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Systematic Review

Management of massive and irreparable rotator cuff tears: an evidence-based review of joint-preserving treatment strategies

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ABSTRACT

Massive and irreparable rotator cuff tears are associated with substantial pain, weakness, and altered shoulder biomechanics. For younger or physically active individuals, surgeons typically prefer joint-preserving operations instead of arthroplasty to keep the original anatomy intact and postpone the need for prosthetic implants. This systematic review evaluates functional outcomes, range of motion, structural integrity, and complications of contemporary joint-preserving surgical options for massive and irreparable rotator cuff tears. A comprehensive search was performed according to PRISMA 2020 guidelines. Studies reporting outcomes of superior capsular reconstruction, tendon transfers, patch augmentation, graft interposition, long head of the biceps augmentation, and subacromial balloon spacers were included. Owing to heterogeneity, qualitative synthesis was conducted. Superior capsular reconstruction, particularly with fascia Lata autograft, demonstrated the most consistent improvements in functional scores and forward elevation. Tendon transfers, especially latissimus dorsi transfer, improved external rotation in selected patients. Patch augmentation and graft interposition reduced re-tear rates compared with partial repair. Less invasive options showed symptomatic benefit but variable structural durability. Joint-preserving procedures offer meaningful clinical improvement; however, further high-quality comparative trials are necessary.

Keywords: Massive rotator cuff tear, Irreparable rotator cuff tear, Superior capsular reconstruction, Tendon transfer, Patch augmentation

INTRODUCTION

Tendon retraction, muscle atrophy, and fatty infiltration are the hallmarks of massive rotator cuff injuries, which impair glenohumeral force coupling.[1-3] Tears are considered irreversible when tendon mobilization is insufficient to allow for anatomic healing.[4] Progressive superior migration of the humeral head and loss of balanced biomechanics compromise deltoid function and shoulder elevation.[5,21]

Reverse shoulder arthroplasty has shown consistent pain alleviation in older patients, but its use in younger people is limited due to concerns about revision risk and implant longevity.[5,6,26] In the past, irreparable tears had few treatment choices, which frequently led to inadequate functional restoration.[22,23]

Joint-preserving options have been made available by advances in reconstructive surgery with the goal of improving shoulder mechanics and stability.[9,14] Superior humeral head constraint is restored via superior capsular repair. Techniques such as patch augmentation and biologic grafting improve structural support and healing potential.[17,18] Tendon transfers make up for weak rotator cuff muscles.[15,16] Furthermore, subacromial balloon spacers and long head of the bicep's augmentation have become fewer invasive methods for improving subacromial biomechanics.[19,20,27]

This systematic review compares the functional results, structural durability, and complication rates of joint-preserving surgical treatments considering the changing landscape of treatment approaches.

METHODS

Study design and reporting guidelines

This systematic review was conducted in accordance with preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines.[11] Review protocol was designed a priori to identify, screen, and synthesize evidence related to joint-preserving surgical treatment options for massive and irreparable rotator cuff tears.

Literature search strategy

A comprehensive literature search was performed using the PubMed, Embase, Scopus, and Cochrane Library databases. The search strategy combined Medical Subject Headings and free-text terms related to massive rotator cuff tear, irreparable rotator cuff tear, superior capsular reconstruction, tendon transfer, patch augmentation, graft interposition, and subacromial balloon spacer. The search was limited to studies published in the English language. Reference lists of included articles were also manually screened to identify additional relevant studies.

Study selection

The database search yielded 742 records. After removal of 186 duplicate records, 556 unique articles were screened based on title and abstract. Of these, 487 articles were excluded for irrelevance, non-surgical management, biomechanical or cadaveric design, case reports, technical notes, or non-English language publication. Full-text review was performed for 69 articles, of which 59 were excluded due to lack of joint-preserving surgical intervention, insufficient outcome reporting, inclusion of arthroplasty procedures, mixed patient populations without subgroup analysis, or duplicate cohorts. Ultimately, 10 studies met all inclusion criteria and were included in the qualitative synthesis. The study selection process is summarized in the PRISMA flow diagram

Eligibility criteria

Studies were included if they reported clinical outcomes of joint-preserving surgical procedures for massive or irreparable rotator cuff tears in adult patients. Exclusion criteria included arthroplasty-based studies, non-operative treatment studies, biomechanical or cadaveric investigations, technical notes without outcome data, and studies with overlapping patient populations.

Data extraction and synthesis

Data extracted from each included study comprised sample size, surgical technique, graft type, pre- and postoperative functional outcome scores, range of motion parameters, structural integrity or re-tear rates, complications, and reoperations. Due to heterogeneity in study design, outcome measures, and follow-up duration, a quantitative meta-analysis was not performed[24]. Instead, a qualitative synthesis was conducted, and outcomes were summarized using simplified tables.

Figure 1: PRISMA flowchart.

RESULTS

Non-operative management

Non-operative treatment remains a cornerstone in selected patients, particularly those with low functional demands or significant comorbidities. Rehabilitation programs emphasizing anterior deltoid strengthening have demonstrated improvements in ROM and functional scores, even in patients with irreparable tears.[6] Pain relief is common; however, strength deficits often persist.

Arthroscopic debridement and biceps procedures

Arthroscopic debridement, with or without biceps tenotomy or tenodesis, aims to reduce pain by removing inflamed tissue and addressing biceps pathology. Long-term follow-up studies report pain relief and improved shoulder motion but minimal improvement in strength.[7,8]

This approach is best suited for pain-dominant symptoms in low-demand patients with preserved active elevation.

Partial repair and margin convergence

Partial repair seeks to restore shoulder biomechanics by re-establishing anterior and posterior force couples, even when complete anatomic repair is not feasible. Multiple studies demonstrate significant improvements in functional outcomes despite high re-tear rates approaching 40-60%.[9,10] Notably, clinical improvement does not always correlate with structural integrity.

Patch augmentation and graft interposition

Biologic and synthetic grafts have been used to augment partial repairs or bridge tendon defects. Patch augmentation improves load distribution and may reduce re-tear rates compared with repair alone.[11] Graft interposition techniques demonstrate promising short- to mid-term outcomes, although graft-related complications and variable incorporation remain concerns.

Superior capsular reconstruction

To restore superior stability in the glenohumeral joint by preventing migration of the humeral head. Biomechanical studies support restoration of normal kinematics and clinical series report significant increases in functional scores and pain relief.[12,13] There appears to be a significant sensitivity to surgical techniques and patient selection in outcomes.

Subacromial balloon spacer

The biodegradable subacromial balloon spacer acts as a temporary depressor of the humeral head. Early clinical studies demonstrate improved pain and function in selected patients without advanced arthritis or pseudoparalysis.[14] However, long-term durability remains uncertain.

Table 1: Functional outcome scores following joint-preserving treatment modalities for massive and irreparable rotator cuff tears.[10-16]

Treatment modality	ASES score (pre-post)	Constant score (pre-post)	UCLA score (pre-post)	Clinical interpretation
Non-operative management	35-45→55-65: Pain relief and improved sleep; basic ADLs possible, overhead activities limited	30-40→50-60: Reduced pain and improved motion, persistent weakness	12-15→18-22: Fair outcome; pain improvement without strength recovery	Pain relief with modest functional gain
Arthroscopic debridement± Biceps procedure	40-50→60-70: Reliable pain relief; improved daily activities, minimal overhead strength	35-45→55-65: Improved comfort and ROM; limited power	14-18→20-24: Fair-to-good pain relief, limited functional endurance	Reliable pain improvement, limited strength recovery
Partial repair	40-50→70-80: Marked pain reduction; improved elevation and functional use	35-45→65-75: Improved elevation and moderate strength restoration	15-18→25-30: Good-to-excellent outcomes with functional satisfaction	Significant functional improvement despite high re-tear rates
Patch augmentation	45-55→70-85: Sustained pain relief with improved endurance	40-50→65-80: Better strength and ROM durability	16-20→26-30: Consistently good outcomes	Improved load sharing and functional durability
Superior capsule reconstruction	35-50→80-90: Restoration of elevation, minimal pain, high satisfaction	30-45→70-85: Near-normal elevation and improved deltoid efficiency	14-18→28-32: Excellent functional recovery	Restoration of joint stability and elevation
Subacromial balloon spacer	40-50→65-75: Pain relief with improved elevation, transient benefit	35-45→60-70: Temporary improvement in motion, limited strength	15-18→22-26: Good short-term satisfaction	Short-term functional improvement
Tendon transfer	40-50→75-85: Improved pain and high-demand functional use	35-45→70-80: Significant restoration of strength and rotation	14-18→26-30: Good-to-excellent outcomes	Best restoration of strength and external rotation

Table 2: Comparative effectiveness of joint-preserving modalities based on functional domains.[3-5,9,12,13,15,16]

Treatment modality	Pain relief	Forward elevation	External rotation	Strength restoration	Durability
Non-operative management	Moderate	Mild–Moderate	Minimal	Minimal	Variable
Arthroscopic debridement	High	Mild	Minimal	Minimal	Limited
Partial repair	High	Moderate-high	Moderate	Moderate	Mid-term
Patch augmentation	High	Moderate-high	Moderate	Moderate	Mid-term
Superior capsular reconstruction	High	High	Moderate	Moderate	Promising mid-term
Subacromial balloon spacer	Moderate-high	Moderate	Minimal	Minimal	Short-term
Tendon transfer	Moderate-high	Moderate	High	High	Long-term (selected patients)

Table 3: Treatment modality yielding the best functional outcome by patient subgroup.[12,13,15,16]

Patient subgroup	Preferred joint-preserving modality	Primary outcome benefit
Young (<65 years), reparable tissue	Partial repair	Best balance of pain relief and function
Young, irreparable posterosuperior tear	Superior capsular reconstruction	Restoration of elevation and joint centering
Young, loss of active external rotation	Tendon transfer	Restoration of strength and rotation
Elderly, pain-dominant symptoms	Debridement or balloon spacer	Pain relief
Poor tissue quality, large defects	Patch augmentation / graft interposition	Improved durability
Low-demand, medically unfit	Non-operative management	Symptom control

Tendon transfers

Tendon transfer strategies-including latissimus dorsi and lower trapezius transfers-are recommended where young, active patients show loss of active external rotation. Studies on long-term patient outcomes have durable gains in strength and function.[15,16] These procedures are challenging to conduct and must involve intact deltoid and subscapularis function.

DISCUSSION

The present systematic review evaluated the clinical and structural outcomes of joint-preserving surgical procedures for massive and irreparable rotator cuff tears. The primary findings demonstrate that superior capsular reconstruction and tendon transfer procedures provide the most consistent functional improvement, while graft augmentation techniques improve structural integrity. Less invasive procedures offer symptomatic relief but demonstrate variable durability. These findings are interpreted below in comparison with previously published literature.

Functional outcomes

In the present review, superior capsular reconstruction demonstrated the most substantial improvement in functional scores, particularly American Shoulder and Elbow Surgeons and Constant scores. This improvement is likely attributable to restoration of superior glenohumeral stability and re-establishment of balanced shoulder biomechanics.[7,13] Biomechanical studies have shown that reconstruction of the superior capsule reduces humeral head migration and restores deltoid efficiency.[21,30] These findings are consistent with clinical reports by Mihata et al and Denard et al who observed significant postoperative improvement in shoulder function following fascia lata-based reconstruction.[7,12]

Tendon transfer procedures, particularly latissimus dorsi transfer, also demonstrated meaningful functional recovery in appropriately selected patients. The present findings support earlier studies by Gerber et al and Namdari et al which reported improved elevation and external rotation following tendon transfer in patients with intact subscapularis function.[15,16] However, functional outcomes following tendon transfer appear more dependent on patient selection and preoperative muscle status compared with superior capsular reconstruction.[16]

Patch augmentation techniques resulted in improved functional durability compared with partial repair alone. This aligns with findings reported by Barber et al and Petri et al who demonstrated that reinforcement reduces repair tension and enhances load-sharing capacity at the tendon-bone interface.[17,25]

Balloon spacers and biceps-based augmentation procedures produced moderate short-term improvement in functional scores. Similar findings have been reported in previous studies describing symptomatic relief and improved forward elevation following subacromial spacer implantation.[19,27] However, long-term durability remains uncertain.

Range of motion outcomes

Forward elevation improved most consistently following superior capsular reconstruction in this review. Restoration of superior restraint likely permits more effective deltoid recruitment during active elevation.[7,13] These findings are comparable to earlier reports demonstrating significant improvement in active elevation following SCR.[12]

External rotation improvement was most notable after latissimus dorsi tendon transfer, consistent with its biomechanical objective of restoring the external rotation moment arm.[15] Similar improvements have been reported by Elhassan et al who emphasized the importance of intact anterior force couples for optimal rotational recovery.[16]

Earlier literature describing untreated massive tears has documented progressive decline in range of motion and development of pseudoparalysis.[22,23] Compared with these natural history studies, the procedures analyzed in this review appear to substantially alter disease progression by restoring active motion.

Structural integrity and re-tear rates

The present review demonstrates that fascia lata–based superior capsular reconstruction is associated with lower failure rates compared with dermal allograft reconstruction.[7,13] Previous systematic reviews have also reported variability in dermal graft incorporation, likely related to graft thickness, fixation technique, and biological integration.[4,14]

Patch augmentation significantly reduced re-tear rates compared with partial repair alone in the included studies. These findings corroborate earlier work by Barber et al demonstrating improved structural integrity with biologic reinforcement.[17] Similarly, graft interposition techniques showed favorable healing rates, supporting the principle that tension-free bridging enhances tendon healing potential.[18]

Long-term follow-up studies of massive tears treated with conventional repair have demonstrated high structural failure rates.[23,24] In comparison, reconstructive procedures analyzed in the present review appear to provide improved structural durability.

Complications

Complication rates across joint-preserving procedures were generally low in the present review. Tendon transfer procedures demonstrated slightly higher complication rates compared with graft-based reconstructions, consistent with prior literature describing risks of nerve injury, tendon rupture, or stiffness.[16] Balloon spacers demonstrated low early complication rates, but concerns remain regarding long-term durability and biodegradation behavior.[19,27]

Compared with reverse shoulder arthroplasty, which carries risks of instability and implant-related complications, joint-preserving procedures may provide a safer alternative in younger populations.[5,26,28]

Comparison with historical treatment strategies

Historically, management options for irreparable rotator cuff tears were limited to debridement, partial repair, or tendon transfer.[22] Advances in biologic reconstruction and capsular restoration techniques have expanded treatment options significantly.[9,14] The present findings reinforce the concept that restoring shoulder biomechanics-rather than merely relieving pain-is critical to improving long-term function.[21,30]

Clinical implications

Based on the present review, superior capsular reconstruction appears to provide the most reliable restoration of elevation and stability.[7,13] Tendon transfer procedures remain valuable in cases with external rotation deficit.[15,16] Patch augmentation and graft interposition improve structural integrity.[17,18] Less invasive procedures such as balloon spacers and biceps augmentation may be considered in low-demand patients or as temporizing measures.[19,20]

The present systematic review demonstrates that joint-preserving surgical procedures can significantly improve shoulder function, restore motion, and enhance structural integrity in selected patients with massive and irreparable rotator cuff tears. Superior capsular reconstruction and tendon transfer procedures demonstrate the most consistent biomechanical and clinical benefits.[7,15] Reinforcement techniques reduce re-tear rates.[17,18] Continued investigation is required to determine long-term durability and optimize patient selection.[24,29]

Limitations

The findings of this review are limited by heterogeneity in study design, outcome measures, and follow-up duration.[24,29] Absence of randomized comparative trials

restricts definitive conclusions regarding superiority among techniques. Future prospective, comparative studies with standardized reporting are required.

CONCLUSION

Massive and irretrievable rotator cuff tears are among the most complicated problems in shoulder surgery of which a treatment strategy should optimize pain control, functional restoration, durability, and future options conservation. While a single joint-preserving procedure may not be superior for all patients, the relevant evidence overwhelmingly shows the best and most durable clinical outcome for patients with joint injury is one that restores shoulder biomechanics and force coupling. Among therapies aimed at preservation of the joint, partial rotator cuff repair along with anterior-posterior force couple restoration is the most reliably effective first-line surgical treatment where possible. Despite high rates of structural failure, partial repair consistently results in an improvement of pain, shoulder elevation, and patient-reported outcomes, highlighting that functional success is more closely connected to biomechanical restoration than complete tendon healing. Partial repair allows for predictable improvement with relatively low morbidity, and preserves future surgical options, when repairable tissue is available. Among joint-preserving procedures, superior capsular reconstruction can currently afford a relatively complete biomechanical restoration in patients with genuinely irreparable posterosuperior cuff tears and preserved deltoid and subscapularis function. With superior capsular reconstruction, effective deltoid-driven shoulder function can be achieved by avoiding superior humeral head migration and re-centering the glenohumeral joint, which leads to significant improvements in pain and functional scores at mid-term follow-up. Given only suitable selection of patients and a seasoned surgeon, this procedure can provide outcomes surpassing debridement, spacer implantation, or graft interposition alone. For young, physiologically active patients that have lost active external rotation, tendon transfer procedures provide the best functional outcome with respect to strength and rotational control. Upon strict indications, tendon transfers offer long-term enhancement and continue to be the recommended joint-preserving alternative for the recovery of rotational biomechanics not amenable to other alternatives. For example, adjunctive operations including patch augmentation, graft interposition, and subacromial balloon spacers are regarded as having critical significance in certain clinical environments but generally demonstrate a limited or lesser effect over partial repair, superior capsular reconstruction, or tendon transfer. Such procedures are most appropriately conceived as adjuncts or temporary answers, but with insufficient overall reconstructive intent. Altogether, joint-preserving modalities should be selected as the preferred option over joint replacement in patients who are younger, active individuals, and those without advanced glenohumeral arthritis when deltoid and subscapularis functions are maintained. A stepwise approach-the least invasive biomechanically restorative procedure and more challenging reconstructions only when required-lends a higher success rate but allows for continued long-term surgical options. Ultimately, partial repair appears to be the most certain approach where it is possible, superior capsular reconstruction is the best choice in case of the irreparable posterosuperior tear, and tendon transfers are the most successful strategy in promoting the return to function in high-demand patients. Management of massive and irreparable rotator cuff tears will ultimately depend significantly on patient selection, biomechanical understanding, and surgical skill.

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