# Medial and Inferior Placement of Biceps Tenodesis Anchor Increases Risk of Postoperative Biceps Pain in Arthroscopic Suprapectoral Biceps Tenodesis

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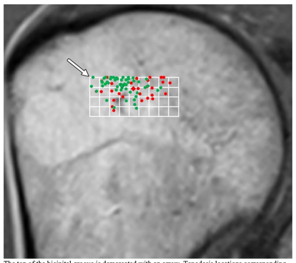
INTRODUCTION: Postoperative biceps pain remains a complication following arthroscopic suprapectoral biceps tenodesis (ASPBT). Analyses of clinical outcomes following ASPBT have not demonstrated an association between tenodesis location and postoperative biceps pain. However, these investigations have honed in on the superior-inferior (SI) dimension. Thus, there exists a paucity of literature investigating the influence of tenodesis location in the medial-lateral (ML) dimension on clinical outcomes. The purpose of this study was to develop a novel method of measuring biceps tenodesis location and to subsequently evaluate for an association between ASPBT suture anchor location and postoperative biceps pain. Secondarily, we aimed to validate our definition of postoperative biceps pain. We hypothesized that more medial tenodesis locations would be associated with a higher rate of postoperative biceps pain and that postoperative biceps pain would be associated with patient-reported outcomes (PROs) which directly measure pain.

METHODS: A retrospective case-control study of patients undergoing ASPBT between 2016-2021 was conducted. Patients without postoperative magnetic resonance imaging (MRI), and those undergoing superior capsular reconstruction, revision rotator cuff repair, open biceps tenodesis, or biceps tenodesis without suture anchors were excluded. A novel MRI-based measurement method for biceps tenodesis location in both ML and SI dimensions was developed as described in Figures 2 and 3. Chi-squared statistics, Fisher's exact test, two-sample t tests, and Kruskal-Wallis analyses were employed for univariate analyses. Once confounders were identified, we constructed a multivariate logistic regression model to investigate the association between tenodesis suture anchor location and risk of postoperative biceps pain. Receiver operating characteristic (ROC) curves were assembled to determine the optimal threshold in the ML and SI dimensions relative to the bicipital groove. An additional multivariate logistic regression model was constructed, compared to the previous multivariate regression model, and validated using the likelihood ratio test. Comparisons of predictability for postoperative biceps pain between continuous and threshold values were made using area under the curve (AUC) values. Finally, validity of postoperative biceps pain was evaluated using VAS, ASES, and PROMIS scores preoperatively and postoperatively via generalized estimating equations (GEE) modeling with either an unstructured or exchangeable covariance matrix. Final GEE models were selected based on smallest quasi-likelihood under independence value to validate correlation structure selection and interaction term inclusion. All analyses were conducted using the same software with a significance level set to $p < 0.05$.

RESULTS: Eighty-one patients (30 BP+, 51 BP-) were analyzed. Tenodesis location in both ML and SI dimensions were predictive of postoperative biceps pain (p=0.011 and p=0.004, respectively). The mean medial and inferior displacement relative to the bicipital groove was 7.4 and 1.9mm, respectively. ROC analysis defined ML and SI thresholds of 8mm and 2mm, respectively, and subsequent regression modeling yielded an area under the curve value of 0.88 (Figure 4). Inter- and intra-class correlation coefficient was 0.95 (95% confidence interval (95%CI):0.90-0.98) and 0.99 (95%CI:0.98-0.99) in the ML dimension, as well as 0.86 (95%CI:0.73-0.94) and 0.96 (95%CI:0.94-0.98) in the SI dimension. The BP+ group had significantly higher VAS scores (p=0.028) and lower ASES scores (p=0.045) relative to the BP- group.

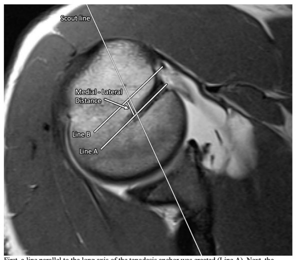
DISCUSSION AND CONCLUSION: The MRI-based measurement method showed excellent inter- and intra-rater correlation and the definition of biceps pain was validated through significant associations with clinical outcome measures. This study revealed that more medially and inferiorly placed biceps tenodesis suture anchors were predictive of postoperative biceps pain following ASPBT. Surgeons should strive to place suture anchors within 8 mm of the bicipital groove in the medial direction and within 2 mm of the top of the bicipital groove to minimize risk of postoperative biceps pain when performing ASPBT.

Figure 1. Schematic depiction of biceps tenodesis anchor locations superimposed on a T1 weighted magnetic resonance image of the humeral head.



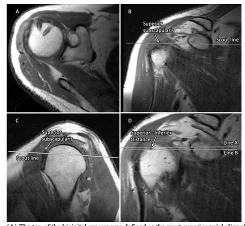
The top of the bicipital groove is demarcated with an arrow. Tenodesis locations corresponding to patients who developed postoperative biceps pain (red) and those who did not (green) are displayed on a plot superimposed on a humeral head. Diamonds are used to illustrate the mean location for those who developed postoperative biceps pain (red) and those who did not (green).

Figure 2: Measurement of the distance of the biceps tenodesis anchor from the center of the bicipital groove along the medial-lateral dimension.




First, a line parallel to the long axis of the tenodesis anchor was created (Line A). Next, the center of the bicipital groove was defined as the midpoint between the medial and lateral edges of the bicipital groove. A second line, parallel to Line A, was created through the center of the bicipital groove (Line B). Using the scout line from the corresponding coronal view as reference, the distance between Line A and Line B was measured along the coronal plane and defined the medial-lateral distance of the biceps tenodesis anchor relative to the top of the bicipital groove (Medial-Lateral distance).

Figure 3: Measurement of the distance of the anchor from the top of the biceps groove along the superior-inferior dimension.




(A) The top of the bicipital groove was defined as the most superior axial slice along the superior-inferior plane in which the subscapularis tendon was still visible. A scout line from this axial slice was placed on a corresponding coronal view (B) of the most anterior portion of the humeral head (B) and a sagittal view (C) showing the subscapularis tendon insertion at the lesser tuberosity to ensure the subscapularis was correctly identified. (D) A scout line was then placed on the anterior-most coronal slice in which the anchor could be seen to identify the top of the bicipital groove in the coronal plane (Line A). Next, a line parallel to Line A in the coronal plane was made through the center of the anchor (Line B). The distance between lines defined the

Figure 4: Illustration of receiver operating characteristic (ROC) curves for the final logistic regression model (4A) and ROC curves based on the most optimal threshold cutoff values (4B) in the ML and SI dimensions.