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Evaluating clinical outcomes of two biceps tenodesis techniques: Loop 'N' Tack and subpectoral biceps tenodesis

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Purpose: Biceps tenodesis is an effective surgical procedure that can address pathologies of the long head of the biceps tendon. The purpose of this study was to evaluate clinical outcomes following two different biceps tenodesis techniques: Loop 'N' Tack biceps tenodesis and subpectoral biceps tenodesis.

Hypothesis: Patients undergoing both the subpectoral biceps tenodesis and Loop 'N' Tack biceps tenodesis will have improvements in patient-reported outcomes.

Methods: Hundred and sixty five consecutive patients who underwent biceps tenodesis were retrospectively identified and contacted by phone to collect visual analog scale pain scores, University of California, Los Angeles shoulder scores, Simple Shoulder Test scores, Single Assessment Numeric Evaluation scores, and American Shoulder and Elbow Surgeons scores. Range of motion, elbow flexion strength, and incidence of bicipital groove pain and Popeye deformity were recorded.

Results: One Hundred and forty five patients were included in the study (55 subpectoral, 90 Loop 'N' Tack). Patients in both groups reported high American Shoulder and Elbow Surgeons, Simple Shoulder Test, University of California, Los Angeles, Single Assessment Numeric Evaluation shoulder function scores, low visual analog scale pain scores, and had a minimal risk of complications when measured one year postoperatively.

Conclusion: Loop 'N' Tack biceps tenodesis and subpectoral biceps tenodesis techniques are reliable and effective procedures that can reduce pain scores and restore shoulder function when patients require surgical intervention.

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Long head of the biceps tendon (LHBT) pathology is a common source of anterior shoulder pain.¹³ When conservative treatments, such as physical therapy and corticosteroid injection, do not offer improvements, surgical intervention can be effective.⁸

Biceps tenodesis is increasingly being used to address LHBT injuries. Werner et al²¹ found that the incidence of biceps tenodesis increased 1.7-fold from 2008 to 2011, and similar recent demographic studies by Vellios and Saltzman^{19,20} have noted comparable growth of the procedure. As this procedure becomes more commonplace and new techniques are developed, each technique's efficacy and clinical outcomes should be investigated. Currently, there are many different bicep tenodesis techniques, but no prevailing gold standard. Different techniques vary by fixation

location (above the groove vs. subpectoral), device used (soft tissue to soft tissue or soft tissue to bone; interference screw or suture anchor), as well as open vs. arthroscopic and suture technique.^{2,4,15,17}

The purpose of this study was to investigate the clinical outcomes of patients having undergone two different biceps tenodesis techniques: an open subpectoral biceps tenodesis and an arthroscopic Loop 'N' Tack biceps tenodesis. Our hypothesis is that patients undergoing both techniques would experience significant improvement in shoulder function and pain relief at a one-year follow-up.

Methods

This study is a retrospective review evaluating clinical outcomes of patients who either underwent an open subpectoral biceps tenodesis or a Loop 'N' Tack biceps tenodesis at a single private practice. All patients underwent the procedure in the same two-year window (2019–2021) and surgeries were performed by

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Table I
Demographics.

	Subpectoral group (n = 55) ¹	Loop 'N' Tack group (n = 90) ¹
Mean age (range) (<i>P</i> = 5.9E-12)	51 (25-76)	62 (32-80)
Standard deviation	8.0	8.8
Sex (<i>P</i> = .012)		
Males	43 (78%)	52 (58%)
Females	12 (22%)	38 (42%)
Laterality		
Left	24 (44%)	30 (33%)
Right	31 (56%)	60 (67%)
Procedures		
Biceps tenodesis	55 (100%)	90 (100%)
Labral débridement	52 (95%)	81 (90%)
Subacromial decompression	50 (91%)	77 (86%)
Acromioplasty	46 (84%)	86 (96%)
Rotator cuff repair	31 (56%)	76 (84%)
Capsular release	8 (15%)	5 (6%)
Humeral chondroplasty	6 (11%)	3 (3%)
Distal clavicle excision ¹	5 (9%)	7 (8%)
Superior capsular reconstruction	1 (2%)	2 (2%)

Demographics collected include age, sex, laterality, and concomitant procedure.

either one author (P.M.S.) or another surgeon in the same practice (S.M.). Both surgeons are board-certified fellowship-trained surgeons with more than 10 years of expertise in shoulder surgery.

After successful induction of anesthesia, all patients were placed in the beach chair position, an examination under anesthesia was conducted and a diagnostic arthroscopy completed. If biceps pathology was noted, the patient underwent either Loop 'N' Tack biceps tenodesis, as described by Hammarstedt and Duerr^{7,10} or subpectoral biceps tenodesis. The choice of procedure was determined by the surgeon based on perceived patient demand. Subpectoral tenodesis was used more often in younger patients, males, and those not undergoing rotator cuff repair. Surgically, we favored a subpectoral approach when the shoulder immobilization was not required for a concomitant surgical procedure (eg, rotator cuff repair). Our subpectoral tenodesis protocol allows for immediate full motion without a sling after 72 hours, which is different than the 4-6 weeks we require after rotator cuff surgery. In addition, we choose the subpectoral technique in muscular males in whom we were worried about cosmesis. Conversely, a Loop 'N' Tack biceps tenodesis selected when concomitant shoulder pathology required 4 or more weeks of immobilization, typically in the setting of full-thickness rotator cuff tears. Any additional pathology that was noted was addressed if necessary and is described in [Table I](#).

The subpectoral biceps tenodesis was performed through a 3 cm incision in the axillary fold. The plane underneath the pectoralis major muscle and above the short head of the biceps was developed bluntly. The short head of the biceps and the neurovascular structures medially were protected, and the pectoralis major retracted superior laterally. The bicipital groove was palpated, and the long head of the biceps sheath opened. The tendon was externalized and whipstitched at the musculotendinous junction. Then, using a bi-cortical button with a docking tension slide technique, the biceps was tenodesed into a 5.0 or a 5.5 mm hole depending on tendon size. No additional screw or fixation was used.

The Loop 'N' Tack biceps tenodesis is an all-arthroscopic procedure that can be performed in the beach chair or lateral decubitus position. The technique is performed through an anterior portal placed laterally in the rotator interval. A racking stitch is placed circumferentially around the midportion of the intra-articular biceps tendon. The free limb of the suture is then passed distal to the

loop placed around the tendon, locking the suture into place. Arthroscopic scissors are used to release the biceps from its origin. A punch is used to create a channel just superior to the subscapularis insertion as visualized from the posterior intra-articular portal. An anchor is then used to secure the suture to the bone.

At a minimum of one-year follow-up, patients were contacted by phone and asked to participate in the study. Patients were asked to rate their shoulder pain using the visual analog scale (VAS) (0-10); Single Assessment Numeric Evaluation (SANE) scores were recorded by asking patients to rate their shoulder as a percentage of normal (0-100), Simple Shoulder Test (SST), American Shoulder and Elbow Surgeons (ASES), and the University of California, Los Angeles (UCLA) shoulder score. Patient charts were reviewed to determine forward flexion strength and range of motion, as well as the incidence of Popeye deformities and bicipital groove pain. A Student *t*-test and chi-squared analysis were performed to determine statistically significant demographic differences (age, sex, concomitant procedures) between the two groups.

Results

We contacted 165 patients. Of these, 145 patients were available and willing to be included in the study (90 Loop 'N' Tack, 55 subpectoral) with an average age of 62 (range, 32-80) in the Loop 'N' Tack group and 51 in the subpectoral group (range, 25-76) ([Table II](#)).

At a minimum of one-year follow-up, patients who underwent a subpectoral biceps tenodesis reported an average VAS pain score of 1.1 out of 10 (range, 0-10), with 89% of patients reporting scores of 3 or under. Consistent with this positive result, patients had high SANE scores, responding with an average 88% when asked to rate their shoulder as a percentage of normal. The average UCLA shoulder rating scale in this group was 32.1 (range, 15-35) and 87% of patients had scores >27, which is the cutoff for a "good/excellent" shoulder score. The mean SST score, which measures shoulder function through yes or no questions, was 92.4 (range, 25-100). The group's average ASES score was 91.5 out of 100. Ninety-five percent of patients (52/55) responded that they were "satisfied and better" than before the procedure, and 5% responded they were "not satisfied and worse." Two patients (4%) in the group had a Popeye deformity and two (4%) had mild or moderate bicipital groove pain.

At the same one-year follow-up, patients who underwent the Loop 'N' Tack biceps tenodesis technique reported an average VAS pain score of 0.7 out of 10 (range, 0-9), with 91% of patients reporting scores of 3 or under. Patients also had high SANE scores, responding with an average of 91% when asked to rate their shoulder as a percentage of normal. The average UCLA shoulder rating scale in this group was 32.2 (range, 19-35) and 87% of patients had scores >27, which is the cutoff for a "good/excellent" shoulder score. The mean SST was 90.8 (range, 33.3-100). This

Table II
Mean outcome scores by technique.

	Subpectoral	Loop 'N' Tack
VAS pain scores	1.1	0.7
SANE	87.8%	91.1%
UCLA	32.1	32.2
SST	92.4	90.8
ASES	91.5	92.2
Satisfied and better	95%	98%
Popeye deformity	4%	0%
Groove pain	4%	4%

VAS, visual analog scale pain score (0-10 scale); SANE, Single Assessment Numeric Evaluation (0%-100% scale); UCLA, University of California Los Angeles shoulder score (0-35 scale); SST, Simple Shoulder Test (0-100 scale); ASES, American Shoulder and Elbow Surgeons shoulder score (0-100 scale).

group also averaged an ASES score of 92.2 out of 100. Ninety-eight percent of patients (88/90) felt that they were “satisfied and better,” and 2% (2/90) felt they were “not satisfied and worse.” No patients were seen with a Popeye deformity and four (4%) had mild or moderate groove pain one year postoperatively.

Our analysis revealed statistically significant demographic differences between groups. Patients undergoing the Loop ‘N’ Tack procedure had an average age of 61.5 ± 8.8 while the average age in the subpectoral biceps tenodesis group was 50.6 ± 8.0 ($P = 5.9E-12$). Additionally, a chi-squared test revealed that the groups varied by gender composition ($P = .012$). Lastly, a chi-squared test revealed differences in concomitant procedures between the groups. Most notably, 84% of patients in the Loop ‘N’ Tack group underwent a rotator cuff repair while only 56% of patients in the subpectoral group did ($P < .001$) ($P = .0002$).

Discussion

Subpectoral and Loop ‘N’ Tack biceps tenodesis provide substantial pain relief and improve shoulder function at a minimum of one year. Patients in both groups had low mean VAS pain scores and shoulder function scores were excellent as evident by high UCLA, ASES, and SST shoulder scores. Both groups also had similar, low rates of bicipital groove pain and Popeye deformity.

The function of the LHBT is often debated. Many studies have described the LHBT as an important humeral head depressor and glenohumeral joint stabilizer, especially when rotator cuff and labral pathology are present, while others have suggested it to be a vestigial structure.^{8,9,13} While there is debate around its function, there is consensus that the LHBT can be a source of anterior shoulder pain.¹¹ When injured, a course of nonoperative treatments, including activity modification, rest, ice, physical therapy, and nonsteroidal anti-inflammatory drugs may be beneficial in restoring function, range of motion, and reducing pain. Subacromial corticosteroid injections can also be beneficial to patients who have concomitant rotator cuff disease. When nonoperative treatments fail, surgery is discussed with the patient.

Biceps tenotomy and biceps tenodesis have become the two mainstay surgical procedures to treat patients with structural long head biceps pathology and/or superior labrum anterior and posterior pathology.^{3,8} Belk et al³ recently performed a systematic review and meta-analysis of five Level I randomized controlled trials to compare the efficacy of biceps tenotomy vs. tenodesis in patients with LHBT pathology and superior labrum anterior and posterior tears and showed that patients experience similar pain relief after both procedures. As outcomes are similar, the differences in procedure can guide the surgeon and patients’ choice of treatment. A biceps tenotomy is a lower-cost, faster procedure, with a shorter rehabilitation time, but it significantly increases the risk of patients developing a cosmetic “Popeye deformity” postoperatively, with studies reporting the incidence of Popeye deformity after tenotomy to be anywhere from 9.1% to 58.1%^{5,12,14,22} (relative risk ratio 3.07²³). Additionally, after a biceps tenotomy, patients have reported biceps muscle spasms/cramps when performing activities that stress the muscle.¹ By anchoring the biceps into the humerus, a biceps tenodesis greatly reduces the risk of cosmetic deformity,^{5,12,14,22} but has a longer rehabilitation time and may increase the risk of persistent bicipital groove pain at the site of fixation. The biceps tenodesis technique is most appropriate for patients looking to avoid the risks of muscle cramps and cosmetic deformity, such as manual workers and competitive athletes with high physical demands, or young patients who wish to avoid the cosmetic deformity.

Belk’s meta-analysis found that 23.3% of biceps tenotomy patients experienced a Popeye deformity vs. 6.8% of biceps tenodesis patients.³ Our study found that both techniques had minimal rates

of Popeye deformity, as zero patients (0%) in the Loop ‘N’ Tack group and only 2 patients (4%) in the subpectoral group were noted to have the deformity. However, the incidence of a Popeye deformity may be underreported in our study as only a small portion of deformities are bothersome, and patients may not recognize them. While fixating the biceps reduces deformity, an argument against doing so is that patients may experience groove pain at the site of fixation. Our results suggest that this is relatively uncommon, as 4 patients (4%) in the Loop ‘N’ Tack group and 2 patients (4%) in the subpectoral group reported such pain ($P = .81$).

Two other essential components of the tenodesis are fixation technique and location. Patzer et al¹⁸ conducted a biomechanical study to investigate fixation techniques and found that interference screws are appropriate for both the suprapectoral and subpectoral biceps tenodesis, whereas knotless suture anchors sustained about 50% lower ultimate failure load. Due to this, they only recommended knotless suture anchors for LHB tenodesis regarding primary stability. However, our study suggests that with a Loop ‘N’ Tack biceps tenodesis, a knotless suture anchor technique, patients still experienced very positive outcomes even though the majority were not primary LHB tenodesis procedures. Regarding fixation site, van Deurzen et al⁶ published a systematic review comparing suprapectoral vs. subpectoral tenodesis, and found comparable results with regard to outcomes, pain scores, and avoiding deformity. McCrum¹⁶ performed a similar review of fixation site by comparing 1526 shoulders. Their study also found no significant difference between suprapectoral (in the groove) vs. subpectoral biceps tenodesis in regard to anterior shoulder pain, cramping, deformity. Both of these studies are consistent with our results, which showed minimal pain and deformity in both the suprapectoral (Loop ‘N’ Tack) and subpectoral techniques.

The Loop ‘N’ Tack technique is a newer, arthroscopic knotless suprapectoral biceps tenodesis. It is a simple, reliable method that can be performed with or without an intact rotator cuff. As a knotless procedure, it limits the potential to over tension, which can be a problem during tenodesis. Duerr et al⁷ performed a retrospective review on the Loop ‘N’ Tack and reported 97% patient satisfaction, minimal complications, and mean ASES scores improved from 42.6 preoperatively to 91.0 at a mean of 43 months follow-up. Our findings reveal a very similar improvement with a mean ASES score of 92.2 and 97.8% patient satisfaction but suggest that these benefits occur earlier than 2 years, as we measured scores one year postoperatively.

Overall, both techniques effectively decrease shoulder pain one year postoperatively with average VAS pain scores reported to be 1.1 and 0.7 for the subpectoral and Loop ‘N’ Tack techniques, respectively. Both procedures provided substantial functional benefit, with patients’ average UCLA scores being 32, average SST of 92 (subpectoral group) and 91 (Loop ‘N’ Tack group), average ASES of 91 (subpectoral group) and 92 (Loop ‘N’ Tack group), and patients rating their shoulder as feeling 88% (subpectoral group) and 91% (Loop ‘N’ Tack group) of normal.

This study is not without limitations. This is not a prospective randomized comparison of two surgical techniques, rather a retrospective review of a single site’s results. While the results of both tenodesis techniques appear to be similar, our data also demonstrate surgical selection bias. Subpectoral tenodesis was used more commonly in younger patients, males, and those not undergoing rotator cuff repair. Additionally, we recognize that relying on verbal communication via phone to measure outcomes, such as the incidence of groove pain, may be inadequate. Finally, since this was a retrospective review, there were 20/165 (12%) patients who were unable to be contacted and a few patients who denied participation during recruitment, which may have introduced selection bias.

However, these limitations do not undermine the study findings and our results may help support future algorithms that define which biceps tenodesis procedure is most appropriate for a given patient. We were initially fearful of cosmetic concerns (Popeye deformity or asymmetry) or groove pain with an all-arthroscopic procedure, but this concern did not clinically manifest.

Conclusion

This study demonstrated that the subpectoral biceps tenodesis and the Loop 'N' Tack biceps tenodesis effectively provide pain relief and improve shoulder function for patients with relevant injury. Patients in both groups had low VAS pain scores, excellent UCLA, SST, and ASES shoulder scores, and low incidence of Popeye deformity and bicipital groove pain when measured one year postoperatively.

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Conflicts of interest: Paul M Sethi reports research grants from Arthrex, Inc. and is a consultant for Arthrex, Inc. The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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