

Systematic Review

Using Biceps Tendon Autograft as a Patch in the Treatment of Massive Irreparable Rotator Cuff Tears Improves Patient-reported Outcome Scores: A Systematic Review

Naga Suresh Cheppalli, M.D., Prabhudev Prasad Purudappa, M.D.,
Sreenivasulu Metikala, M.D., Akshay Goel, M.D., Amit Singla, M.D., and
Senthil Sambandam, M.D.

Purpose: To review the clinical studies describing the use of ipsilateral biceps tendon autograft for bridging irreparable massive rotator cuff tears (MRCTs). **Methods:** A systematic review was conducted of MEDLINE, Embase, Cochrane, CINAHL, and Scopus databases using search terms “massive rotator cuff tear,” “irreparable rotator cuff tear,” and “long head of the biceps tendon.” Only clinical human studies in which the biceps tendon was used as a bridging graft in MRCTs were included. All review studies, technique papers, and studies describing the use of biceps tendon as superior capsular reconstruction equivalent or rotator cable were excluded. **Results:** A total of 45 studies were initially identified, of which only 6 studies met the inclusion criterion. All studies were retrospective in nature, with a total of 176 patients. All studies reported a clinically significant improvement in postoperative functional outcomes, although this was not compared to a control group in all the studies. Pain was assessed using the visual analog scale (VAS) in 4 studies, and all reported an improvement in postoperative VAS ranging from 5 to 6 points. One study reported an improvement in pain scale from Japanese Orthopedic Association from 13.1 to 22.5 (9 points). One study did not report a VAS score as this study was published before the VAS score was developed. All the reported studies saw improvements in range of motion. **Conclusions:** The use of the long head of the biceps tendon as an interposition/bridging patch to augment the MRCT repair can reduce the VAS score, improve elevation and external rotation, and improve clinical and functional outcomes. **Level of Evidence:** IV, systematic review of Level III and IV studies.

Rotator cuff tears (RCTs) account for 4,500,000 specialist visits and more than 250,000 surgical procedures performed in the United States every year.¹ Because of tissue loss, scarring, and retraction, surgical treatment of massive rotator cuff tears (MRCTs) is challenging even after extensive release and mobilization. The structural failure rate of surgically treated MRCT ranges from 20% to 94%.² To achieve tendon-to-bone healing, repair the rotator cuff with desirable

tension, and avoid mechanical failures, some surgeons have used tenotomized biceps tendon from the same shoulder as an interposition graft to bridge the defect between the torn edges of the cuff tendon and augment the rotator cuff repair.

The literature has no consensus regarding the ideal way to treat irreparable MRCTs. Several surgical procedures, simple debridement with biceps tenotomy, partial repair of rotator cuff including medializing the

From the Department of Orthopedic and Rehabilitation University of New Mexico, Raymond Murphy Medical Centre, Albuquerque, New Mexico (N.S.C.); VA Boston Health Care, Boston, Massachusetts (P.P.P.); VCU Department of Orthopaedic Surgery, Richmond, Virginia (S.M.); Department of Orthopaedics, Marshall University, Joan C. Edwards School of Medicine, Huntington, West Virginia (A.G.); St. Barnabas Hospital, Albert Einstein College of Medicine, Bronx, New York; and University of Texas Southwestern (S.S.) and Dallas VAMC (S.S.), Dallas, Texas, U.S.A.

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received October 15, 2022; accepted January 27, 2023.

Address correspondence to Akshay Goel, M.D., Department of Orthopaedics, Marshall University, Joan C. Edwards School of Medicine, 1600 Medical Center Dr., Huntington, WV 25701. E-mail: akshaypgimer@gmail.com

© 2023 THE AUTHORS. Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). 2666-061X/221311

<https://doi.org/10.1016/j.asmr.2023.01.016>

rotator cuff footprint, tuberopecty, superior capsular reconstruction (SCR) using either tensor fascia lata or human acellular dermis allograft, implantable balloon spacers, or reconstruction of superior restraint using locally available biceps tendon³ have been described as salvage procedures with short-term comparable results. However, most of them were retrospective isolated case series and did not provide the best evidence.

The goal of this study was to review the literature systematically and to evaluate all the relevant clinical evidence associated with using the biceps tendon harvested from the same shoulder for bridging irreparable MRCTs. Our hypothesis was that using the biceps tendon interposition graft could provide good functional outcomes in massive rotator cuff tears.

Methods

A systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines. MEDLINE, Embase, Cochrane Database Library, Web of Science, CINAHL, and Scopus databases were searched for all English-language studies on February 7, 2022, without any date restriction by 2 authors independently using the following search terms: (“irreparable rotator cuff tears” OR “irreparable rotator cuff tear” OR “massive rotator cuff tears” OR “massive rotator cuff tear”) AND (“long head of biceps” OR “biceps long head” OR “long head of the biceps tendon”). All search terms and search result discrepancies were resolved with further discussion among all the authors.

The commonly accepted definition for a massive rotator cuff includes a tear size of >5 cm, a complete tear of at least 2 tendons, or both. Although most irreparable cuff tears are large, not all massive rotator cuff tears are necessarily irreparable.² This review included only studies in which the biceps tendon (autograft harvested from the operating shoulder) was used as a bridging

graft to patch a defect in a massive rotator cuff tear that was deemed irreparable by the authors.

All the review studies, animal studies, technique papers, biomechanical studies, scientific meeting abstracts, proceedings, studies describing graft other than autologous biceps graft to reinforce or augment the repair, studies in which proximal biceps tendon was used as SCR equivalent or rotator cable, and studies from non-English language literature were excluded.

Methodologic Quality Assessment

Two investigators independently assessed the included studies for quality using the Modified Coleman Methodology Score (Table 1). The Modified Coleman Methodology Score has a maximum score of 100 ranging from 0 to 100 (85-100 excellent; 70-84 good; 55-69 fair; <55 poor).

Extraction and Data Synthesis

Two independent reviewers (N.C. and S.M.) separately extracted data from the included studies. The extracted data included patient demographics, the preoperative status of the rotator cuff, range of motion (ROM), surgical technique, pre- and postoperative visual analog scale (VAS) score, and gain in VAS score, patient-reported functional outcome scores described by the studies (American Shoulder and Elbow Surgeons [ASES], University of California at Los Angeles, Simple Shoulder Score), and the gain in the functional score, gain in ROM, postoperative radiologic findings, complications, failures, statistical significance, duration of follow-up, and complications.

Results

Number, Type, and Quality of Studies

A total of 45 studies were identified in the initial literature search. A Preferred Reporting Items for Systematic Review and Meta-Analyses flowchart of the

Table 1. Qualitative Assessment of the Studies Using Modified Coleman Methodology

	Cho et al. ⁴	Nevaser et al. ⁹	Rhee et al. ⁵	Rhee et al. ⁶	Sano et al. ⁷	Vitalli et al. ⁸
Part A						
Study size: number of patients (0-10)	7	0	0	4	0	10
Mean follow-up (0-10)	4	0	4	4	4	4
Surgical approach (0-10)	7	0	7	7	10	7
Type of study (0-15)	0	0	0	0	0	0
Description of diagnosis (0-5)	5	5	5	5	5	5
Descriptions of surgical technique (0-10)	10	10	10	10	10	10
Description of postoperative rehabilitation (0-5)	5	0	5	5	5	5
Part B						
Outcome criteria (0-10)	7	0	7	7	7	7
Procedure of assessing outcomes (0-15)	8	5	8	8	8	8
Description of subject selection process (0-10)	5	0	5	5	5	5
Total score	58	20	51	55	54	61

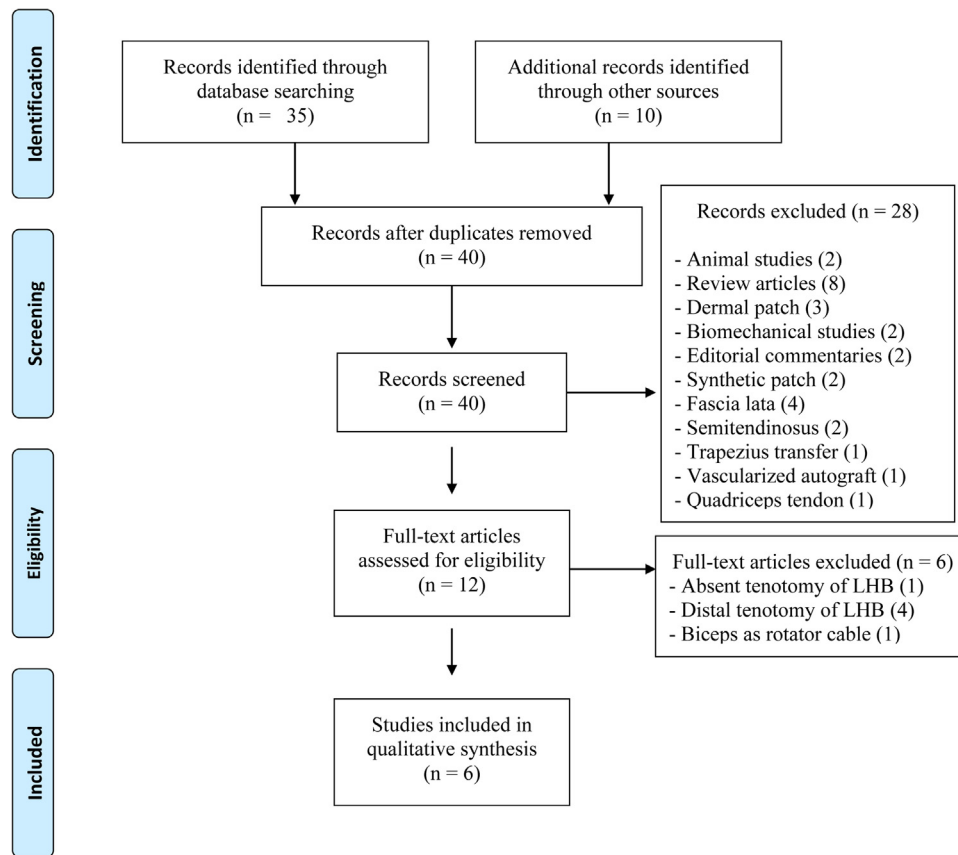


Fig 1. Flow diagram of the systematic review. (LHB, long head of the biceps.)

search process is featured in [Figure 1](#). After we removed duplicate studies, 40 articles were available for further analysis. Of these, 28 studies were excluded after reviewing the titles and abstracts. The full-text articles and bibliography of the remaining 12 studies were thoroughly inspected for details, of which only six studies match the inclusion criteria. A total of 6 studies were included for the final qualitative and quantitative analysis.⁴⁻⁹ In one prospective study, biceps tendon was used as a free graft to recreate rotator cable.¹⁰ This study was excluded, as it is used not used as a patch. All the studies included in this review were retrospective in nature ([Table 2](#)). One study was retrospective cohort studies comparing this technique with an allogenic dermal patch graft. One of the articles from 1971 describes the technique but does not included any validated outcome score methods or radiologic outcomes.⁹ All the rest of the studies have included radiologic follow-up to report outcomes.

Methodologic Quality of the Studies

The mean Coleman methodology score of the included studies was 50 ([Table 1](#)). If the study by Neviasser et al.⁹ (published in 1974) is excluded, the mean Coleman methodology score is 56. The score ranged from 20 to 61.

Demographics and Preoperative Variables of the Patients Studied

In total, 6 studies were included in this review, comprising 176 patients.⁴⁻⁹ The largest study included 60 patients, and the smallest reported 10 patients. All 6 studies reported age in the range of 57 to 67 years. Studies varied in follow from 36 months to 12 months ([Table 2](#)).

Rotator Cuff and Biceps Tendon Status

All the authors declared the RCT as massive and irreparable (used the criteria either using magnetic resonance imaging [MRI] or intraoperative assessment of rotator cuff tendon more than 2 tendons or more than 5 cm with variable degrees of fatty infiltration). The status of biceps tendon insertion on the supraglenoid tubercle was not uniformly reported in all the studies. Three studies excluded any patients with a SLAP lesion.^{4,6,8} One study included 3 patients with type II SLAP lesions, and in these cases, the biceps tendon was tenotomized from its insertion to the labrum⁵ ([Table 2](#)).

Surgical Technique

The biceps tendon is tenotomized and fixed to greater tuberosity in anteroposterior direction, and the rotator cuff is repaired to anchored biceps tendon.^{4-7,9}

Table 2. Demographic Details of the Studies

Study	Study Type (Level of Evidence)	No of Patients (M: F)	Mean Age, y	Mean Follow up, mo.	Preoperative Rotator Cuff Status	Status of Biceps Tendon	Country of Origin
Cho et al., ⁴ 2008	Retrospective case control (3)	37 (16:21)	59.4	21	Massive RCT (>5 cm in AP dimension). Ssc tear: 10 patients >2 preoperative GFDI in 4 patients	Partial tear <50%: 15 Partial tear >50%: 21 Dislocation: 1	Korea
Neviaser et al., ⁹ 1971	Retrospective case series (4)	10	57	12			U.S.A.
Rhee SM et al., ⁵ 2017	Retrospective case control (3)	24 (10:14)	66.9	14.5	Massive immobile RCT Retraction: 39.3 mm AP dimension: 33.7 mm GFDI: 2.2 for 4 muscles Ssc tear: 8 patients	Partial tear: 8 Subluxation: 5 Partial tear + subluxation: 8 type 2 SLAP tear: 3	Korea
Rhee et al., ⁶ 2008	Retrospective case series (4)	31 (20/11)	61	32	Massive RCT (>5 cm in AP dimension) Ssc tear: 8 patients	Partial tear <50%: 10 Partial tear >50%: 20 Dislocation: 1	Korea
Sano et al., ⁷ 2010	Retrospective case series (4)	14 (12:2)	64	28	Massive irreparable RCT involving at least 2 tendons and LHB tendon pathology	Partial tears: 9 Dislocation: 5	Japan
Vitali et al., ⁸ 2015	Retrospective case control (3)	60 (15:45)	66	36	Massive RCT involving 2 tendons and stage 1 or 2 fatty degeneration. Excluded pts with Goutallier stage >2	Pts with biceps lesions were excluded	Italy

AP, anteroposterior, F, female; GFDI, global fatty degeneration index; LHB, long head of the biceps; M, male; RCT, rotator cuff tear; Ssc, subscapularis.

Table 3. Technical Details of the Surgical Procedures

Author Year	Technique	Patient Position	Procedure	Additional Details	Rehab
Cho et al., ⁴ 2008	Arthroscopic	Beach-chair position	Tenotomized LHBT sutured to RC. Combination then attached to GT using suture anchors		Passive exercises immediately Assisted active exercises at 6 weeks
Neviaser et al., ⁹ 1971	Open, acromion osteotomized, and deltoid detached from clavicle	Beach-chair position	Intra-articular portion of LHBT resected after tenodesis of tendon in bicipital groove. Graft sutured to RC edges	LHBT was split in half	Velapeau bandages for 3 weeks AROM >4 weeks
Rhee et al., ⁵ 2017	Arthroscopic	Lateral decubitus position	Tenotomized LHBT interposed within the RC defect. repair of RC using suture anchors		No passion ROM for 6 weeks AAROM at 6 weeks
Rhee et al., ⁶ 2008	Open deltoid split: 15 Arthroscopic: 16	Beach-chair position	Tenotomized LHBT sutured to RC tendon, followed by tendon to bone repair using transosseous method for open techniques and suture anchors for arthroscopic technique		Passive exercises immediately Assisted active exercises at 6 weeks
Sano et al., ⁷ 2010	Open deltoid split	N/A	Intra-articular portion of LHBT resected after tenodesis of tendon in bicipital groove. LHBT first sutured to RC tendon stump, then inserted into a bone trough a bony trough using trans osseous suture technique	LHBT was split in half when tendon was smaller than cuff tear defect	Active assistive shoulder elevation started at postoperative day 3
Vitali et al., ⁸ 2015	Open deltoid split	Fowler position	Tenotomy of LHBT from glenoid after tenodesis of tendon in bicipital groove. Tenography of LHB tendon with ant and post. margins of RCT.	Polypropylene patch placed over repair site	Immobilized in abduction brace: 2 weeks PROM: >2 weeks AROM >5 weeks

AAROM, assisted-active range of motion; AROM, active range of motion; LHBT, long head of biceps tendon; N/A, not available; PROM, passive range of motion; RC, rotator cuff; RCT, rotator cuff tear; ROM, range of motion.

This technique allows medialization of the footprint and repair of the rotator cuff to the bone without significant tension while the rest of the biceps tendon covers the footprint. In one study, the biceps tendon was tenodesed laterally, and anterior and posterior borders of the rotator cuff were repaired to the anchored biceps tendon and augmented with synthetic patch.⁸ If the defect to be covered is larger, the biceps tendon is split to open book fashion and repaired to remaining rotator cuff.^{7,9} Three of the aforementioned techniques were mainly described in an open technique,⁷⁻⁹ and the other 3 authors used arthroscopic repair⁴⁻⁶ (Table 3).

Functional Outcomes

Several different scoring systems have been used to report this procedure's functional outcome, making it difficult to pool the results. The JOA (Japanese Orthopedic Association) Shoulder score is used by Sano et al.,⁷ the ASES and DASH scores were used to report functional outcomes by Rhee and Oh,⁵ and the UCLA score used by Cho et al.,⁴ Vitali et al.,⁸ and Rhee et al.⁶ Gains in UCLA score ranged between 13.8 and 18.6.^{4,6,8}

Rhee and Oh⁵ reports gains in ASES scores of 36.2. Cho et al.⁴ and Rhee et al.⁶ reported improvements of Constant scores of 44.1 and 33.4, respectively. The study by Sano et al.⁷ also reported similar improvement in functional outcome score with an improvement of 28.4 in JOA score (Table 4).

Postoperative Outcomes for VAS and ROM

The pain was assessed using a VAS score and was reported pre- and postoperatively in 4 studies. All these studies reported improvement in VAS from the preoperative VAS score (range 6.1-7.9) to the postoperative VAS score (range 0.1-2.9). The improvement in VAS score ranged from 5 to 6 points. One study was predated before the development VAS score and did not report pain scores. One study reported pain score in JOA score and has reported significant improvement in pain scale from 13.1 to 22.5.

There was no uniformity in the reporting of a ROM. Three studies reported external rotation, elevation was reported by 2 studies, and 4 studies reported flexion. The gain in ROM is reported in Table 5.

Table 4. Functional Outcome Scores

Study	Preoperative Outcome		Postoperative Outcome		Gain
	Score \pm SD	Range	Score \pm SD	Range	
ASES					
Rhee et al., ⁵ 2017	45.4 \pm 19.1	N/A	81.6 \pm 17.6	N/A	36.2
UCLA score					
Cho et al., ⁴ 2008	14.1	6-21	32.6	22-35	18.5
Rhee et al., ⁶ 2008	12.5	6-19	31.1	9-35	18.6
Vitali et al., ⁸ 2015	10.8 \pm 1.4		24.6 \pm 3.3		13.8
Constant					
Cho et al., ⁴ 2008	38.5	N/A	82.6	69-96	44.1
Rhee et al., ⁶ 2008	48.4	8-70	81.8	37-96	33.4
JOA					
Sano et al., ⁷ 2010	54.6 \pm 9.3		83.1 \pm 7.5		28.4
Q-DASH					
Rhee et al., ⁵ 2017	50.0 \pm 17.9	N/A	14.2 \pm 20.0	N/A	35.8
SST					
Rhee et al., ⁶ 2008	4.2	1-8	10.2	8-12	6
Veen et al., ¹⁰ 2020	5.5	1-8	6.3	6-7	0.8

ASES, American Shoulder and Elbow Surgeons score; CMS, Constant Murley Score; JOA, Japanese Orthopaedic Association score; N/A, not available; Q-DASH, Quick Disabilities of the Arm, Shoulder, and Hand; SD, standard deviation; SST, Simple Shoulder Test, UCLA, University of California Los Angeles.

Complications

Five of 6 studies have reported good anatomical results as assessed by follow-up MRI, with healing rates ranging from 45.8% to 92.8%⁴⁻⁸; one study from 1971 had only clinical follow-up.⁹ Other than retears, no major postoperative complications were described. Frozen shoulder was reported in one patient, Popeye deformity in 4 patients, 1 failed repaired deltoid (in a technique described by in which deltoid is peeled off from acromion for exposure of rotator cuff defect), and 1 of the patients with advanced osteoarthritis underwent shoulder arthroplasty at 9 months (Table 5).

Discussion

The findings of this systematic review were that using the long head of the biceps tendon as an interposition patch to augment/bridge the massive rotator cuff repair can significantly reduce the VAS and improve ROM. All the studies included in this review reported significant pain reduction, improvement in ROM, and improved functional scores.

Five of 6 studies have reported good anatomical results as assessed by follow-up MRI, with healing rates ranging from 45.8% to 92.8%⁴⁻⁸; one study from 1971 had only clinical follow-up.⁹ Sano et al.,⁷ Rhee et al.,⁵ Rhee et al.,⁶ and Cho et al.⁴ reported excellent radiologic outcomes using the biceps tendon as an interposition graft. In their technique, the sutures were passed through the native rotator cuff tendon and then secured to the greater tuberosity with the biceps tendon interposed between the torn edge of the rotator cuff and the greater tuberosity. This helped decrease the tension at the rotator cuff–biceps tendon junction,

which might have been the reason for the greater success of such a repair.

Vitali et al.⁸ tenodesed the biceps tendon at the lateral margin of the footprint, and the tendon is split longitudinally like an open book or spread the tendon (tenography) and repaired anterior and posterior edges of the rotator cuff to the tendon edges. This technique also retained its vascularity and claimed the repair was more biologic. They also used a synthetic patch to augment the repair.⁸ They reported an 85% healing rate on MRI with this technique, although their results have a confounding factor due to the presence of the synthetic patch.

The results showed significant improvement in the clinical scores, which were reported by 6 studies.⁴⁻⁸ Of these, 2 studies^{6,7} included patients of only this technique, whereas the other 4 have compared it with other controls, acellular dermal allograft by Rhee et al.,⁵ and rotator cuff repair without biceps augmentation by Cho et al.⁴ and Vitali et al.⁸ Cho et al.⁴ found that in the group with biceps augmentation, there was significantly less failure of a repair and significantly more improvement in ROM and strength, whereas the clinical scores were equivalent as compared with the rotator cuff repair without biceps augmentation. Rhee et al.⁵ have compared biceps augmentation with acellular dermal allograft and have found that all the clinical scores, including DASH, ASES, and VAS improved in a group with biceps augmentation; only VAS improved in the acellular dermal allograft. In all these studies, the range of motion also showed clinical improvement. Based on the outcome of the included studies using biceps autograft from the same shoulder as an interpositional graft is a potentially safe procedure

Table 5. Clinical Outcomes and Complications

Study	VAS Gain	Gain in Functional Score	Gain in ROM, °	Retear Rates	Other Complications
Cho et al., ⁴ 2008	6	18.5 (UCLA score) 44.1 (Constant score)	24.6° (FF) 7.2° (ER at side)	41.7% (10/24 patients based on MRI)	Popeye deformity: 1
Neviaser et al., ⁹ 1971	N/A	N/A	7° (Abd.)	N/A	Adhesive capsulitis: 2 Re-exploration with failure of repair: 1 Nil
Rhee et al., ⁵ 2017	5.9	36.2 (ASES score) 35.8 (Q- DASH)	31.7° (FF) 20° (ER at side)	54.2% (13/24 patients based on MRI or US at 1 year postoperative)	Nil
Rhee et al., ⁶ 2008	5.3	18.6 (UCLA score) 33.4 (Constant score) 6 (SST score)	36° (FF) 9° (ER)	35.7% (5/14 patients based on MRI) Partial tears: 2 Complete tears: 3	Popeye deformity: 2
Sano et al., ⁷ 2010	N/A	28.4 (JOA score)	80° (AE)	7.1% (1/14 patients based on MRI)	Popeye deformity: 1 Advanced shoulder OA: 2 Nil
Vitali et al., ⁸ 2015	5	13.8 (UCLA score)	34° (AE)	15% (9/60 patients based on MRI)	Nil

Abd., abduction; AE, active elevation; ER, external rotation; FF, forward flexion; JOA, Japanese Orthopaedic Association score; MRI, magnetic resonance imaging; N/A, not available; OA, osteoarthritis; Q- DASH, Quick Disabilities of the Arm, Shoulder, and Hand.

with no significant complications reported other than retearing in some patients.

Several other treatment options have been proposed for massive irreparable rotator cuff tears, including simple debridement, superior capsular reconstruction, reverse total shoulder arthroplasty, and latissimus transfer.² A systemic review of reverse total shoulder arthroplasty for irreparable MRCT showed an ASES score improvement of 30.8 to 42.1 and Constant score gains of 28.4 to 35.9. Complications of 17.4% were reported, with a need for revision surgery in 7.3%.¹¹ Another systemic review of SCR conducted by Altintas et al.¹² noted an improvement in ASES score ranging from 20 to 56. These results appear to be comparable with the functional improvements reported in the studies in this review which used biceps as an autograft to repair MRCTs.

Based on this systemic review, we observed that the biceps tendon is usually available during the rotator cuff repair. Even when the biceps tendon is degenerative and pathologic, it can still be safely used as an interposition graft to bridge the rotator cuff repair, decreasing the undue tension at the cuff repair and promoting biologic healing. There are several proposed advantages of this technique over the existing methods. The biceps tendon is a locally available graft, technically less demanding, has fewer anchors than SCR, and decreases the possibility of reaction to allograft or possible, although rare infection transmission. However, this technique can be applied only to the subset of patients with massive irreparable RCT with intact proximal biceps tendon. This technique can be used in cases where there is up to 1 cm of the lateral defect after the cuff mobilization. The biceps interposition can fill up that defect, decrease the tension at cuff repair, and enhance biologic healing. If the surgeon elects to tenodesis, the biceps tendon Popeye deformity can be prevented. This is a safe procedure, as none of the studies have found any significant complications related to this procedure.

Limitations

There are several limitations to this study. All the studies included in this review are of Level III or IV evidence with modified Coleman scoring, demonstrating that the quality of evidence was poor. The data are heterogenous in nature, making comparison, pooling of the data, and meta-analysis difficult. One of the included studies predated before the MRI scan and does not mention radiologic follow-up. The status of the biceps attachment at the supraglenoid tubercle, quality of the biceps tendon, mobility of the tissue, and fatty infiltration were not reported in all the studies. An intact and functioning subscapularis is an essential determinant of outcomes, but the status of subscapularis was not mentioned in most studies. These

studies used varying techniques; in some studies, the biceps tenotomy was done from the supraglenoid tubercle and was tenodesed along with the rotator cuff, whereas in others, the subpectoral tenodesis was done, and removed tendon was used to bridge the defect. In one study, the repair was augmented with a synthetic graft. Several variations in the technique, patient demographics, and different reported outcome measures make it difficult to interpret the final outcome categorically. We also observed that even though this technique is initially described in the United States,⁹ most of the published studies are from Korea,⁴⁻⁶ Japan,⁷ and Italy.⁸

Conclusions

The use of the long head of the biceps tendon as an interposition/bridging patch to augment the MRCT repair can reduce the VAS score, improve elevation and external rotation, and improve clinical and functional outcomes.

References

1. Rahman H, Currier E, Johnson M, Goding R, Johnson AW, Kersh ME. Primary and secondary consequences of rotator cuff injury on joint stabilizing tissues in the shoulder. *J Biomech Eng* 2017;139(11).
2. Thorsness R, Romeo A. Massive rotator cuff tears: Trends in surgical management. *Orthopedics* 2016;39:145-151.
3. Cheppalli NS, Purudappa PP, Metikala S, et al. Superior capsular reconstruction using the biceps tendon in the treatment of irreparable massive rotator cuff tears improves patient-reported outcome scores: A systematic review. *Arthrosc Sports Med Rehabil* 2022;4:e1235-e1243.
4. Cho NS, Yi JW, Rhee YG. Arthroscopic biceps augmentation for avoiding undue tension in repair of massive rotator cuff tears. *Arthroscopy* 2009;25:183-191.
5. Rhee SM, Oh JH. Bridging graft in irreparable massive rotator cuff tears: Autogenic biceps graft versus allogenic dermal patch graft. *Clin Orthop Surg* 2017;9:497-505.
6. Rhee YG, Cho NS, Lim CT, Yi JW, Vishvanathan T. Bridging the gap in immobile massive rotator cuff tears: Augmentation using the tenotomized biceps. *Am J Sports Med* 2008;36:1511-1518.
7. Sano H, Mineta M, Kita A, Itoi E. Tendon patch grafting using the long head of the biceps for irreparable massive rotator cuff tears. *J Orthop Sci* 2010;15:310-316.
8. Vitali M, Cusumano A, Pedretti A, Naim Rodriguez N, Fraschini G. Employment of synthetic patch with augmentation of the long head of the biceps tendon in irreparable lesions of the rotator cuff: Our technique applied to 60 patients. *Tech Hand Up Extrem Surg* 2015;19:32-39.
9. Neviasser JS. Ruptures of the rotator cuff of the shoulder. New concepts in the diagnosis and operative treatment of chronic ruptures. *Arch Surg* 1971;102:483-485.
10. Veen EJD, Diercks RL, Landman EBM, Koorevaar CT. The results of using a tendon autograft as a new rotator cable for patients with a massive rotator cuff tear: A technical note and comparative outcome analysis. *J Orthop Surg Res* 2020;15:47-54.
11. Petrillo S, Longo UG, Papalia R, Denaro V. Reverse shoulder arthroplasty for massive irreparable rotator cuff tears and cuff tear arthropathy: A systematic review. *Musculoskelet Surg* 2017;101:105-112.
12. Altintas B, Scheidt M, Kremser V, et al. Superior capsule reconstruction for irreparable massive rotator cuff tears: Does it make sense? A systematic review of early clinical evidence. *Am J Sports Med* 2020;48:3365-3375.