[Orthopaedic Surgery]

A Systematic Review and Meta-analysis Comparing Clinical Outcomes After Concurrent Rotator Cuff Repair and Long Head Biceps Tenodesis or Tenotomy

Timothy Leroux, MD, MEd,[†] Jaskarndip Chahal, MD, MSc, FRCSC,[*†‡] David Wasserstein, MD, MSc, FRCSC,[†§] Nikhil N. Verma, MD,[‖] and Anthony A. Romeo, MD[‖]

Context: A comparison of clinical outcomes after long head of biceps (LHB) tenotomy or tenodesis performed concurrently with rotator cuff repair (RCR) is of interest to physicians and patients.

Objective: A systematic review of clinical outcome studies examining LHB tenotomy or tenodesis performed concurrently with RCR. Secondarily, perform a meta-analysis of data from comparative studies.

Data Sources: MEDLINE (1946 to week 30 of 2013) and EMBASE (1980 to week 30 of 2013).

Study Selection: Levels 1 through 4 studies reporting clinical outcomes of concurrent RCR and LHB tenotomy or tenodesis with minimum 1-year follow-up.

Study Design: Systematic review and meta-analysis.

Level of Evidence: Level 4.

Data Extraction: Two independent reviewers identified eligible studies and applied the exclusion criteria. Clinical outcome data, including functional outcome score(s), biceps deformity and cramping, and patient satisfaction, were extracted. Clinical outcome data from included studies were pooled (weighted according to study size) and reported. A meta-analysis was performed only on outcomes extracted from comparative studies ($\alpha = 0.05$).

Results: Twelve studies (N = 565 patients; mean age, 61.3 years; 46.3% men) were included. Of these, 6 (N = 263) included RCR and LHB tenotomy and 9 (N = 302) included RCR and LHB tenodesis. A meta-analysis was performed on 3 comparative studies (levels 1 and 2), demonstrating that the postoperative Constant score at a mean follow-up of 25.5 months was significantly greater after tenodesis (92.8 [tenodesis] vs 90.6 [tenotomy], $P < 0.01$); however, this difference was less than the reported minimal clinically important difference of 10.4 points. Similarly, the rate of biceps deformity was significantly less after tenodesis (15.5% [tenotomy] vs 3.9% [tenodesis], $P < 0.01$); however, most patients were not bothered by it. There were no significant differences in the rate of biceps cramping or patient satisfaction.

Conclusion: Although the postoperative Constant score and rate of biceps deformity favor LHB tenodesis statistically, the clinical significance appears negligible.

Keywords: biceps tenodesis; biceps tenotomy; rotator cuff repair; meta-analysis; systematic review

From the [†]University of Toronto Orthopaedic Sports Medicine, Toronto, Ontario, Canada, [‡]Osteoarthritis Research Unit, University Health Network, Toronto, Ontario, Canada, [§]Sunnybrook Health Sciences Center, Toronto, Ontario, Canada, and [‖]Division of Sports Medicine, Rush University Medical Center, Chicago, Illinois

*Address correspondence to Jaskarndip Chahal, MD, MSc, FRCSC, University of Toronto Orthopaedic Sports Medicine, 399 Bathurst Street, Toronto, Ontario, M5S 2T8, Canada (e-mail: jchahal@utosm.com).

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Pathology of the long head of the biceps (LHB) includes tendinitis, partial tears, subluxation, and/or dislocation. Depending on the severity of the pathology, surgical management of these lesions may be indicated, including debridement, tenotomy, or tenodesis.[20] There is, however, ongoing controversy regarding which surgical technique—specifically, LHB tenotomy or tenodesis—results in the best patient outcomes.[20] In fact, 2 systematic reviews[8,24] have compared clinical data between patients undergoing LHB tenotomy or tenodesis and concluded that clinical outcomes were similar (proportion of excellent/good outcomes, 77% tenotomy vs 74% tenodesis[24]) and that there is a higher incidence of biceps muscle deformity ("popeye" deformity)[20] after tenotomy (proportion of deformity, 43% tenotomy vs 8% tenodesis[24]; 41% tenotomy vs 25% tenodesis[8]). A significant limitation of these systematic reviews, however, is the comparison of low-quality data and the inclusion of heterogeneous patient populations that vary with respect to demographics, concomitant shoulder pathology, and concurrent shoulder procedures. Ultimately, interpretation and generalizability of these findings is limited.

Pathology of the LHB tendon is most commonly encountered in the setting of a rotator cuff tear.[20] In the present study, we sought to determine which clinical differences might exist between LHB tenotomy and LHB tenodesis when performed concurrently with rotator cuff repair (RCR), the results of which we believe would assist in treatment selection. Specifically, we summarize the available literature on this topic through a systematic review and perform a meta-analysis of clinical outcome data from comparative studies. We hypothesize that there are no differences in patient outcomes between the 2 procedures.

METHODS

Literature Search

Two individuals (TL and JC) independently performed a computerized search of the electronic databases MEDLINE (1946 to week 30 of 2013) and EMBASE (1980 to week 30 of 2013) using the subject title "biceps AND (tenotomy OR tenodesis)" and identified 335 unique studies. A title screen looking for studies that met the inclusion criteria identified 35 relevant studies. Each abstract was then thoroughly reviewed, and 12 studies[2,4-7,9-12,16,19,27] met the exclusion criteria (below) and were included in this systematic review. Of these 12 studies, 3 studies[4,12,27] directly compared both techniques, and only data from these studies was used in the meta-analysis. The references of all included studies were manually cross-referenced for completeness, and full articles were reviewed to further verify appropriateness for inclusion and level of evidence (LOE).[21,26] Disagreements were resolved by discussion with the senior author (AAR).

Exclusion criteria consisted of (*a*) a heterogeneous patient population, (*b*) patient age less than 16 years, (*c*) less than 10 patients, (*d*) less than 1-year follow-up, (*e*) cadaver or animal studies, and (*f*) case reports, biomechanical studies, or technique articles that did not report clinical outcome data.

It is important to note that given the limitations in classifying rotator cuff tears and determining repairability,[13,15,25] any partial- or full-thickness rotator cuff tear deemed repairable by the respective study investigator(s) was included. We also did not stratify according to concomitant procedures—specifically, subacromial decompression and distal clavicle excision—as evidence suggests that these procedures do not influence clinical outcomes in the context of RCR.[1]

Data Extraction

Two independent reviewers (TL, JC) extracted data from each relevant study and grouped it according to the LHB procedure (tenotomy or tenodesis). Data included study characteristics (study type, patient number, and duration of follow-up), patient demographics (age, sex, and arm dominance), procedure characteristics (rotator cuff pathology, LHB pathology, surgical details, and concomitant procedures), and clinical outcomes (reported at maximum follow-up for each study). Clinical outcomes included postoperative functional outcome score(s), biceps deformity ("popeye" deformity[20]) and cramping, and patient satisfaction.

Data Analysis

Data were pooled for each demographic and outcome parameter according to sample size, and frequency-weighted means were reported. A formal meta-analysis was conducted only for clinical outcome data from comparative studies using Review Manager 5.1 (Cochrane Collaboration). For the latter analysis, results for continuous or categorical outcomes were reported as a mean difference or an odds ratio, respectively, with 95% confidence intervals. A fixed-effects model was used for all analyses, as the observed heterogeneity (I^2) was <50%. For all statistical tests, α was set to 0.05.

RESULTS

Study Characteristics

Of the 12 studies included in the systematic review, 6 studies[4,5,7,11,12,27] reported outcomes after RCR and LHB tenotomy, and 9 studies[2,4,6,9,10,12,16,19,27] reported outcomes after RCR and LHB tenodesis (Table 1). Study design varied (4 randomized controlled trials [RCTs],[4,5,7,27] 2 prospective cohort studies [PCSs],[11,12] and 6 retrospective cohort studies[2,6,9,10,16,19]). Similarly, level of evidence varied (3 level 1 studies,[4,7,27] 3 level 2 studies,[5,11,12] and 6 level 4 studies[2,6,9,10,16,19]) (Table 1). There were 3 comparative cohort studies[4,12,27] included in the meta-analysis, of which 2 were RCTs[4,27] and 1 was a PCS.[12]

Patient Demographics

Those patients who underwent LHB tenotomy were slightly older (63.5 vs 59.3 years), more likely to be female patients (proportion, 57.5% vs 50.4%), and had a greater proportion of procedures performed in the dominant arm (83.0% vs 69.7%) (Table 2).

Table 1. General study characteristics

Study	LOE	LHB Procedure	Patient No.	Male Patients, %	Mean Patient Age, y	Mean Follow-up, mo	FOM
Franceschi et al[7]	I	Tenotomy	27	55.6	64.7	62.4	UCLA
Kim et al[11]	II	Tenotomy	20	45.0	63.3	24.0	UCLA ASES SST
Dezaly et al[5]	II	Tenotomy	68	44.1	67.5	12.0	Constant
Koh et al[12]	II	Tenotomy	41	22.0	66.0	27.9	ASES
		Tenodesis	43	37.2	65.0	27.1	Constant
De Carli et al[4]	I	Tenotomy	30	NR	56.9	23.0	Constant
		Tenodesis	35	NR	56.3	25.0	SST
Zhang et al[27]	I	Tenotomy	77	46.8	61.0	25.0	Constant
		Tenodesis	74	47.3	61.0	25.0	VAS
Checchia et al[2]	IV	Tenodesis	15	60.0	62.0	32.4	UCLA
Franceschi et al[7]	IV	Tenodesis	22	50.0	59.2	47.3	UCLA
Nho et al[19]	IV	Tenodesis	13	84.6	54.7	34.6	ASES SST VAS
Ji et al[9]	IV	Tenodesis	39	38.5	56.2	16.0	UCLA ASES SST VAS
Kim et al[10]	IV	Tenodesis	20	60.0	56.0	32.0	ASES Constant VAS
Lu et al[16]	IV	Tenodesis	41	46.3	57.7	12.0	UCLA Constant SST VAS

ASES, American Shoulder and Elbow Surgeons score; Constant, Constant-Murley score; DASH, Disabilities of the Arm, Shoulder, and Hand score; FOM, functional outcome measures; LHB, long head of the biceps tendon; LOE, level of evidence; NR, not reported; repairable RCT, repairable rotator cuff tear (as determined by study investigators); SST, Simple Shoulder Test score; UCLA, University of California Los Angeles score; VAS, visual analog scale.

Procedure Characteristics

Across studies, there was variation in rotator cuff tear size, involvement, and classification (Appendix 1, available at http://sph.sagepub.com/content/suppl); however, all rotator cuff tears underwent repair at the discretion of the investigators. Overall, 9 studies[2,4-7,11,16,19,27] included full-thickness rotator cuff tears, 2 studies[10,12] included partial- and/or full-thickness rotator cuff tears, and 1 study[9] included only partial rotator cuff tears.

RCR and LHB Tenodesis

There was wide variation across all 9 studies with respect to LHB tendon pathology, tenodesis technique, tenodesis fixation, RCR technique, and concomitant procedures (Appendix 1).

RCR and LHB Tenotomy

There was variation across all 6 studies with respect to LHB pathology, RCR technique, and concomitant procedures (Appendix 1).

Table 2. Patient demographics by long head of biceps (LHB) procedure

LHB Procedure	Patient No.	Mean Patient Age, y	Sex, % male	Dominant Arm, %
Tenodesis	302	59.3	49.6	69.7
Tenotomy	263	63.5	42.5	83.0
Overall	565	61.3	46.3	73.7

Clinical Outcomes

Clinical outcomes of the included studies are available in Appendix 2 (available at http://sph.sagepub.com/content/suppl).

DISCUSSION

A meta-analysis of cohort studies comparing clinical outcomes after LHB tenodesis or tenotomy in the setting of an RCR revealed that both postoperative Constant scores and the rate of biceps deformity were statistically better among patients who underwent LHB tenodesis. On the other hand, the statistical differences in the Constant score and rate of deformity may not bear clinical significance, and there were no statistical differences in the rate of postoperative biceps cramping and patient satisfaction between either of the techniques.

Prior to this study, 2 systematic reviews[8,24] had compared outcomes between LHB tenodesis and tenotomy. As compared with LHB tenodesis, both reviews[8,24] found a higher rate of cosmetic deformity after LHB tenotomy (43% vs 8%[24] and 41% tenotomy vs 25% tenodesis[8]); however, clinical outcomes and complications were otherwise similar. A notable limitation of both reviews, however, is the inclusion of studies with considerably different patient populations, including demographics, primary pathology, and concurrent operative procedures. Ultimately, this limits the generalizability of these findings to specific patient populations. For this reason, we sought to summarize clinical outcomes pertaining to a specific patient population—the most common—and statistically analyze data from only higher quality comparative cohort studies.

Deformity of the biceps muscle can follow an LHB procedure. In this systematic review, the rate of deformity was greater after tenotomy as compared with tenodesis (23.1% vs 5.2%). Similarly, the meta-analysis revealed a statistically higher rate of deformity after tenotomy as compared with tenodesis (15.5% vs 3.9%, $P < 0.01$).

An important consideration with respect to biceps deformity is patient symptoms (cramping) and satisfaction. Although we found a statistically higher rate of deformity in patients who underwent tenotomy, almost all of these patients were not bothered by the appearance.[4,7,11,12,27] Moreover, we did not find a statistically significant difference in the rate of biceps cramping or patient satisfaction between tenotomy and tenodesis.

Patient function is also an important consideration after an LHB procedure. In our systematic review, a number of different functional outcome scores were reported; however, variably so. In fact, this heterogeneity is reflected in our observation that only 1 of the functional outcome scores, the Constant score, had been uniformly reported across all 3 comparative cohort studies.[4,12,27] Interestingly, we found a significant difference in the postoperative Constant scores favoring tenodesis; however, the clinical relevance of this finding is limited as the reported minimal clinically important difference in the Constant score among patients undergoing rotator cuff surgery is 10.4[14] (our difference was 1.2). As such, there does not appear to be a functional difference between patients undergoing LHB tenotomy or tenodesis in the setting of an RCR, an observation that is consistent with past systematic reviews.[8,24]

One notable observation of this systematic review was the disproportionate number of studies that performed a proximal, intra-articular tenodesis (8 studies[2,4,6,9,10,12,16,27] of 9 studies). This is interesting given the present variation and controversy pertaining to LHB tenodesis technique and the commonly held belief that proximal tenodesis increases the potential for postoperative tenosynovitis within the biceps sheath.[20] Post hoc we reviewed the reported outcomes after LHB tenodesis and RCR, and across the 5 studies that reported residual bicipital groove pain,[2,6,9,10,19] the rate was very low (1/109, 0.9%). As such, the potential for residual bicipital groove pain appears to be low and should not deter surgeons from performing proximal tenodesis.

There are a number of limitations to this study. First, lower quality evidence (level 4) was included, which increases the potential for selection bias. Second, the outcomes reported by each study varied, making direct study comparisons difficult.

CONCLUSION

There is a statistically significant difference in both postoperative Constant score and the rate of biceps deformity favoring LHB tenodesis; however, the clinical significance of these findings appears to be negligible. Moreover, there was not a statistically significant difference in the rate of biceps cramping or patient satisfaction.

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