Systematic Review

Superior Capsular Reconstruction Using the Biceps Tendon in the Treatment of Irreparable Massive Rotator Cuff Tears Improves Patient-Reported Outcome Scores: A Systematic Review

Naga Suresh Cheppalli, M.B.B.S., Prabhudev Prasad Purudappa, M.B.B.S., Sreenivasulu Metikala, M.B.B.S., Krishna I. Reddy, M.B.B.S., Amit Singla, M.B.B.S., Harshadkumar A. Patel, M.B.B.S., and Srinath Kamineni, M.D.

Purpose: To systematically evaluate the clinical outcomes of superior capsular reconstruction (SCR) using the long head of the biceps tendon for irreparable massive rotator cuff tears. **Methods:** Multiple electronic databases were searched for studies treating massive and/or irreparable rotator cuff tears with SCR using the biceps tendon while retaining its proximal attachment to the superior glenoid. A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) flowchart was created. All the included studies were assessed for quality with the Modified Coleman Methodology Score. Multiple variables including patient demographic characteristics, functional scores, visual analog scale (VAS) scores, and complications were extracted and analyzed. **Results:** Seven studies were included in this review, with a total of 133 patients. The age range of patients was 39 to 82 years, and the duration of follow-up ranged from 6 to 40.7 months. Various validated scoring systems were used for functional outcome evaluation in all studies; all of them showed post-operative improvement greater than the minimal clinically important difference. The VAS score improvement ranged from 3.8 to 7.1. Five studies reported improvement in shoulder forward elevation, with a range of 22° to 95°. Three studies reported retear rates of 21%, 37%, and 66% on postoperative magnetic resonance imaging scans. Two studies reported complications, with the first study reporting revision surgery in 4 of 35 patients and the second study reporting 1 infection and 1 case of deltoid detachment (open procedure) among 17 patients. **Conclusions:** SCR using the long head of the biceps tendon is a safe and effective procedure. VAS and patient-reported outcome scores showed significant improvement with minimal short-term complications. **Level of Evidence:** Level IV, systematic review of Level III and IV studies.

Over 460,000 rotator cuff surgical procedures are being performed annually in the United States alone, and their number is expected to surpass 570,000 by 2023.[1] Massive rotator cuff tears (MRCTs) may not be amenable to primary repair owing to tissue loss, scarring, and retraction. The structural failure rate of surgically treated MRCTs ranges from 20% to 94%.[2] In MRCTs, the crescentic cable of the rotator cuff is dysfunctional and the force couple across the glenohumeral joint is unbalanced. This causes a loss of "concavity compression" of the humeral head against the glenoid surface and superior migration of the humeral head when arm elevation is attempted.[3] This results in pain, weakness, loss of range of motion (ROM), and pseudoparalysis, and in some

From the Department of Orthopedic and Rehabilitation, University of New Mexico, Albuquerque, New Mexico, U.S.A. (N.S.C.); VA Boston Health Care, Boston, Massachusetts, U.S.A. (P.P.P.); Department of Orthopaedic Surgery, Virginia Commonwealth University, Richmond, Virginia, U.S.A. (S.M.); Department of Orthopedics and Sports Medicine, University of Cincinnati, Cincinnati, Ohio, U.S.A. (K.I.R.); Orthopedics Department, Cincinnati VA Medical Center, Cincinnati, Ohio, U.S.A. (K.I.R.); St. Barnabas Hospital, Bronx, New York, U.S.A. (A.S.); Albert Einstein College of Medicine, Bronx, New York, U.S.A. (A.S.); Department of Orthopedic Surgery, Westchester Medical Center, New York Medical College, Valhalla, New York, U.S.A. (H.A.P.); and University of Kentucky, Lexington, Kentucky, U.S.A. (S.K.).

The authors report 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 November 16, 2021; accepted April 8, 2022.

Address correspondence to Prabhudev Prasad Purudappa, M.B.B.S., VA Boston Health Care, 150 S Huntington Ave, Boston, MA 02130, U.S.A. E-mail: prabhudevprasad@gmail.com

2666-061X/211597

https://doi.org/10.1016/j.asmr.2022.04.003

patients, this may eventually lead to rotator cuff tear (RCT) arthropathy.[4] Several surgical procedures, including medialization of the rotator cuff footprint,[5] superior capsular reconstruction (SCR) using either tensor fascia lata (TFL) or human acellular dermis,[6,7] placement of implantable balloon spacers,[8] and reconstruction of the superior capsule using locally available biceps tendon, have been described as salvage procedures.[9-15] The common biomechanical principle in all these procedures is to restore the fulcrum and prevent proximal migration of the center of rotation of the glenohumeral joint.[16] Several studies have confirmed the role of the biceps tendon as a humeral head depressor during shoulder abduction and forward elevation.[17-19] Several studies have reported on the outcomes of rotator cuff repair to the biceps tendon while retaining its proximal attachment to the glenoid with subsequent tenodesis of the biceps tendon to the greater tuberosity.[9-15] The proposed advantage of this technique is that, after tenodesis, the biceps tendon acts as a restraint to superior migration of the humeral head while providing some structural support for rotator cuff healing.[20]

The goal of this study was to systematically evaluate the clinical outcomes of SCR using the long head of the biceps tendon (LHBT) for irreparable MRCTs. Our hypothesis was that SCR using the biceps tendon could provide good functional outcomes in the treatment of irreparable RCTs.

Methods

A systematic review was conducted and reported according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines.[21] The following databases were searched for all English-language studies from database inception until February 7, 2021, with an updated search performed on January 25, 2022: MEDLINE, Embase, Cochrane Library, Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Scopus. The search was conducted independently by 2 authors (N.S.C. and S.M.) 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"). Any discrepancies regarding the search results were resolved with further discussion among all the authors.

Inclusion Criteria

This review included only studies of MRCTs that underwent repair to the proximal biceps tendon in which the biceps attachment to the supraglenoid tubercle was retained or reinforced and the distal part of the biceps tendon underwent tenodesis to the greater tuberosity.

Exclusion Criteria

We excluded all 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 the proximal biceps tendon was tenotomized and used as a free graft, and studies in the non–English-language literature.

Methodologic Quality Assessment

All the included studies were assessed for quality independently by 2 investigators (P.P.P. and K.I.R.) using the Modified Coleman Methodology Score (MCMS) (Table 1). The MCMS ranges from 0 to 100 (85-100, excellent; 70-84, good; 55-69, fair; and <55, poor); the maximum score is 100.[18] The scoring system consists of 2 parts: Part A has 7 criteria, with 1 score given to each section, and part B has 3 criteria, with scores given for each option in each of the 3 sections if applicable.

Extraction and Data Synthesis

Two investigators (N.S.C. and S.M.) independently reviewed and extracted data from the included studies. The extracted data included patient demographic characteristics, preoperative rotator cuff status, ROM, surgical technique, preoperative visual analog scale (VAS) score, postoperative VAS score, gain in VAS score, patient-reported functional outcome scores described by the studies (American Shoulder and Elbow Surgeons [ASES] score, University of California–Los Angeles [UCLA] score, Simple Shoulder Test [SST] score, and Oxford Shoulder Score), gain in functional scores, gain in ROM, postoperative radiologic findings, complications, failures, statistical significance, duration of follow-up, and complications.

Results

A total of 172 studies were identified in the initial literature search. After removal of duplicate studies, 93 articles were available for further analysis. Of these studies, 80 were excluded after review of the titles and abstracts. The full-text articles and bibliographies of the remaining 13 studies were inspected in detail, and only 3 of these studies matched the inclusion criteria. Four more studies were identified for inclusion from bibliography review. Thus, a total of 7 studies were included for final qualitative and quantitative analysis (Fig 1).

Number, Type, and Quality of Studies

Of the 7 studies, 5 were retrospective case series[9,12-15] and 2 were retrospective cohort studies.[10,11] One study compared SCR outcomes using the long head of the biceps (LHB) versus TFL autograft with double-row fixation,[11] and another compared SCR versus patch augmentation.[10] Four studies reported both clinical and

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

	Barth et al.[10]	Chillemi et al.[9]	Ikemoto et al.[12]	Guven et al.[14]	Ji et al.[13]	Kocaoglu et al.[11]	Fletcher[15]
Part A							
Study size: No. of patients (0-10)	7	0	0	0	4	0	0
Mean follow-up (0-10)	4	0	4	4	4	4	4
Surgical approach (0-10)	7	7	10	10	10	7	10
Type of study (0-15)	0	0	0	0	0	0	0
Description of diagnosis (0-5)	5	5	5	5	5	5	0
Description of surgical technique (0-10)	10	10	10	10	10	10	10
Description of postoperative rehabilitation (0-5)	5	5	5	5	5	5	5
Part B							
Outcome criteria (0-10)	7	0	7	7	7	7	7
Procedure of assessing outcomes (0-15)	7	0	10	12	8	8	8
Description of subject selection process (0-10)	5	5	5	5	5	5	5
Total score	57	32	56	58	58	51	49

radiologic outcomes,[10-13] whereas 3 studies reported only clinical outcomes.[9,14,15]

Methodologic Quality of Studies

The mean MCMS of the included studies was 52; the MCMS ranged from 32 to 58 (Table 1). The detailed score for each included study is shown in Table 1. The MCMS was fair in 4 studies[10,12-14] and poor in 3 studies.[12,16]

Patient Demographic Characteristics

There were a total of 133 patients in the included studies. Four studies reported sex data; there were 65

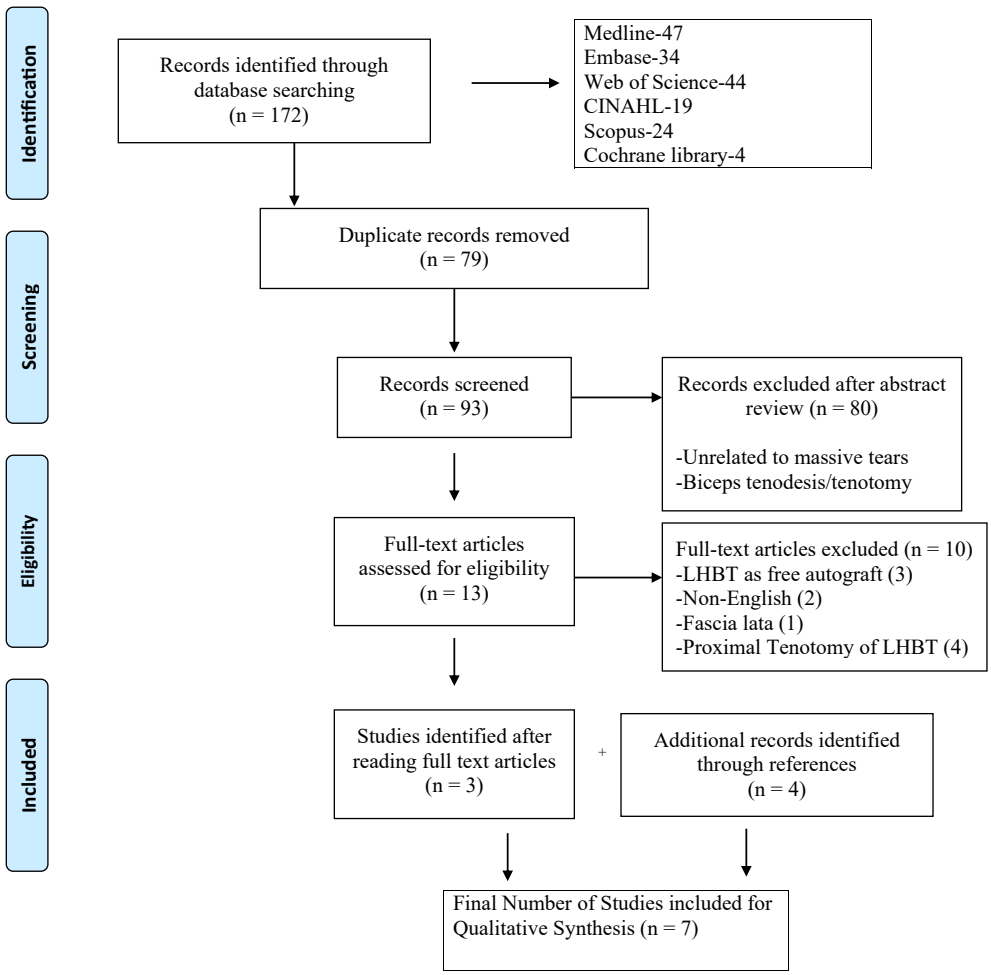

Figure 1. Flow diagram of systematic review. (CINAHL, Cumulative Index to Nursing and Allied Health Literature; LHBT, long head of biceps tendon.)

Table 2. Demographic Details of Studies

Authors	Study Type (Level of Evidence)	Procedure	No. of Patients	Mean Age, yr	Mean Follow-up, mo	Preoperative Rotator Cuff Status
Barth et al.,[10] 2020	Retrospective comparative cohort study (3 groups) (III)	SCR with LHBT autograft; LHBT tenotomized and fixed to greater tuberosity	24 (16 M and 8 F)	60	25	Massive posterosuperior retracted tear Goutallier grade 3 or lower
Chillemi et al.,[9] 2018	Retrospective case series (IV)	SCR using arthroscopic biceps Chillemi technique	9 (4 M and 5 F)	66.4	6	Irreparable posterosuperior tear Subscapularis tear in 6 Fatty infiltration: NA
Ikemoto et al.,[12] 2013	Retrospective case series (IV)	Cuff sutured to biceps and combination attached to greater tuberosity	20 (16 M and 4 F)	58.95	34	Massive tear, not mobile Fatty infiltration (Goutallier grades of 2.9 and 2.4)
Guven et al.,[14] 2001	Retrospective case series (IV)	Reconstruction of irreparable rotator cuff using biceps	14	60.3	40.7	Two-tendon tears in 8 patients, three-tendon tears in 5, and four-tendon tear in 1 Fatty infiltration: NA
Ji et al.,[13] 2014	Retrospective case series (IV)	Biceps tendon incorporated into cuff repair without detachment of biceps origin	35 (29 M and 6 F)	61.8	24	Large tear (3- to 5-cm tear size) in 18 patients and massive tear (>5 cm) in 17 Fatty infiltration: NA
Kocaoglu et al.,[11] 2020	Retrospective comparative cohort study (2 groups) (III)	Partial RCR and SCR using LHB vs fascia lata used as SCR graft	26 (LHB in 14 and fascia lata in 12)	63.7	30.9	Irreparable, massive tear Goutallier grades 3.8 and 2.6
Fletcher,[15] 2013	Retrospective case series (IV)	Infraspinatus and teres minor repair and biceps in situ tenodesis	17 (NA)	53	12	Massive, irreparable tear Fatty infiltration: NA

F, female; LHB, long head of biceps; LHBT, long head of the biceps tendon; M, male; NA, not available; RCR, rotator cuff repair; SCR, superior capsular reconstruction.

Table 3. Technical Details of Surgical Procedures Among Various Studies

Authors	Biceps Attachment at SGT	Rotator Cuff Repaired to Biceps	Margin Convergence	Tenotomy Distal to GT	Tenodesis Distal to GT	Implant	Technique	Additional Details	Rehabilitation
Barth et al.,[10] 2020	Retained	Yes	Yes	Yes	NA	Suture anchor	Arthroscopic	CA ligament preserved; acromioplasty performed	NA
Chillemi et al.,[9] 2018	Retained	Yes	Yes	Yes	Surgeon preference	Knotless anchor	Arthroscopic	CA ligament preserved; acromioplasty not performed	4 wk
Ikemoto et al.,[12] 2013	Retained	Yes	Yes	NA	NA	NA	Arthroscopic	NA	6 wk
Guven et al.,[14] 2001	Retained	Yes	Yes	No	Yes	Anchors	Open	NA	6 wk
Ji et al.,[13] 2014	Retained	Yes	Yes	NA	Yes	Anchors	Arthroscopic	NA	6 wk
Kocaoglu et al.,[11] 2020	Reinforced	Yes	Yes	Yes and no	NA	Anchors	Arthroscopic	Acromioplasty performed; medialized footprint	NA
Fletcher,[15] 2013	Retained	Yes	Yes	No	No	Anchors	Open	Subacromial decompression performed	6 wk

CA, coracoacromial; GT, greater tuberosity; NA, not available; SGT, supraglenoid tubercle.

male and 23 female patients.[10,11,13,15] The age range of patients who underwent SCR procedures was 39 to 82 years, and the follow-up range was 6 to 40.7 months (Table 2).

Preoperative Rotator Cuff Status

All 7 studies reported the preoperative rotator cuff status. Six studies included MRCTs described as retracted and/or irreparable. One article included both large RCTs (n = 18) and MRCTs (n = 17).[13] MRCTs were defined as either tears greater than 5 cm or tears involving at least 2 complete tendons. Three studies reported the fatty infiltration status of the cuff and classified this using the Goutallier grade (range, 2.4-3.8) (Table 2).[10-12]

Surgical Technique

All the studies included the LHB as an SCR construct (Table 3). However, minor variations in the described surgical techniques were noted. In all but 1 study,[12] the LHBT attachment to the supraglenoid tubercle was retained, and the remaining posterior rotator cuff was mobilized and repaired with the LHB, which subsequently underwent tenodesis to the greater tuberosity. Kocaoglu et al.[11] detached the LHB from the glenoid and then reattached it with suture anchors because they reported that a large proportion of their patients had degenerative glenoid attachments.[12] All but 2 studies used arthroscopic techniques,[14,15] and in all studies, the LHBT underwent tenodesis to the greater tuberosity using anchors. A margin convergence technique was used in all patients in an attempt to repair the edges of the rotator cuff to the biceps tendon (Table 3). The biceps was tenotomized distal to the greater tuberosity tenodesis site in 3 studies.[9-11] In 4 studies, the biceps tendon underwent tenodesis to the greater tuberosity without tenotomy.[12-15] Two studies reported performing acromioplasty concomitantly with SCR,[10,11] and 1 article mentioned that acromioplasty was not performed.[9] One article mentioned medialization of the rotator cuff footprint,[11] and 2 studies mentioned preservation of the coracoacromial ligament.[9,10] All the studies used anchors, but no detailed information was provided regarding the types of anchors.

Rehabilitation

Five studies mentioned rehabilitation protocols in brief,[9,12-15] whereas 2 studies did not provide information on rehabilitation.[10,11] Active-assisted ROM was reported at 6 weeks in 4 studies[12-15] and at 4 weeks in 1 study.[9]

Postoperative outcomes

All the studies used validated scores to measure outcomes, with the exception of 1 study.[9] Barth et al.[10] and Guven et al.[14] reported outcomes using the Constant-

Table 4. Clinical Outcome Scores in Individual Studies and MCID Achievement

	Preoperative Outcome		Postoperative Outcome			
Authors	Mean ± SD	Range	Mean ± SD	Range	Gain	MCID Achieved
ASES score						
Barth et al.,[10] 2020	45 ± 19	13-75	80 ± 15	35-97	35	Yes
Ji et al.,[13] 2014	35.5 ± 19.4	0-76.5	82.6 ± 14.5	35-100	47.1	Yes
Kocaoglu et al.,[11] 2020	46.2 ± 16.2	—	85.2 ±12.4	—	39.04	Yes
UCLA score						
Ji et al.,[13] 2014	13.6 ± 5.4	5-24	30 ± 3.6	18-35	16.4	Yes
Ikemoto et al.,[12] 2013	15.05	10-24	28.95	14-35	13.9	Yes
CMS						
Guven et al.,[14] 2001	46.7	28-64	75.35	45-100	28.65	Yes
SST score						
Barth et al.,[10] 2020	4 ± 3	0-8	8 ± 3	3-12	4	Yes
Ji et al.,[13] 2014	3.6 ± 2.8	0-8	9.0 ± 2.1	1-12	5.4	Yes
OSS						
Fletcher,[15] 2013	47.4	35-58	13.6	12-23	33.8	Yes
QuickDASH score						
Kocaoglu et al.,[11] 2020	52.5 ± 12.8	—	12.6 ± 18.0	—	39.9	Yes

ASES, American Shoulder and Elbow Surgeons; CMS, Constant-Murley score; MCID, minimal clinically important difference; OSS, Oxford Shoulder Score; QuickDASH, short version of Disabilities of the Arm, Shoulder and Hand questionnaire; SD, standard deviation; SST, Simple Shoulder Test; UCLA, University of California–Los Angeles.

Murley score (CMS). Barth et al., Ji et al.,[13] and Kocaoglu et al.[11] used the ASES score to report outcomes. Ikemoto et al.[12] and Ji et al. used the UCLA score. Barth et al. and Ji et al. reported outcomes with the SST score. Table 4 presents the preoperative and postoperative outcomes of the various studies.

Kocaoglu et al.[11] compared partial rotator cuff repair with SCR using either LHBT or TFL and reported significant overall improvements in patient-reported outcome (PRO) scores, with no difference between the 2 groups. Barth et al.[10] compared SCR utilizing LHBT with double-row repair and a transosseous-equivalent technique with absorbable patch reinforcement. They found significant overall improvements in PRO scores, with no statistically significant difference between the 2 groups. However, they noted that in the group that underwent SCR with LHBT, arm strength improved from 2.3 kg to 6.4 kg, which was significantly more than in the other 2 groups. Guven et al.[14] reported that 85.7% of patients were satisfied with their surgical procedures and the Constant score improved from 46.7 to 75.35 after surgery. Fletcher[15] reported excellent outcomes in 54% of cases, good outcomes in 41%, and fair outcomes in 5%. Five studies reported VAS score improvements, ranging from 3.8 to 7.1 points[9-11,13,14] (Table 5).

Range of Motion

ROM was reported in all but 1 study.[9] Five studies reported improvement in forward elevation, which ranged from 22° to 95° (n = 119 patients).[10-14] Fletcher[15] reported a mean abduction gain of 60°. Ji et al.[13] reported significant improvement in all ROM measures except external rotation (ER) at the side. Kocaoglu et al.[11] reported improvement in forward flexion and ER at the side but no improvement in ER at 90° and internal rotation behind the back. Ikemoto et al.[12] reported significant improvement in elevation by 34° and in medial rotation by 2 vertebral levels. In contrast, Barth et al.[10] mentioned that there was no difference in ROM measures between the groups undergoing SCR with LHBT, double-row repair, and a transosseous equivalent technique with patch augmentation (Table 5).

Radiologic Outcome to Identify Retears

Postoperative magnetic resonance imaging scans were performed in 3 studies to look for retears,[12,15,16] and ultrasound scans were performed in 1 study.[10] The retear rates among the studies that performed magnetic resonance imaging postoperatively were 21%,[12] 37%,[15] and 66%.[13] Kocaoglu et al.[11] did not find any difference in retear rates in the SCR-LHBT group vs the SCR-TFL group. Barth et al.[10] performed ultrasound scans at 1 year after surgery that showed an intact supraspinatus in 91.7% of patients in the SCR-LHBT group versus 56.7% of those in the patch graft group and 60.7% of those in the double-row repair group. The infraspinatus remained intact in 75% of patients in the double-row group, 76.5% of those in the patch graft group, and 100% of those in the SCR-LHBT group. Kocaoglu et al. reported a significant increase in the acromiohumeral distance in patients who underwent SCR with LHBT and TFL (Table 5).

Complications

Minor complications were reported in some studies. Chillemi et al.[9] found the Popeye sign in 4 of 9 patients because no biceps tenodesis was performed. Ji et al.[13] reported revision surgery in 4 patients, reverse total

Table 5. Various Outcome Parameters in Included Studies

Authors	Gain in VAS Score	Gain in Functional Score	Gain in ROM, °	Complications	Outcomes	Level of Evidence	Country of Origin
Barth et al.,[10] 2020	3.8	CMS: 25 ASES score: 35 SST score: 4.8	22 (FF)	None	91.7% survival rate at 1 yr	III	France
Chillemi et al.,[9] 2018	4.9	NA	NA	NA	NA	IV	Italy
Ikemoto et al.,[12] 2013	NA	UCLA score: 13.9	34 (FF)	NA	Postoperative MRI, showing complete healing in 6 cases and 12 retears, only 4 of which were symptomatic	IV	Brazil
Guven et al.,[14] 2001	3.4	CMS: 26.65	95 (FF)	None	No comment	IV	Turkey
Ji et al.,[13] 2014	5	ASES score: 47 SST score: 5 UCLA score: 16	39 (FF)	Revision RCR in 4 cases; 1 patient in this group underwent RSA	No tear in 22 cases (63%), partial tear in 7, and full-thickness tear in 6; 13 patients had discontinuity after cuff repair (13 of 35 [37%])	IV	France
Kocaoglu et al.,[11] 2020	7.1	ASES score: 38 QuickDASH score: 39.9	27 (FF)	NA	Retear in 3 cases in LHB group and 2 cases in FL group; AHD decreased by 3 mm	III	Turkey
Fletcher,[15] 2013	NA	OSS: 33.4	60 (abduction)	Infection in 1 patient and deltoid detachment in 1 patient	Excellent in 54% of cases, good in 41%, and fair in 5%	IV	Canada

AHD, acromiohumeral distance; ASES, American Shoulder and Elbow Surgeons; CMS, Constant-Murley score; FF, forward flexion; FL, fascia lata; LHB, long head of biceps; MRI, magnetic resonance imaging; NA, not available; OSS, Oxford Shoulder Score; QuickDASH, short version of Disabilities of the Arm, Shoulder and Hand questionnaire; RCR, rotator cuff repair; ROM, range of motion; RSA, reverse total shoulder arthroplasty; SST, Simple Shoulder Test; UCLA, University of California—Los Angeles; VAS, visual analog scale.

shoulder arthroplasty in 1 patient, and capsular release in 1 patient for postoperative stiffness at 18 months after revision repair. Some patients experienced biceps irritation, which resolved in 4 weeks (Table 5).

Comparison of Functional Outcomes Between Studies

The various studies included in our review used different scoring systems to evaluate functional outcomes. To compare the data, we relied on assessment of the minimal clinically important difference (MCID). Outcome measures such as the CMS, UCLA score, OSS, ASES score, SST score, and VAS score are validated tools for PROs, and the calculated MCIDs for these scores can serve as a tool for comparative studies.[22-24] The MCID for the CMS was defined as 6.3; UCLA score, 2.9; OSS, 2.6; ASES score, 27.13; SST score, 4.32; and VAS score, 2.37 (Table 4).

Discussion

This systematic review showed that SCR using the biceps tendon improved VAS scores and PRO scores compared with the preoperative status. Every study achieved the MCID for the VAS score and all other functional scores. The gain in the CMS ranged from 25 to 26.25,[10,14] the gain in the ASES score ranged from 35 to 47,[10,11,13] the gain in the UCLA score was 13.9,[12,13] the gain in the SST score ranged from 4.8 to 5, and the gain in the OSS was 33.4. The gain in ROM ranged from 22° to 39° of forward flexion. SCR using the biceps tendon is a potentially safe procedure, and the number of short-term complications reported was minimal, including 1 superficial infection and 1 case of deltoid detachment[15]; both of these complications were associated with an open technique. Failures were reported in some patients: Revision rotator cuff repair was performed in 4 patients, and revision to reverse total shoulder arthroplasty was performed in 1 patient.[13]

There is no consensus in the literature regarding the treatment of irreparable MRCTs. Several treatment modalities have been described in the literature for their treatment.[2,5,8,10,25] Despite surgical repair of these massive retracted tears, a significant number of such repairs fail postoperatively.[19] Tendon retraction, fatty infiltration of the muscle, repair under tension, poor tissue vascularity, and insufficient length of the

available tendon stump are some of the known causes of rotator cuff repair failure.[2] Some of the described methods of SCR include the use of either TFL, acellular human dermal matrix, or porcine dermal matrix.[26] This procedure acts as a restraint to superior migration of the humeral head, thus providing a fulcrum and decreasing acromiohumeral contact pressure.[27] Given the biomechanical importance of preventing proximal migration of the humeral head, many authors believe in reconstructing the superior capsule. Mihata et al.[27,28] described SCR using fascia lata autograft with promising clinical results. Allograft, notably acellular dermal matrix, was popularized for SCR to avoid donor-site morbidity. SCR can be technically demanding and expensive. Theoretically, allografts may cause a local inflammatory tissue reaction, may yield low healing rates, and can structurally fail. However, no significant difference in outcomes has been noted with either TFL autograft or allograft.[7] Other salvage procedures offered for irreparable MRCTs include biodegradable balloon spacer placement, tuberoplasty, and reverse shoulder arthroplasty.

Some authors used the LHB for SCR by preserving its attachment at the superior labrum and rerouting the biceps more posteriorly, followed by performing tenodesis of the biceps to the greater tuberosity. Whenever possible, the rest of the cuff was repaired to the LHBT. Biomechanical studies by multiple authors have noted that performing SCR using the LHB improved shoulder function by preventing superior humeral migration and decreasing deltoid forces required for abduction.[20,29,30] This technique translated the humeral head inferiorly at 30° and 60° of abduction and decreased acromiohumeral contact pressure. El-Shaar et al.[31] noted that SCR with an LHB autograft was biomechanically equivalent to—and potentially even stronger than—SCR with a TFL autograft in preventing superior humeral migration. Several proposed advantages of using the LHB for SCR include local availability of autologous graft and the cost; in addition, the procedure is less technically demanding and additional anchors are not always required on the glenoid. Several biomechanical studies have evaluated the LHB's role in preventing superior head migration when used in this fashion. Despite having several advantages, this technique is not popular owing to the perceived fear that the biceps tendon may be a "pain generator" in the shoulder.[32]

Because of the heterogeneity in patients and surgical techniques, it is difficult to directly compare the outcomes of SCR using LHB with the remainder of the options for MRCTs. McLaughlin[18] described a similar procedure in 1944 using biceps tendon to augment repairs of irreparable RCTs.[8] Despite having been described long ago, this technique is not very popular because the biceps tendon is considered a pain generator. Pain in the biceps groove has not been reported as a long-term complication in any study. There are several proposed advantages of this technique over the existing techniques, and it does not "burn any bridges." The biceps tendon is a locally available graft, the procedure is technically less demanding, the procedure requires fewer anchors than SCR, and there is no need for glenoid anchors when the biceps tendon is well attached. However, this technique can only be applied in the subset of patients with massive irreparable RCTs with intact and healthy proximal biceps tendons. Properly conducted randomized studies will help us to determine the true efficacy of this procedure in the future.

Limitations

There are several limitations to this study. All the studies included MRCTs; however, Ji et al.[13] also included large RCTs (17 patients) in their outcome analysis, and this can skew the results. All the studies included in this review presented Level III or IV evidence, with the MCMS showing that the quality of evidence was poor. The status of the biceps attachment at the supraglenoid tubercle, biceps tendon quality, tissue mobility, and fatty infiltration were not reported in all the studies. An intact and functioning subscapularis is an important determinant of outcomes, but the status of the subscapularis was not mentioned in most studies. In some studies, the biceps was rerouted without any tenotomy, and in others, a tenotomy of the biceps was performed distal to the tenodesis site. Furthermore, derivations and calculations of the MCID are obtained from retrospective studies using prospectively collected databases, and as such, the use of the MCID is a limitation of this methodology, which applies to our study as well. The anchor-based questions used in some of the studies have not been validated,[21,22] even though all the PRO measures used have been validated. With several variations in technique and patient demographic characteristics, as well as different reported outcome measures, it is difficult to categorically interpret the final outcome.

Conclusions

SCR using the LHBT is a safe and effective procedure. VAS and PRO scores showed significant improvement with minimal short-term complications.

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