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General

Advances in Arthroscopic Superior Capsular Reconstruction of the Shoulder: A Narrative Review

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Background

Irreparable massive rotator cuff tear (IMRCT) is a significant challenge in shoulder surgery, with traditional treatments yielding suboptimal outcomes. Superior Capsular Reconstruction (SCR), an innovative arthroscopic joint-preserving procedure, provides a new solution for IMRCT by restoring superior glenohumeral joint stability.Methods: This narrative review systematically searched PubMed, Web of Science, Embase and Cochrane Library for arthroscopic SCR studies using the terms “superior capsular reconstruction”, “irreparable massive rotator cuff tear”, “arthroscopy” and “graft material”. The search covered 2013 (the first SCR report) to 2025. Peer-reviewed English full-text articles were included, and duplicate, low-quality and irrelevant literatures were excluded. Finally, 45 high-quality studies (clinical cohort, biomechanical experiments, systematic reviews) were selected to analyze SCR advances in indications, graft selection, surgical techniques and rehabilitation.Results: SCR effectively improves shoulder function, alleviates pain and increases acromiohumeral distance (AHD) in IMRCT patients without severe glenohumeral arthritis. Tensor fascia lata autograft has the best long-term survival but donor-site morbidity risk; acellular dermal matrix allograft avoids donor-site injury but has high cost and slow integration; long head of the biceps tendon autograft is ideal for small-to-medium tears due to minimal invasiveness and cost-effectiveness. Hamstring and peroneus longus tendon grafts have specific clinical applications.Conclusion: SCR is an effective IMRCT treatment, with individualized graft selection based on patient conditions, cost-effectiveness and regional availability being critical. Future research should establish SCR technical standards, evaluate long-term outcomes, refine patient selection and explore biologic augmentation and 3D-engineered grafts.

1. INTRODUCTION

IMRCTs are often accompanied by severe tendon retraction, fatty infiltration, and muscle atrophy, leading to the destruction of the superior shoulder stabilizers, causing pain, functional impairment, and pseudoparalysis. Traditional treatments, such as debridement alone, partial repair, tendon transfer, and reverse total shoulder arthroplasty, have limitations in efficacy, complications, or applicability, often yielding unsatisfactory results, especially for young, active patients.

This therapeutic dilemma has driven biomechanical innovation. In 2013, Mihata et al[1] first proposed SCR, which involves implanting a graft to reconstruct the deficient superior capsule, aiming to restore its biomechanical function as a “hammock” preventing superior humeral head migration. This procedure not only restores glenohumeral stability but also creates a favorable environment for healing of the remaining rotator cuff tissue by re-establishing force couple balance. With the popularization of the technique, graft options for SCR have rapidly expanded from the initial TFL autograft to include various types such as allogeneic dermis, LHBT, hamstring tendons, and even xenografts and synthetic materials.

However, this diversity of grafts also brings confusion in selection. Different grafts vary significantly in biological integration capacity, mechanical strength, donor-site morbidity, cost, and availability, yet there is currently a lack of consensus guidelines for selection. Therefore, this article aims to comprehensively review and critically compare the current evidence, surgical techniques, clinical outcomes, and rehabilitation strategies for various grafts in the field of SCR to provide a clear decision-making framework for clinical practice and identify future research directions.

2. ANATOMY OF THE SUPERIOR GLENOHUMERAL JOINT CAPSULE

The glenohumeral joint has a large range of motion but poor intrinsic stability. Its anterior, posterior, and superior regions are reinforced by the fusion of the muscle-tendon complexes with the capsular layer, while the anteroinferior region is prone to dislocation. Joint stability relies on the combined action of dynamic stabilizers (deltoid, LHBT, rotator cuff) and static stabilizers (glenoid labrum, glenohumeral ligaments, joint capsule). The superior capsule, a key static stabilizer, originates from the superior glenoid, runs deep to the supraspinatus (SSP) and infraspinatus (ISP) tendons, and inserts onto the greater tuberosity, preventing superior migration of the humeral head .[2] IMRCTs disrupt this structure, leading to glenohumeral instability, pain, and dysfunction. SCR aims to restore the function of the superior capsule in preventing abnormal humeral head translation.

3. INDICATIONS AND CONTRAINDICATIONS

Traditional treatments for irreparable massive rotator cuff tears are limited by high re-tear rates. SCR can enhance glenohumeral stability, reduce subacromial pressure, and increase the acromiohumeral distance (AHD), making it an ideal alternative. Its main indications include irreparable massive rotator cuff tear; intact deltoid function: Weakness compromises dynamic stability, potentially leading to inferior humeral head translation and increased AHD[3]; intact or reparable subscapularis tendon: Involvement of more than one-third of the subscapularis significantly increases the failure rate of repair[4]; unsuitability for reverse shoulder arthroplasty (RSA): Contraindications for RSA include active shoulder forward flexion <90° (severely <45°), while SCR can effectively improve pseudoparalysis.[5] Additionally, indications for SCR include irreparable supraspinatus/infraspinatus tears, severe tendon retraction, or Goutallier grade 3-4 fatty infiltration.

Contraindications: advanced glenohumeral arthritis (Hamada classification ⩾ grade 3); severe glenohumeral joint fracture/dislocation; severe osteoporosis (affecting anchor fixation); cervical radiculopathy or axillary nerve injury; active shoulder joint infection; poor compliance with postoperative rehabilitation.

4. GRAFTS

4.1. TENSOR FASCIA LATA (TFL) AUTOGRAFT[1,6,7]

The TFL autograft is a well-established option with excellent biocompatibility and low cost, particularly suitable for young, high-demand patients unconcerned about a thigh incision and where cost is important. However, the risk of donor-site complications is its primary limitation.

Advantages: Excellent biomechanical properties; autologous tissue, no rejection or graft-related infection; rapid vascularization and remodeling potential post-transplantation, transforming into viable tissue.

Disadvantages: donor-site morbidity and additional trauma; prolonged surgical time and complexity; limitations in graft size and thickness.

4.2. ACELLULAR DERMAL MATRIX ALLOGRAFT (ADMA)[8,9]

ADMA provides an efficient, convenient option for SCR that avoids donor-site complications. It is suitable for patients highly concerned about donor-site issues, complex cases requiring reduced operative time, patients with poor TFL condition or unavailability, and when cost is not the primary concern. However, its high cost and relatively slow biological integration are main drawbacks. Advantages: No donor-site morbidity; off-the-shelf availability, saving time; initial stiffness and strength often higher than native superior capsule; integration capacity slower than TFL but better than non-resorbable synthetics. Disadvantages: High cost; slow vascularization and remodeling; potential "weak phase"; risk of low-grade immune/inflammatory reaction; Theoretical disease transmission risk.

4.3. LONG HEAD OF BICEPS TENDON (LHBT) AUTOGRAFT[10,11]

Using the LHBT for SCR is an intelligent, minimally invasive, and cost-effective strategy, but its application has strict indications. It is most suitable for patients with small-to-medium-sized irreparable tears, patients with a relatively healthy, robust LHBT, patients with concomitant LHBT pathology requiring treatment, and patients wishing to avoid additional donor-site trauma and unable/unwilling to bear the high cost of allografts.

Advantages: True "in-situ" graft, no additional donor-site trauma; performed through standard arthroscopic portals; avoids TFL donor-site complications; high surgical efficiency, very low cost; excellent biocompatibility and healing potential.

Disadvantages: Limitations in graft size and quality; potential insufficient biomechanical strength for large tears; sacrifice of biceps' flexor function; technical challenges and learning curve.

4.4. HAMSTRING TENDON AUTOGRAFT[12,13]

The hamstring tendon autograft is a strong, biologically favorable, and low-cost option for SCR. It is suitable for SCR candidates unable/unwilling to use TFL, massive defects requiring high mechanical strength, and when cost is a significant factor. However, potential impact on knee function, technical complexity, and relative lack of long-term data are main constraints. Advantages: High ultimate tensile strength; autologous tissue, good integration potential; for some, medial knee discomfort may be more tolerable than lateral thigh issues; potential smaller impact on gait; high customizability via folding/braiding. Disadvantages: Donor-site morbidity and functional impact; tech-

nical complexity and prolonged preparation time; ropelike structure requires conversion to sheet-like form.

4.5. PATELLAR TENDON GRAFT[14,15]

For most patients and surgeons, TFL, ADMA, LHBT, or hamstring tendons are far superior choices to patellar tendon. Advantages: Extremely high initial mechanical strength; Bone-tendon-bone structure allows bone-to-bone healing; Autologous tissue, no rejection, low cost. Disadvantages: Significant donor-site morbidity (anterior knee pain); Quadriceps weakness; Risk of patellar tendon rupture/fracture; Mismatch between graft morphology (thick) and surgical need (thin sheet).

4.6. ACHILLES TENDON ALLOGRAFT[16,17]

Surgeons must carefully weigh the size advantage against the risk of impingement when considering the Achilles tendon allograft. Advantages: Large graft size and volume; Excellent mechanical strength; Calcaneal bone block allows bone-to-bone healing; Off-the-shelf, no donor-site morbidity. Disadvantages: Excessive bulk leading to impingement; High cost; Challenges in biological integration; Technical difficulty in handling; Immune reaction and disease transmission risk.

4.7. XENOGRAFT[18,19]

Xenografts are tissues from other species, most commonly porcine dermis or bovine pericardium, processed to serve as human tissue substitutes. Advantages: Stable supply; Standardized specifications; Potentially controllable cost; Avoids human disease transmission and donor-site morbidity. Disadvantages: Immune reaction risk; Integration difficulties due to cross-linking; Lack of evidence for mid-to-long-term safety/efficacy in SCR; Theoretical zoonotic disease risk; Cultural/psychological factors.

4.8. SYNTHETIC GRAFT[20,21]

Currently, for most SCR patients, mature biological grafts remain safer and more reliable choices than synthetic grafts. Advantages: Supply and standardization; No donor-site injury; High initial strength; No disease transmission risk; Potentially lower cost than allografts. Disadvantages: Lack of integration and foreign body reaction; Poor long-term durability (wear, rupture); High infection risk; Potential for joint stiffness; Lack of long-term evidence.

4.9. PERONEUS LONGUS TENDON AUTOGRAFT[22,23]

The peroneus longus tendon autograft is a promising newcomer, balancing excellent mechanical properties, relatively low donor-site morbidity, and low cost. However, the lack of strong long-term evidence is the main barrier to widespread use. Advantages: Excellent mechanical properties; Minimal donor-site impact on ankle function; Good customizability due to sufficient length; Excellent biocompatibility; Low cost. Disadvantages: Persistent donor-site risks; Technical demands; Non-ideal sheet-like morphology post-braiding; Lack of long-term evidence in SCR. (Table 1: Summary of Outcomes from Different Studies Using Various Grafts)

5. KEY SURGICAL TECHNIQUES FOR SCR[35]

5.1. COMMON PRINCIPLES

Assess & Repair Subscapularis: Prioritize preoperative evaluation and anatomical reduction of the subscapularis tendon. Restore Force Couple: Reconstruct mechanical balance by repairing any residual, reparable rotator cuff tendons. Integrate Graft & Cuff: Securely incorporate the graft with the residual cuff tissue to minimize re-tear risk.

5.2. SCR USING LHBT AUTOGRAFT

Snake Technique: (Beach chair position) Arthroscopic assessment, LHBT harvest & preparation, Fixation to anterior GT and glenoid (posterior GT if needed), Partial cuff repair + Abduction brace. Key Focus: Precise graft fixation points and tensioning. Chinese Technique: (Multiple portals) Assess LHBT quality, Transfer tendon to SSP footprint using a “sling” technique, Layered fixation with anchors + repair of residual ISP, Tension-free side-to-side suture integration. Key Focus: Achieving stable, layered fixation and force couple integration without overtensioning. LHBT In-Situ Reconstruction: (Lateral decubitus) Prepare bone bed, Anatomically reduce LHBT, Secure with lasso-loop and anchor double-loop reinforcement, Augment with double-row/bridging repair if needed. Key Focus: Robust fixation of the in-situ tendon, often requiring reinforcement techniques.

5.3. SCR USING TFL / ADMA CORE STEPS

Positioning & Assessment: Beach chair or lateral decubitus position. Perform diagnostic arthroscopy. Preparation: Measure the defect. Decorticate bone beds on the glenoid rim and greater tuberosity (GT). Place suture anchors along the superior glenoid (e.g., 10-2 o’clock). Graft Implantation: Size and prepare the graft (ADMA ~3mm thick; TFL typically folded to 6-8mm). Implant with the rough/porous side facing the joint. Fixation & Tensioning: Fix the graft under appropriate tension at 45° of glenohumeral abduction. Perform side-to-side repair to the residual anterior and posterior cuff. Final tension should balance stability with deltoid load. Critical Nuances: Graft Tensioning: Achieving the correct tension at 45° abduction is technically critical; overtensioning restricts motion, while undertensioning fails to restore stability. Graft Fixation: Secure medial fixation to the glenoid and lateral fixation to the GT is paramount. Robust side-to-side suturing to the residual cuff is essential for creating a continuous, functional “hammock.”

Table 1: Summary of Outcomes from Different Studies Using Various Grafts

Study	Study Design (LoE)	No. of patients	Graft Type	Graft Thickness (mm)	outcome			
					Follow-up Time	result	Scores	Complications (Including Re-tear)
Mihata[24]	Case series; Level 4	34	TFL	7.8 ± 1.6	10 years	Graft survival rate 89% (32/36 shoulders) at 5-10 years	ASES and JOA scores increased significantly post-op, remained stable	Complication rate 2.8% (1 anchor pullout)
Hasegawa[6]	Retrospective study; Level III	154	TFL	≥6	≥2 years		VAS 0.5, ASES 93.1, JOA 92.3	Graft tear rate 11.7% (18/154)
Ohta[25]	Retrospective cohort; Level III	49	TFL		≥2 years	Mean AHD improved from 5±2.6 mm pre-op to 9±2.8 mm post-op	JOA, UCLA scores improved significantly	5 graft tears, 2 infections, 1 progressive arthropathy
Burkhart[26]	Retrospective case series; Level IV	41	Dermal Allograft		≥2 years	85% complete graft healing, AHI improved from 7mm to 8mm	ASES improved from 46-57 pre-op to 87-92 at 1 year and 86-92 at final follow-up	2 revisions (5%), 1 reoperation, 1 medical complication
Bi[27]	Retrospective case series; Level IV .	43	TFL		≥2 years	Improved abduction strength	VAS 0.7 vs 5.4; ASES 92.6 vs 34.8	39/43 (91%) grafts intact on MRI
Lacheta[28]	Case series; Level IV	22	Dermal Allograft	Avg. 3	≥2 years	Mean AHD increased significantly from 7.0 mm pre-op to 8.3 mm post-op	ASES improved from 54.0 to 83.9; VAS median 4 to 0	100% integrity at tuberosity, 76% mid-substance, 81% glenoid side
Makki[29]	Case series; Level 4	25	Dermal Allograft		≥2 years	Mean forward flexion/abduction improved 20°, ER improved 7°	Mean OSS improved ≥10 points	3 revisions to RSA (12%), 4 graft failures (16%)
Llinás[26]	Cohort study; Level 3	56	LHBT		2 years	Significant increase in flexion, abduction ROM	ASES: 77.23 ± 7.45; VAS: 1.64 ± 1.03	Re-tear rate 14%
Chiang[30]	Retrospective comparative; Level III	18	LHBT		≥2 years	Survival rate 94.4% (17/18), significant improvement in flexion, ER, IR	VAS, ASES improved significantly	Re-tear rate 16.7% (3/18)
Gao[31]	Retrospective study; Level IV	89	LHBT		≥2 years	FF improved 51±21.7°, ER 21.0±8.1°, Abd 58.5±22.5°. AHI increased 2.1±0.8 mm	ASES: 42.8±7.6 to 87.4±6.1; VAS: 6.0 to 1.0	11 re-tears, 1 reoperation
Funakoshi[32]	Retrospective study	25	Semitendinosus Autograft (Hamstring)		≥2 years	23 (92%) shoulders had intact graft/tendon; AHI 6.2±1.9mm	ASES: 39.9±14.5 to 88.9±10.6; JOA: 62.5±13.4 to 88.5±6.2; VAS: 5.3±2.4 to 0.72±1.2	Re-tear rate 20% (5 shoulders), 2 graft failures with cuff re-tear

Joo[33]	Case series; Level 4	32	Achilles Tendon Allograft	Min. 8	≥2 years	AHI from 4.8 to 8.2 mm	VAS: 6.7 to 1.8; ASES: 42.7 to 83.8; Constant: 47.2 to 78.5	4 failures (12.5%)
Lee[17]	Retrospective study	11	Achilles Tendon Allograft		≥2 years	AHD improved from 3.88±1.21 mm to 6.37±1.72 mm; ~73% (8/11) grafts intact	VAS: 4.1±1.5 to 1.1±0.9; ASES: 51.6±11.4 to 76.4±13.6	1 infection, 2 graft discontinuities at tuberosity (27.3% failure)
Okamura[20]	Cohort study; Level 3	35	Teflon graft (Synthetic)		≥2 years	Significant AHI increase in 3-layer group; Abd strength: single-layer +11.9N, 3-layer +10.9N	ASES: single-layer +20.8, 3-layer +31.1; VAS: single-layer -3.2, 3-layer -3.0	2 graft tears (single-layer), 1 severe synovitis (single-layer). No tears in 3-layer group
Takayama[5]	Retrospective study	19	Teflon PTFE graft (Synthetic)	6 ± 0	≥2 years	AHD from 4.3±2.2 to 8.7±2.2 mm	ASES: 55.8±6.4 to 82.3±15.9	1 progressive GH OA, 1 ALS
Ilg[19]	Case series; Level 4	22	Xenograft (Porcine Dermis)	1.5	2 years	15 (68.2%) patients had intact graft on humeral side	VAS: 4.2±2.5 to 1.0±1.4; ASES: 47.7±15.3 to 86.4±12.9	7 (31.8%) graft non-healing/ tear
Ferrando[18]	Retrospective study	56	Xenograft (Porcine Dermis)		≥2 years	Recovery of FF/ER function	VAS: 6.5±2.1 to 1.4±2.2; ASES: 41±19 to 78±18	14 SCR graft failures, 4 revised to RSA. 5/11 pts with true pseudoparalysis reversed post-op
Polacek[34]	Case series; Level IV	19	Xenograft	3 mm	1 year	Active Abd from 65.4° to 149.3°, Active FF from 68.6° to 151.4°	SPADI significantly improved from 51.3% to 10.4%	Complication rate 30%, immune rejection 15%
Bi[27]	Retrospective case series; Level IV	43	TFL combined with Synthetic Scaffold		≥2 years	39 (91%) intact on MRI	VAS 0.7 vs 5.4; ASES 92.6 vs 34.8	

Abbreviations: LoE=Level of evidence; VAS=Visual Analog Scale; ASES=American Shoulder and Elbow Surgeons Score; JOA=Japanese Orthopaedic Association Score; UCLA=University of California Los Angeles (Shoulder Score); SPADI=Shoulder Pain and Disability Index; AHD=Acromiohumeral Distance; ER=External rotation; FF=Forward flexion; IR=Internal rotation; RSA=Reverse shoulder arthroplasty; GH OA=Glenohumeral osteoarthritis; ALS=Amyotrophic lateral sclerosis

6. CLINICAL OUTCOMES AND REHABILITATION[36,37]

The core concept of postoperative rehabilitation is to achieve a precise balance between protecting graft healing and restoring shoulder function. The graft is mechanically weakest initially, gradually strengthening through cellular remodeling and collagen fiber realignment. Rehabilitation must follow this biological healing pattern.

I. MAXIMUM PROTECTION PHASE (0-6 WEEKS)

Goals: Protect graft fixation; reduce pain/inflammation; maintain distal joint ROM. Interventions: Strict abduction brace (30°-45°); Passive ROM (PROM): pendulum, supine passive FF, ER (<30°); Hand/wrist/elbow AROM; Ice. Contraindications: No Active ROM (AROM) or Resistance Training (RET); Avoid stretching; Avoid ER/IR beyond safe angles.

II. MODERATE PROTECTION PHASE (6-12 WEEKS)

Goals: Gradually restore full PROM; begin early controlled AROM; activate/scapular stabilizers. Interventions: Week 6: Remove brace, begin gravity-assisted AROM; Weeks 8-10: Progress to AAROM and light AROM; Continue PROM; Scapular stabilization; Isometrics for rotator cuff. Contraindications: No lifting, high-intensity RET; All activities pain-free; Avoid sudden movements.

III. STRENGTH STRENGTHENING PHASE (12-24 WEEKS)

Goals: Restore full AROM; enhance rotator cuff, deltoid, scapular muscle strength/endurance; prepare for functional return. Interventions: From Week 12: Systematic resistance training (bands, light weights) for rotator cuff, deltoid, dynamic GH stability; Closed chain exercises; Endurance/proprioception training. Guidelines: Low load, high repetition; Monitor form; Stop if pain/fatigue.

IV. RETURN TO ACTIVITY PHASE (≥24 WEEKS)

Goals: Restore full functional activity; return to work/sports/labor. Interventions: Sport-specific training; Gradual return to labor/sports. Guidelines: Return to strenuous activity requires medical/therapist approval; Graft maturation takes 9-12 months.

This is a general framework; individualize based on graft type, fixation, tissue quality, age, and healing progress. Graft-specific considerations include varying healing speeds, monitoring for stiffness vs graft failure, and prioritizing pain management and patient education. Emerging Technology: Blood Flow Restriction (BFR) Training[9] can prevent muscle atrophy and enhance strength early post-op without high graft stress. (Table 2: Postoperative Rehabilitation Protocols from Different Studies)

7. DISCUSSION

This review synthesizes the current evidence on Superior Capsular Reconstruction (SCR) for the treatment of Irreparable Massive Rotator Cuff Tears (IMRCTs). Although the existing body of research predominantly consists of retrospective cohort studies with room for improvement in their level of evidence, the data consistently demonstrate that SCR effectively restores glenohumeral joint stability, improves shoulder function, alleviates pain, and increases the Acromiohumeral Distance (AHD). However, no single graft represents a universal "best choice," and its success largely depends on the precise matching of patient factors, tear characteristics, and graft properties.

Our analysis clearly reveals the core trade-offs between different graft categories. The Tensor Fascia Lata (TFL) autograft, with its exceptional long-term survival rate (89% at 10-year follow-up in Mihata et al.'s study) and stability of functional scores, has established its position as the "gold standard" for SCR.[1,24] Its success is rooted in the excellent biocompatibility and powerful in vivo remodeling potential inherent to autologous tissue. However, its 11.7% re-tear rate[6] and the unavoidable risk of donor-site morbidity are major constraints on its clinical application.

In contrast, the Acellular Dermal Matrix Allograft (ADMA) offers the convenience of being "off-the-shelf" and completely avoids donor-site injury. Studies confirm its effectiveness in restoring AHD (mean increase of 1-1.3 mm) and improving early functional outcomes (ASES scores reaching 83.9-92).[26,28] Nonetheless, its relatively high revision/failure rate (16%-18.2%)[6,29] exposes the inherent challenges of biological integration for acellular scaffolds, including slow vascularization and a potential "weak mechanical phase." Data on xenografts are even more cautionary; although some patients achieve good Patient-Reported Outcomes (PROs),[19] the high rates of graft non-union (31.8%) and immune rejection (15%)[19,34] indicate significant ongoing challenges in controlling immunogenicity and ensuring reliable integration with current materials.

Synthetic grafts (e.g., PTFE) show potential in restoring AHD and function.[20,21] However, the case of "severe synovitis in a single-layer graft" reported by Okamura et al.[20] highlights the risks of wear particles causing foreign body reactions and insufficient long-term durability. Their current use should be strictly limited to salvage procedures.

Within the category of autografts, selection must also be individualized. For patients seeking an alternative to TFL, the hamstring tendon provides an option with comparable mechanical strength, particularly suitable for massive defects.[32] However, its 20% re-tear rate suggests a potential learning curve and healing challenges associated with this technique. The peroneus longus tendon is an emerging option with theoretical advantages of lower donor-site morbidity, but it currently lacks large-scale, long-term data to support its widespread application.

The use of the Long Head of the Biceps Tendon (LHBT) must strictly adhere to indications. Its frequent degeneration and limited length/volume dictate its suitability primarily for small-to-medium sized tears. For massive tears,

Table 2. Postoperative Rehabilitation Protocols from Different Studies

Table 2: Postoperative Rehabilitation Protocols from Different Studies								
Study	Study Design (LoE)	No. of Pts	Graft Type	Brace	ROM			Strengthening & Return to Sport
					PROM	AAROM	AROM	
Mihata[38]	Cohort; Level 3	193	Autograft	0-4 weeks (Sling)	>5 weeks	>5 Weeks	Not specified	>12 Weeks: Gradual strengthening. RT Sport not specified
Kholin[39]	Cohort; Level 3	72	Autograft	0-6 Weeks (Abduction)	>3 Weeks: Pendulums	Not specified	Not specified	>3 Months: Strengthening periarticular/rotator cuff. RT Sport not specified
Polace[40]	Case series; Level 4	24	Autograft	0-6 Weeks (Sling)	>2 Weeks	>6 Weeks	Not specified	>12 Weeks: Deltoid/periarticular strengthening; 6-12 Months: Full activity
Barth[8]	Cohort; Level 3	24	LHBT	0-6 Weeks	>4 Weeks	>4 Weeks	0-4 Weeks: Hand/Wrist/ elbow	>6 Months: Begin strength/resistance exercises
Takayama[5]	Retrospective	46	Autograft	0-6 Weeks (45° Abduction)	>4 days: Supine passive	>5 Weeks: Supine AAROM	>8 Weeks: Supine/sitting AROM	>5 Months: Strengthening; >6 Months: Sports participation
Makki[29]		25	Allograft	0-6 Weeks (Sling)	>6 Weeks: Full PROM	Not specified	6W-3M:	>3 Months: Strengthening, progress to full AROM; >6 Months: Unrestricted activity
Campbell[41]	Retrospective	23	Allograft	0-6 Weeks (Sling)	0-6 Weeks: Pendulums	>6 Weeks	>6 Weeks: Gradual	Not specified
Ferrand[18]	Retrospective	56	Xenograft	0-6 Weeks (Sling)	0-6 Weeks: Can start PROM	6W-4M	6W-4M: GH/ Scapular motion	4-6M: Advanced strengthening (free weights, bands, bodyweight); >6M: Full functional return

Abbreviations: ROM=Range of Motion; AROM=Active range of motion; AAROM=Active-assisted range of motion; PROM=Passive range of motion; M=Month; W=Week; GH=Glenohumeral

its mechanical strength and tissue volume are often insufficient. Therefore, the LHBT is an excellent choice for achieving minimal invasiveness, efficiency, and cost-effectiveness under strict indications, but it is not a universal solution.

Graft selection cannot be performed in isolation but should be incorporated into a broader clinical decision-making framework. Beyond classic indications and contraindications, the following factors are crucial:

Cost and Resource Availability: In resource-limited settings, TFL and LHBT offer high cost-effectiveness. While ADMA is expensive, its value in saving operative time and avoiding donor-site morbidity must be evaluated within specific healthcare systems.

Patient Values and Expectations: The advantages and disadvantages of different options must be fully communicated with patients. Young, active patients seeking long-term biointegration may be more willing to accept the donor-site risks of TFL, whereas patients with zero tolerance for aesthetic concerns or early discomfort might prefer ADMA, albeit with awareness of its potential integration uncertainty.

Surgeon Experience: The preparation and fixation techniques for each graft type involve a learning curve. Surgeons should choose the graft they are most familiar with and can deploy with the highest technical accuracy.

To advance the field of SCR, future research should move beyond descriptive analysis and focus on:

Technical Standardization: Biomechanical studies and clinical consensus are needed to establish the optimal graft tensioning angle, thickness, and fixation methods based on tear type.

High-Level Evidence: There is an urgent need for multicenter Randomized Controlled Trials (RCTs) to directly compare the medium- to long-term efficacy and cost-effectiveness of mainstream options like TFL, ADMA, and hamstring tendons.

Bio-enhancement Techniques: Exploring adjuncts such as Platelet-Rich Plasma (PRP), stem cells, or growth factors to accelerate the integration of allografts and xenografts, safely navigating the "weak mechanical phase."

3D-Engineered Grafts: Developing customized grafts via 3D bioprinting to match individual anatomical defects, potentially improving integration and mechanical performance.

8. CONCLUSION

The treatment of irreparable massive rotator cuff tears (IMRCTs) has long been a major challenge in shoulder surgery. Due to the often unsatisfactory clinical outcomes of traditional treatments, superior capsular reconstruction (SCR) has been widely introduced and applied in recent years as an innovative surgical solution. Unlike traditional patch grafting, SCR effectively restores glenohumeral stability, increases the acromiohumeral distance (AHD), and inhibits abnormal superior migration of the humeral head by reconstructing the integrity of the superior capsule.

Currently, SCR is considered optimally indicated for IMRCTs without severe glenohumeral arthritis, with the specific technique choice depending on the injury characteristics and remaining rotator cuff conditions. Regarding grafts, the tensor fascia lata (TFL) autograft and acellular dermal matrix allograft (ADMA) are the most widely used clinical options presently. However, no unified standard for graft selection has been established yet, necessitating ongoing research focused on graft materials, technical standardization, and patient-specific factors to optimize surgical strategies and patient outcomes. Future directions, including biologic augmentation with PRP or stem cells and the development of 3D-engineered grafts, hold great promise for further advancing the efficacy and versatility of SCR.

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AUTHORS' CONTRIBUTIONS

Tao Xiong: Conceived the research idea, designed the review framework, systematically collected and screened the relevant literature, and drafted the entire manuscript.
Zihan Zhang: Assisted in literature collection and classification, sorted out the data and tables, and participated in revising the manuscript.
Yibo Li: Conducted literature screening and data extraction, assisted in manuscript arrangement and formatting modification.
Zhang Wu: Participated in literature sorting and data verification, provided constructive suggestions for the manuscript structure.
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DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST

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N/A

ETHICS STATEMENT

Not applicable,.This study did not require ethical approval or institutional review board (IRB) approval as it is a narrative review based on the comprehensive analysis and synthesis of previously published peer-reviewed literature. No human or animal subjects were involved in the present work, and all data used were derived from publicly available research articles.

ADDITIONAL INFORMATION

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