JSES International 6 (2022) 978–983

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Shoulder surgeon techniques and preferences in treatment of massive rotator cuff tears: current practices for rotator cuff repair and superior capsule reconstruction

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ARTICLE INFO

Keywords:
Massive rotator cuff tear
Rotator cuff repair
Irreparable rotator cuff tear
Superior capsule reconstruction
Human dermal allograft
Rotator cuff augment
Questionnaire

Level of evidence: Survey Study; Experts

Background: Massive rotator cuff tears can be difficult to manage and consensus regarding treatment is debated. The purpose of this questionnaire study was to examine surgeon techniques and considerations for treatment of massive rotator cuff tears including how they implement superior capsule reconstruction (SCR), when indicated.

Methods: A 21-item questionnaire was sent to members of the American Shoulder and Elbow Surgeons and the American Orthopedic Society for Sports Medicine. Questions covered management preferences for massive rotator cuff tears, rotator cuff repair and SCR techniques, beliefs about SCR, implant choices, use of augments, demographics, and patient management scenarios.

Results: The questionnaire had 230 respondents. In rotator cuff repair of massive rotator cuff tears, preferred responses were long head biceps tendon preservation (when asymptomatic, 45.3%), routine subacromial decompression (62.1%), solid threaded anchors (71.1%), double row configuration (65.1%), and bone marrow stimulation of the footprint (55.6%). For providers that perform SCR (n = 166), preferred strategies included long head biceps tenodesis (55.4%), human dermal allograft tissue (93.2%), glenoid fixation with 3 implants (71.2%) using solid threaded anchors (42.3%), and humeral fixation with 2 solid threaded anchors medially (71.0%), and 2 solid threaded anchors laterally (46.9%). Other highly recommended strategies were side-to-side repair to the posterior rotator cuff if able (97.6%) and to use the thickest graft available (62.2%).

Conclusion: Despite improved techniques and growing interest in SCR, many questions still remain. This study identifies the significant variability in repair constructs and methodology with SCR; further investigation into these variables could be analyzed to identify best practice guidelines.

Pathology involving the rotator cuff is an incredibly common reason for referral to a shoulder surgeon.[11,12,26,31,35] Treatment paradigms can vary from provider to provider depending on several factors including surgeon training or level of experience; patient factors such as age, activity level, or medical comorbidities; or characteristics of the cuff including tear size, tendon retraction, muscle quality, or chronicity. Massive rotator cuff tears can be difficult to manage and consensus regarding treatment is debated. Many strategies exist including nonoperative management, partial or total rotator cuff repair (RCR), interval slide, tendon transfers, superior capsule reconstruction (SCR), and reverse total shoulder arthroplasty.[8,36] Additionally, for joint preserving techniques such as RCR surgeon preferences can vary widely, such as when and how to repair each tendon, how to manage the long head biceps (LHB) tendon, implant and fixation strategies, and augment or graft usage. For patients with irreparable tears, especially those who are younger and more physically active, the decision-making process can be challenging. The presence of a significant functional deficit or pseudoparalysis further complicates the clinical scenario.

This study (STUDY00001412) was approved by the Institutional Review Board at Cedars-Sinai (institution of the principal investigator) prior to study initiation.

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https://doi.org/10.1016/j.jseint.2022.07.007

SCR has been described as an effective treatment modality in patients with massive or irreparable rotator cuff tears.[7,33] Mihata initially described SCR as a means to restore superior stability, thus decreasing the superior migration of the humeral head.[22,25] The restoration of the superior capsule helps to improve the dysfunctional rotator cuff force couples and to reestablish the concavity compression effect.[11] Initial clinical results following SCR have shown promising pain relief, patient satisfaction, and return of functional deficit.[6,22] Patient selection and indications for SCR continue to evolve with time and growing surgeon familiarity. While SCR continues to gain in popularity as a treatment option, debate exists as to the optimal fixation methods or techniques, graft choice, and concomitant procedures.

The purpose of this study was to examine surgeon techniques and considerations for treatment of massive rotator cuff tears, including how they implement the use of SCR using a questionnaire. We chose to survey surgeons with expertise in the field; we targeted members of orthopedic professional societies, namely the American Shoulder and Elbow Surgeons (ASES) and the American Orthopedic Society for Sports Medicine (AOSSM). This cross-sectional descriptive study aimed to give observations about provider management preferences and opinions. We hypothesized that the management of massive rotator cuff tears and the usage of SCR would vary widely in terms of technical preferences and indications.

Methods

We designed and implemented a survey for members of the ASES and AOSSM. The survey was administered as a one-time, anonymous link sent via primary contact email for participants from August to December 2019. Prior to study initiation, the protocol was approved by the institutional review board at the institution of the principal investigator.

Study population

Participants were members of either (or both) the ASES or the AOSSM. Membership within these professional societies is exclusive to orthopedic surgeons and includes providers that focus on sports medicine and/or shoulder and elbow primarily. All participants were over 18 years old.

Survey design

We constructed a 21-item questionnaire which included: 2 questions on surgeon practice and experience, 5 questions on management preferences for treatment of massive rotator cuff tears, 2 questions on treatment choice for patient scenarios, 2 questions on implant choices and augmentation in massive rotator cuff tears, and 3 questions of beliefs about SCR. The last section was specific only to providers that perform SCR as part of their practice; this included 7 questions on SCR specifics regarding technique, implants, and augments. The questions were developed based upon expert opinion at the discretion of the principal investigator.

Results

A total of 230 participants responded to the survey (Fig. 1). The providers represented a wide spectrum of years in practice: 0-5 years (21.9%), 6-10 years (21.9%), 11-20 years (27.2%), and >20 years (29.0%). Polled providers reported performing a number of yearly RCRs ranging from: 0-20 (3.5%), 20-50 (21.0%), 50-100 (28.0%), and 100+ (47.6%).

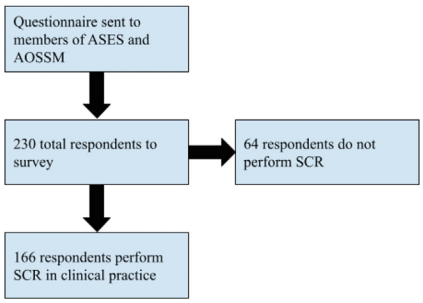

Figure 1 Flow chart demonstrating study participants. *ASES*, American Shoulder and Elbow Surgeons; *AOSSM*, American Orthopedic Society for Sports Medicine; *SCR*, superior capsule reconstruction.

Massive RCR

Polled providers were asked how many massive RCRs (2+ tendon tear) they performed per year; results were as follows: 0-10 (10.9%), 10-20 (23.9%), 20-30 (24.8%), 30-50 (20.4%), and 50+ (20.0%). Respondents were asked about percentage of subscapularis repair performed in massive RCRs, percentage of massive RCRs where interval slides were performed, percentage of massive RCRs where subacromial decompression (SAD) was performed, preferences for LHB tendon management in massive RCR, instrumentation preferences in massive RCR, and strategies employed outside of standard repair in massive RCR. These data are shown in Table I.

SCR

When asked about how many SCRs polled providers performed over the previous 6 months, responses were 0 (33.6%), 1-5 (45.4%), 5-10 (14.0%), 10-20 (6.1%), and 20+ (0.9%). For those providers that did not perform an SCR in the last 6 months, 73.6% said they were planning to perform one within the next year if a patient met their indications. For those providers who said they would not perform an SCR in the next year, reasons for choosing against SCR included (multiple answers permitted): I do not believe that this procedure will help my patients (33.7%), I have concerns about the use of human dermal allograft for this surgery (4.6%), I would not perform enough SCRs to feel comfortable doing so occasionally (10.5%), the technique is too technically demanding (1.2%), I prefer performing arthroplasty in this population (17.4%), I prefer performing partial repair and débridement (32.6%).

For providers that performed SCR, respondents were asked about preferred treatment of the LHB tendon during SCR if no bicipital symptoms were present and the tendon is relatively healthy, preferred treatment of the superior labrum when performing SCR, preferred graft choice for SCR, preferred glenoid fixation strategies (multiple responses allowed), preferred humeral fixation strategies (multiple responses allowed), preferred techniques in SCR (multiple responses allowed), and SCR beliefs/pearls (multiple responses allowed). These data are shown in Table II.

Clinical scenarios

Providers were asked about their decision-making in the clinical scenario of early stage rotator cuff arthropathy (Hamada stage 1-2) with a rotator cuff that cannot be completely repaired in either a 1) 60-year-old patient and a 2) 70-year-old patient. For the 60-year-old patient scenario, responses were as follows: partial repair and débridement (42.0%), isolated SCR (5.73%), combined repair and SCR (45.4%), reverse arthroplasty (4.0%), partial repair and biceps augmentation (4.0%), and subacromial balloon (0.0%). For the 70-year-old patient scenario, responses were as follows: partial

Table I
Survey results for management preferences for massive rotator cuff repair (RCR) and associated pathology.

Response	Percentage	N in group
In what percentage of massive RCR surgery (2+ tendons) do you perform a subscapularis tendon repair?		
0-25%	33.91	78
26-50%	36.52	84
51-75%	19.13	44
76-100%	10.43	24
In what percentage of massive RCR surgery do you perform an interval slide to mobilize tissue?		
0%	24.35	56
1-25%	42.17	97
26-50%	13.04	30
51-75%	11.30	26
76-100%	9.13	21
In what percentage of massive RCR surgery do you perform some form of SAD (CA ligament release, acromioplasty, etc.)?		
0%	7.39	17
1-25%	15.65	36
26-50%	14.78	34
51-75%	16.96	39
76-100%	45.22	104
What is your preferred treatment of the LHB during massive RCR if the patient has no bicipital symptoms and the tendon is relatively healthy?		
Tendon preservation	45.22	104
Tenotomy	13.48	31
Tenodesis	41.30	95
Which implants and strategies do you prefer in massive RCR? (please check all that apply)		
Solid threaded anchor (eg, Corkscrew, SwiveLock, etc.)	71.18	163
Soft-anchor (eg, FiberTak)	19.65	45
Knotless techniques	40.61	93
Knot-tying technique	59.39	136
Double-row repair	65.07	149
Transosseous equivalent repair	49.34	113
Single-row repair	24.89	57
High-strength suture	45.41	104
High-strength tape	51.09	117
Do you ever employ any of the following strategies outside of standard repair when performing massive RCR? (please check all that apply)		
Platelet-rich plasma (PRP)	11.23	21
Bone-marrow aspirate concentrate (BMAC)	8.56	16
Bone marrow stimulation of the footprint	55.61	104
Synthetic material patch (non-tissue)	4.81	9
Human allograft augmentation (non-SCR)	29.41	55
SCR	66.84	125
Xenograft collagen implant (Regeneten)	32.09	60

SAD, subacromial decompression; *CA*, coracoacromial; *LHB*, long head biceps; *SCR*, superior capsule reconstruction.
N = 230, however, not all participants answered every question.

Table II
Survey results of participants that perform superior capsule reconstruction (SCR) including their treatment strategies, fixation methods, and graft choices.

Response	Percentage	N in group
What is your preferred treatment of the LHB during SCR if the patient has no bicipital symptoms and the tendon is relatively healthy?		
Tendon preservation	30.12	50
Tenotomy	14.46	24
Tenodesis	55.42	92
What is your preferred treatment of the superior labrum when performing SCR?		
Complete preservation	12.20	20
Debridement enough to allow for bone preparation	78.05	128
Completely excise for bone preparation	9.76	16
What is your preferred graft choice for SCR?		
Fascia lata autograft	3.11	5
Human dermal allograft tissue	93.17	150
Other human allograft tissue	1.86	3
Synthetic patch (no tissue or combined)	1.86	3
What are your preferred glenoid fixation strategies (please check all that apply)		
2 implants	28.22	46
3 implants	71.17	116
4 implants (if necessary)	2.45	4
Solid-punched anchor (eg, SutureTak)	42.33	69
Solid threaded implant (eg, Corkscrew)	17.18	28
Soft anchor (eg, FiberTak)	22.70	37
All-knotless technique	39.88	65
Knot-tying technique	35.58	58
Combined knotless and knot-tying technique	11.04	18
What are your preferred humeral fixation strategies (please check all that apply)		
2 solid threaded implants medially (eg, SwiveLock, Corkscrew)	70.99	115
3 solid threaded implants medially (eg, SwiveLock, Corkscrew)	14.20	23
2-3 soft implants medially (eg, FiberTak)	8.02	13
2 solid threaded implants laterally (double-row)	44.44	72
3 solid threaded implants laterally (double-row)	5.56	9
2 solid threaded implants laterally (trans-osseous equivalent)	46.91	76
3 solid threaded implants laterally (trans-osseous equivalent)	8.02	13
Which of the following techniques do you try to include in SCR surgery? (Please check all that apply)		
Side-to-side repair to the intact/repaired posterior rotator cuff	97.56	160
Side-to-side repair to the subscapularis tendon or anterior interval tissue	54.88	90
Incorporate partial repair of the rotator cuff into the SCR	69.51	114
Incorporate complete repair of the rotator cuff along with the SCR	21.34	35
Acromioplasty	51.83	85
Which of the following statements do you agree with regarding SCR surgery? (please check all that apply)		
I just approximate the graft size	8.54	14
I accurately measure the distance between sutures to size the graft	88.41	145
I add load-bearing sutures between the glenoid and humerus to protect the graft	4.88	8
I believe the SCR functions as a dynamic trampoline	53.66	88
I believe the SCR functions as a subacromial spacer	59.15	97
I intentionally pretension the graft by measuring the graft in relative abduction or decreasing the medial-lateral dimensions	32.32	53
I try to use the thickest graft available	62.20	102

LHB, long head biceps.
N = 166, however, not all participants answered every question.

repair and débridement (28.4%), isolated SCR (4.4%), combined repair and SCR (20.1%), reverse arthroplasty (41.9%), partial repair and biceps augmentation (5.24%), and subacromial balloon (0.0%).

Discussion

This study highlights some interesting trends among sports medicine and shoulder specialists that treat a high number of rotator cuff tears. The vast majority of surgeons in this study (75.6%) perform 50-100 or more RCRs per year. However, only a small number of surgeons (20.0%) perform 50+ massive RCR (2+ tendon) repairs per year. Even fewer surgeons regularly perform SCR; from this cohort of specialists 79.0% of surgeons had performed 5 or fewer SCRs in the past 6 months. Thus despite improved techniques and growing interest in SCR, many questions still remain for optimal usage. When asked about a patient with early stage rotator cuff arthropathy with a rotator cuff that cannot be completely repaired, polled providers favored partial repair and débridement (42.0%) or combined repair and SCR (45.4%) over reverse arthroplasty (4.0%) in a 60-year-old patient. For a 70-year-old patient, reverse arthroplasty (41.9%) was favored over partial repair and

débridement (28.4%), or combined repair and SCR (20.1%). As indications for surgery for RCR vs. SCR vs. reverse arthroplasty vary widely and consensus treatment algorithms have not been established, the goal of this study was to report on preferences and attitudes among current practicing experts.

Management of patients with massive rotator cuff tears remains a complicated issue. The decision-making process must consider a variety of factors including tear pattern, chronicity, and tissue quality. Additionally, tears must be considered in light of patient factors such as demographics (age, comorbidities, etc) and associated pain, weakness, or disability secondary to their condition. Descriptive classifications of rotator cuff tears have been described however currently no consensus exists for which is best.[30] For those patients who have a massive rotator cuff tear that is deemed amenable to repair, many factors still need to be considered surgically. Consensus regarding these factors has not been established though the present study identifies some trends. In the management of clinically asymptomatic LHB which intraoperatively appears healthy, providers were split between tendon preservation (45.3%) and tenodesis (41.2%) with minimal role for tenotomy (13.5%). In the setting of massive rotator cuff tear, Boileau et al reported positive outcomes and no significant difference between tenodesis and tenotomy for LHB lesions.[2] The scenario of an asymptomatic LHB tendon with massive rotator cuff tear has minimal published data. Performing SAD in the setting of massive rotator cuff tear has been deemed controversial because of the importance of maintaining the coracoacromial ligament to prevent superior escape of the humeral head in rotator cuff insufficiency. If the coracoacromial arch and the acromion are kept intact, SAD for massive rotator cuff tears can be performed effectively with good clinical results.[34] For providers in this study, the majority perform SAD routinely in massive RCR; 45.2% perform SAD in almost all cases (75-100%) while 17.0% of providers perform SAD in 50-75% of cases. The use of interval slides for mobilizing cuff tendons in RCR was historically a common technique.[19] Interval slides appear to be decreasing in their popularity; the present study showed that 66.5% of providers used the technique in 25% or less of their cases. The preferences for implants for the participants varied widely; the most common implant choice was solid threaded anchors such as Corkscrew or SwiveLock (Arthrex Inc., Naples, FL, USA) (71.1%). The most preferred method of fixation was a double row repair (65.1%). A recent systematic review reported that double row fixation constructs may be associated with better patient-reported outcomes in massive rotator cuff tears.[31] For method of repair, knotless technique (59.4%) was preferred over knot-tying technique (40.6%). Meta-analysis by Paramasivam Meenakshi Sundaram in 2020 reported no difference in clinical outcomes scores over 8 studies comparing knotless and knot-tying techniques.[28] Similarly, Nemirov et al showed no difference in outcome scores, repair failure rates or complications at 2 years postoperatively.[27] Preferences between use of high-strength tape (51.1%) and high-strength suture (45.4%) were similar for respondents. Previous biomechanical studies have shown higher footprint contact pressure, load to failure, and stiffness with high-strength tape.[3,18] Liu et al reported that clinically retear rates remain similar at 6 months postoperatively, however.[18] Strategies for adjuncts to RCR in massive rotator cuff tear were varied; the most commonly cited augments were bone marrow stimulation of the footprint (55.6%) and SCR (66.8%). Kim et al examined RCR with or without bone marrow stimulation of the footprint and reported no significant differences in outcomes or imaging studies looking at structural integrity of the cuff postoperatively.[13]

SCR remains a growing area of interest in the management of massive and irreparable rotator cuff tears. The use of SCR has had positive results clinically with promising pain relief, patient satisfaction and recovery of functional deficit in short-term and medium-term follow-up.[4,6,7,11,21,33] In a medium-term follow-up clinical study at 5 years patients had high rates of satisfaction, return to recreational sport, and return to physical work.[21] The present study identified 166 providers out of 230 that perform SCR in their clinical practice. For providers that perform SCR (n = 166), management of clinically asymptomatic LHB that appears healthy was associated with a greater preference for tenodesis (55.4%) than preservation (30.1%) or tenotomy (14.5%). In preparation of the superior labrum for SCR fixation, the majority of providers débrided only enough superior labrum to allow for bone preparation (78.8%). Human dermal allograft tissue was the overwhelming preference for graft choice in SCR (93.2%). The initial clinical description by Mihata utilized tensor fascia lata autograft.[22] Dermal allograft for SCR was described by Hirahara as a viable graft option which obviated the surgical time and risks associated with autograft harvest.[9] Other graft options such as LHB rerouting have also been described.[14]

The strategies for graft fixation in SCR have been quite variable; glenoid fixation is typically with 2-3 anchors sized between 1.8 mm to 3.5 mm using biocomposite, suture-based, and titanium anchors.[1,5,10,15,17,20,29] Humeral sided fixation in most cases has been reported as double row fixation with biocomposite anchors sized 3.9 mm to 5.0 mm.[1,5,9,10,17,20,29] In this study, for glenoid fixation, the preferred strategy was 3 implants (71.2%), with solid threaded anchors being the most common response (42.3%). For humerus fixation, the preferred strategy was 2 solid threaded anchors medially (71.0%) and 2 solid threaded anchors laterally (46.9%). Other highly recommended strategies in SCR surgery were to perform side-to-side repair to the intact/repaired posterior rotator cuff if able (97.6%), to accurately measure the distances between sutures when sizing the graft (88.4%), and to use the thickest graft available (62.2%). Side-to-side repair of the remnant rotator cuff to the graft has been recommended in previous studies.[23,24,32] The addition of the partial repair to the posterior cuff has been theorized to aid in postoperative external rotation strength.[32] Graft thickness has been variably reported; most studies using acellular dermal allograft reported a thickness of 1 to 3.5 mm.[6,10,29] Studies using tensor fascia lata autografts reported a range of 5 to 8 mm.[5,17,20] Clinical studies have favored the use of thicker grafts for both allograft and autograft if possible, with the reasoning that thicker grafts increase the superior restraint and decrease the risk of graft tearing.[6,7,22] Strategies for obtaining a thicker graft have been described, including folding the graft or adding two grafts, though no gold standard exists.[16,24,26]

Limitations

This study has several limitations to discuss. The first limitation is the survey nature of the study protocol. The use of a survey as a primary means of polling our cohort of surgeons has some inherent bias. Additionally, the format of our study allowed participants to skip questions which resulted in decreased and variable numbers throughout the survey. The choice to only poll members of the ASES and AOSSM limits the generalizability of our findings. Given the descriptive nature of the study, statistical analyses could not be performed. This limited the ability of the study to go beyond making observations of trends. This study intentionally did not define what made the difference between reparable and irreparable rotator cuff tear. As such, much of the decision-making on techniques and preferences in this article was subjective to the respondents. This vagueness in the “irreparability” component of RCR limited this study’s ability to report clearly on indications for SCR despite the expert cohort. Providers in this poll were not asked to differentiate whether they would use SCR only in irreparable tears or also in massive RCRs in certain clinical scenarios. This may

have resulted in some confusion among respondents who did not understand whether questions about SCR (Table II) were being specifically asked about reparable or irreparable cuff tears. Further clarification on SCR indications is needed with future studies, including whether providers consider it to be solely a salvage option in setting of irreparable cuff tears or whether it can or should be employed as a supplement in reparable massive tears. Additionally, aside from the techniques and preferences for RCR and SCR, many other viable options for joint preserving procedures (such as tendon transfers and subacromial balloon) were not investigated with separate questions in the questionnaire. This limited the scope of the study and did not reflect the variety of individualized options surgeons can implement in this difficult patient cohort.

Conclusions

This survey is the first major compilation of provider preferences for management of massive rotator cuff tears with SCR. This study illustrates the varying thoughts and preferences of expert shoulder and sports medicine surgeons across the country. As indications for surgery for RCR vs. SCR vs. reverse arthroplasty vary widely for massive rotator cuff tears and consensus treatment algorithms have not been established, the goal of this study was to report on current practice standards. In the setting of RCR of massive rotator cuff tear, respondents in this study preferred LHB preservation when asymptomatic, routine SAD, double row repair with solid threaded anchors, and bone marrow stimulation, and/or SCR as indicated for augmentation. Preferences for respondents in this study that perform SCR include LHB tenodesis, superior labral preparation only as much as necessary, human dermal allograft tissue, 3 solid threaded anchors in the glenoid, and double row solid threaded anchors on the humeral side. This study identifies the significant variability in repair constructs and methodology with SCR; further investigation into these variables could be analyzed to identify best practice guidelines.

Disclaimers:

Funding: This study did not receive any outside funding or grants.
Conflicts of interest: Thomas Dooney: The author is a senior group product manager at Arthrex Inc. Thay Q. Lee: The author is a consultant for Arthrex inc. Orr Limpisvasti: The author is a consultant for Arthrex Inc. and Linvatec. The other author, his immediate families, and any research foundation with which he are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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