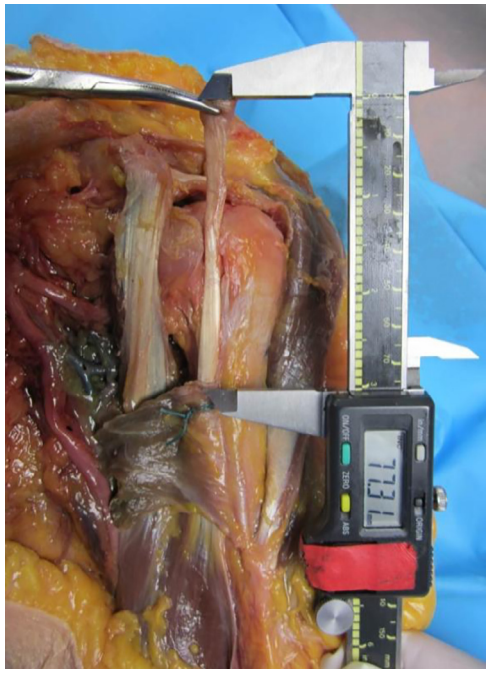

**Figure 1** Intraoperative measurement of exteriorized tendon to be resected.