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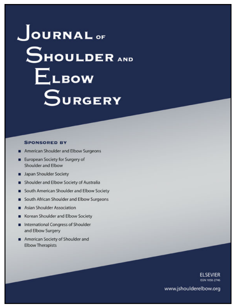

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No Clinical Difference in Outcomes Between Inlay and Onlay Arthroscopic Biceps Tenodesis Techniques during Rotator Cuff Repair

"Impact of Biceps Tenodesis on Outcomes"

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Abstract

Background: Both inlay and onlay arthroscopic biceps tenodesis (ABT) are common procedures performed during rotator cuff repair. The inlay method involves creating a bone socket in the bicipital groove to secure the long head of the biceps tendon (LHBT) using an interference screw. The onlay method utilizes a suture anchor to secure the LHBT on the surface of the bicipital groove. Little is known on the long-term differences in patient reported outcomes (PROs) between these two techniques. The primary purpose of this study was to compare PROs of inlay versus onlay ABT with a minimum follow-up of two years. Secondary aims were to evaluate the impact of rotator cuff tear size on outcomes and compare rates of complications between the two techniques.

Methods: A retrospective chart review was performed to identify patients who had an ABT during a full-thickness rotator cuff repair. Any symptom specific to the biceps were noted, including pain and cramping, Popeye deformity, or revision surgery. Complication rates were compared between groups. The VAS pain score, ASES, SANE, and VR-12 scores were compared at two years. The impact of rotator cuff tear size was analyzed by categorizing into small/medium or large/massive based on operative reports and arthroscopic images.

Results: There were 165 patients identified (106 in the inlay group and 59 in the onlay group). No revision surgeries were performed secondary to the biceps tendon in either group. Eleven patients (10%) in the inlay group complained of biceps pain or cramping compared to 2 patients (3%) in the onlay group ($p = .11$). One Popeye deformity was noted in each group ($p = .67$). No significant differences were found between groups for VAS (p=.41), ASES functional (*p* = .61), ASES Index (*p* = .91), SANE (*p* = .09), VR-12 PCS (*p* = .77), or VR-12 MCS (*p* = .09). Rotator cuff tear size within the groups also did not demonstrate statistical significance.

Conclusion:

No clinical differences or complications were found at minimum two-year follow-up between inlay and onlay arthroscopic biceps tenodesis in patients undergoing rotator cuff repair when controlling for tear size. The clinical relevance suggests either technique is effective and can be based on surgeon preference.

Level of Evidence: Level III

Keywords: Biceps Tenodesis; Inlay; Onlay; Patient Outcomes; Complications; Rotator Cuff Repair

The long head of the biceps tendon (LHBT) is often damaged in patients with full-thickness tears of the rotator cuff leading to additional anterior shoulder pain and functional impairment.[6, 8, 20]A tenodesis of the LHBT is often done as a concomitant procedure during rotator cuff repair. Several different arthroscopic biceps tenodesis (ABT) procedures have been proposed and can be divided into inlay and onlay techniques.[8, 9, 11, 20] The inlay method involves creating a bone socket in the bicipital groove to dock and secure the LHBT using an interference screw (Figure 1). The onlay method utilizes a suture anchor or a unicortical suspensory device to secure the LHBT on the surface of the bicipital groove (Figure 2).

The clinical outcomes of various ABT techniques are difficult to study since they are rarely done in isolation. Many studies have reported improved biomechanical strength with the inlay technique,[12-15] but it creates a larger defect in the proximal humerus that can be more painful in the immediate postoperative phase and serve as a stress riser for torsional fracture of the proximal humerus.[1, 17] Some studies have shown a lower revision rate with the onlay technique.[7, 8] Although both inlay and onlay techniques have been shown to improve clinical outcomes, current literature is not clear on the clinical significance of the differences and does not consider the effect of rotator cuff tear size on outcomes.[8, 9, 20]

The purpose of this study was to compare the two-year clinical outcomes of inlay versus onlay ABT in patients undergoing repair of a full thickness rotator cuff tear. The size of the rotator cuff tear was considered to limit confounding outcomes related to rotator cuff healing. The authors hypothesized that there would be no difference in clinical outcomes between techniques at two years irrespective of tear size. Secondary aims of this study were to evaluate the impact of rotator cuff tear size on outcomes and to compare rates of complications and Popeye deformities, which is an indirect sign of tendon healing, between the two ABT techniques.

Methods:

A retrospective chart review was performed on prospectively collected data to identify patients who had a concomitant ABT during full-thickness rotator cuff repair. Institutional review board approval was obtained. The inclusion criteria included an inlay or onlay ABT procedure performed with arthroscopic repair of a full thickness rotator cuff tear with a minimum of two-year clinical follow-up. The surgeons in this cohort had been using an inlay technique historically. Based on some of the literature referenced, the surgeons gradually transitioned to mostly an onlay technique. No changes were done to the arthroscopic rotator cuff tear techniques during the study. All ABT were done in the middle of the bicipital groove regardless of fixation method per surgeon preference. Exclusion criteria included irreparable rotator cuff tears, partial rotator cuff repairs, and revision surgeries. Rotator cuff tear sizes were determined by independent review of preoperative MRI and arthroscopic images by a fellowship-trained shoulder surgeon. Tear size was divided into small/medium (up to 3cm) and large/massive tears (>3cm) based on the anterior-posterior dimension of the tear.

All procedures were done by 1 of 3 fellowship-trained orthopedic surgeons in the lateral decubitus position. The LHBT was released from the superior labrum during the initial diagnostic arthroscopy. The inlay ABT was done by releasing the LHBT from the superior glenoid, externalizing the tendon from an accessory lateral portal overlying the bicipital groove, and whip-stitching the tendon with a Number 2 looped stitch (Fiberloop, Arthrex, Naples, FL, USA). The suture was sewn beyond the length of the interference screw in attempts to protect the tendon during screw insertion. A guide pin gently tapped in place in the middle of the bicipital groove under direct arthroscopic visualization. A 7.5mm cannulated reamer was used over the pin to make a bone socket depth of approximately 25mm. The reamer was 0.5mm larger than the screw size to minimize damage of the screw on the tendon. The LHBT was then inserted into the socket using a tenodesis screwdriver and secured using a 7mm x 23mm biocomposite tenodesis screw (Arthrex, Naples, FL, USA). All onlay ABT procedure were done at the same location with a Number 2 stitch (FiberLink; Arthrex, Naples, FL, USA). A luggage tag followed by a distal penetrating stitch was used while viewing within the subacromial space. The free ends of the stitches were then passed through a knotless suture anchor (4.75mm biocomposite Swivel-lock; Arthrex, Naples, FL, USA). A pilot hole was made in the center of the bicipital groove, and the anchor was inserted. The anchors used for the onlay technique were independent of the rotator cuff anchors. In both the inlay and onlay techniques, the articular length of the LHBT was excised in attempt to maintain an anatomic length-tension relationship of the biceps muscle.

All patients wore an abduction sling for six weeks after surgery. The same supervised physical therapy program was followed by both groups at the same facility. Passive range of motion of the shoulder beneath shoulder height as well as active range of the motion of the elbow, wrist, and hand was allowed immediately. At six weeks, overhead passive motion and active motion of the shoulder were allowed. Strength training was initiated at 8 weeks for small-medium rotator cuff tears and 12 weeks for large-massive rotator cuff tears.

Inlay versus onlay, rotator cuff tear size, and number of suture anchors used for the rotator cuff repair were collected for each patient. The rotator cuff tear size was categorized into small/medium or large/massive based on operative reports and arthroscopic images. The number of suture anchors was collected as an additional surrogate for rotator cuff size, as the authors preferences was to perform a single lateral based anchor for small tears, and a double row repair for medium, large, and massive tears. Any symptoms specific to the biceps including pain and cramping, Popeye deformity, or revision surgery due to the biceps were noted.

Blinded members of the research staff collected the patient reported outcomes (VAS pain score, ASES, SANE, and VR-12) at a minimum of two years postoperatively. These groups were matched and covaried to evaluate the impact of rotator cuff tear size on the two-year outcomes using Fisher exact two-sided tests. For continuous measures, general linear modeling with covariate control of tear-size and outcome measure at baseline was used. For complications, chi-square/Fisher exact measures were used. Boundary values for partial eta squared ($\eta 2$-an effect measure) are as follows: $\eta 2 = 0.01$ indicates a small effect; $\eta 2 = 0.06$ indicates a medium effect; $\eta 2 = 0.14$ indicates a large effect.

Results:

A total of 165 patients were identified during the study period with a minimum two-year clinical outcome follow-up 24.5 months. Based on surgeon preference during the study period, more inlay ABT procedures were done (106 inlay versus 59 onlay). Baseline patient demographics are presented in Table 1.

No significant differences were found between the groups for VAS (p=.41), ASES functional (p = .61), ASES Index (p = .91), SANE (p = .09), VR-12 PCS (p = .77), or VR-12 MCS (p = .09) scores (Table 2). No revision surgeries were performed secondary to the biceps tendon in either group. Eleven patients (10%) in the inlay group complained of biceps pain or cramping compared to only two patients (3%) in the onlay group (p = .11). One Popeye deformity was noted in each group (p = .67).

Rotator cuff tear sizes were recorded within ABT groups: 43 small/medium tears with inlay ABT, 63 large/massive tears with inlay ABT, 22 small/medium tears with onlay ABT, and 37 large/massive sized tears with onlay ABTs. The effect of rotator cuff tear size within the groups did not demonstrate statistical significance in any of the outcomes.

Discussion:

The main finding of this study was that no differences in PROs were found between the inlay and onlay ABT techniques at two-year follow-up regardless of rotator cuff tear size. There were no statistical differences in complications, including biceps pain/cramping, deformity, or revision biceps operations. There was a trend towards more biceps pain and cramping in the inlay group, which is consistent with previous literature.[8, 9] Strength of the study included the consideration of rotator cuff tear size in its outcomes. The size of the rotator cuff tear did not influence outcomes or complication rate. Based on these findings, the onlay method has advantages as it is less destructive to the proximal humeral bone and potentially cost-effective, since it can be combined with an anchor used for repairing the rotator cuff. The larger tenodesis screw used for inlay may damage the tendon at the time of insertion resulting in failure, causes more concern of persistent osteolysis in the case of an absorbable screw, and may produce a stress riser for proximal humerus fracture.[1, 3, 11, 17]

Several controversies exist with regards to biceps tenodesis technique. The current literature reports improved outcomes with few complications regardless of ABT technique.[9] Biomechanical studies have shown mixed results when comparing load to failure with inlay and onlay biceps tenodesis techniques, although the cadaveric biomechanical studies may not translate to clinical differences.[4, 12, 15] Cagle et al found no significant difference between an inlay and onlay technique in a recent cadaveric study.[4] Park et al found that the inlay technique had less healing compared to the onlay technique but did not affect outcome scores.[11] Mazzocca et al found no difference in cyclic displacement and load to failure in 20 cadaveric shoulder when comparing onlay with a suture anchor to an inlay with a biotenodesis screw with a suprapectoral approach.[10]

The onlay technique has a theoretical advantage in that it can be performed with the biceps still intact at its proximal attachment. An accurate length-tension relationship can be assured if the biceps is released after the tenodesis is performed. The onlay technique can also be done with less proximal humeral bone preparation, since no socket for tendon insertion is needed.

The ideal location has been debated with some reports describing less bicipital groove pain with a more inferior location (suprapectoral or subpectoral).[9] A high in the groove suprapectoral tenodesis has been reported to have a higher incidence of anterior shoulder pain.[10] The increased pain has been thought to be due to persistent tenosynovitis within the intertubercular groove. Others have reported excellent outcomes and low complications with a more proximal ABT location high in the groove.[2, 8] A recent systematic review showed no difference in VAS, Constant score, or Popeye deformities between suprapectoral and subpectoral biceps tenodesis.[9]

Haidamous et al compared inlay and onlay techniques for a ABT high in the groove in 90 patients.[8] After minimum one year follow-up, they found no difference between groups with regards to postoperative range of motion, functional outcome scores, or elbow flexion strength. The inlay group had a higher revision rate (10.8% vs. 0%, p=.015), although only 2 of the revisions were related to the biceps tenodesis. There was a statistically higher percentage of postoperative Popeye deformities in the inlay group (27%) compared to the onlay group (9.4%), p=0.028. The increased incidence of Popeye deformities in the inlay group is thought to be due to tendon damage from the interference screw during its insertion.[19] A meta-analysis by Jackson et al found similar outcomes.[9] They found no statistically significant differences in ASES, VAS, CS, Popeye deformities, or failure rates between the two techniques.[9]

The authors prefer a middle of the bicipital groove location for the tenodesis, since it avoids additional open dissection, can be easily reached with standard arthroscopic portals, and lessens surgical risk. Open distal tenodesis techniques have been associated with neurologic[5, 18] and fracture risk.[1, 17] As opposed to using the top of the bicipital groove, the middle of the bicipital groove location ensures releasing the overlying biceps sheath, which has been shown to reduce residual bicipital groove pain and lower revision rates.[16]

Limitations of the study include its retrospective nature, which is dependent on the accuracy and completeness of the medical records. For example, only 2 Popeye deformities were documented, which is a low incidence compared to previous literature (11.3% after an inlay technique and 7.8% after on onlay technique in a recent meta-analysis).[9] Additional outcome measures including strength and return to activities were not consistently documented in the medical records so could not be considered based on the study design. Another limitation is the inability to determine if the outcomes are related directly to the ABT technique or rather influenced more so by rotator cuff healing, other concomitant procedures, or postoperative physical therapy. An attempt to minimize effect of rotator cuff healing was to control for rotator cuff tear size and exclude patients with irreparable tears and partial repairs. The same physical therapy protocol was used in both groups to minimize effect of postoperative rehabilitation. Another limitation is that the results may not be generalizable to other tenodesis locations within the proximal humerus, such as high in the groove, suprapectoral, or subpectoral regions. The site of tenodesis in this study was consistent between techniques (middle of the bicipital groove) to avoid difference related to different tenodesis locations.

Conclusion:

No clinical differences or complications were found at minimum two-year follow-up between inlay and onlay arthroscopic biceps tenodesis in patients undergoing rotator cuff repair when controlling for tear size. The clinical relevance suggests either technique is effective and can be based on surgeon preference.

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Figure Legend:

1. Figure 1: Illustration of inlay method of biceps tenodesis.
2. Figure 2: Illustration of onlay method of biceps tenodesis.

Table 1: Baseline patient demographics

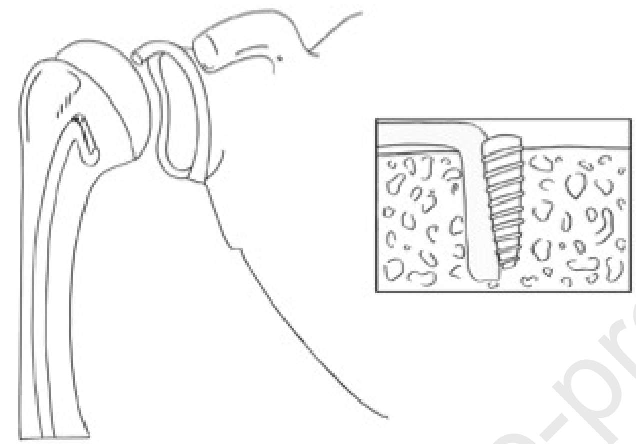
	Onlay	Inlay	P value*
Sex	35=male 24=female	75=male 31=female	.13
Age	59.33 (SD=8.8)	58.41 (SD=9.1)	.93
Tear Size	22=small/medium 37=large/massive	43=small/medium 63=large/massive	.68

Table 2. Differences in Two-Year Outcomes between Inlay and Onlay Approaches.

Outcome Measured	Inlay Approach N=106; Mean (SD) / N (%)	Onlay Approach N=59; Mean (SD) / N (%)	P value	Partial Eta Square (effect size)
Visual Analog Scale	1.00 (1.57)	1.36 (2.16)	.41	0.00
ASES Functional Score	28.16 (5.53)	27.52 (3.55)	.61	0.00
ASES Index Score	88.94 (13.58)	88.14 (15.62)	.91	0.00
SANE	82.40 (23.57)	74.98 (30.28)	.09	0.02
VR-12 PCS	49.06 (6.92)	48.45 (6.99)	.77	0.00
VR-12 MCS	55.35 (8.18)	55.56 (9.36)	.09	0.02
Complication-Popeye Deformity	1 (<1%)=Yes	1 (2%)=Yes	.67	NA
Complication-Biceps Cramping/Pain	11 (10%)=Yes	2(3%)=Yes	.11	NA

For continuous measures, general linear modeling with covariate control of tear-size and outcome measure at baseline was used. For complications, chi-square/Fisher exact measures were used. Boundary values for partial eta squared (η2-an effect measure) are as follows: η2= 0.01 indicates a small effect; η2 = 0.06 indicates a medium effect; η2 = 0.14 indicates a large effect.

Figure 1



The inlay method involves creating a bone socket in the bicipital groove to dock and secure the long head of the biceps tendon (LHBT) using an interference screw.

Figure 2

The onlay method utilizes a suture anchor to secure the LHBT on the surface of the bicipital groove.