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Review

Current concepts in the management of massive, irreparable, rotator cuff tears

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Abstract

Massive irreparable rotator cuff tears (MIRCT) are clinical entities difficult to treat and can cause severe impairment in the shoulder joint due to pain, restricted motion, and lack of strength. Arthroscopic debridement, partial tendon repair, subacromial balloon spacer, superior capsular reconstruction (SCR), tendon transfers and reverse shoulder arthroplasty (RSA) are the commonest techniques addressing the problem depending on patient age, clinical evaluation and tendon loss. Tendon transfers and SCR have shown promising results in younger patients. In contrast, RSA and arthroscopic debridement with or without a balloon spacer are reserved for older individuals. This mini comprehensive review will discuss the above techniques' indications, rationales, and evidence.

Keywords

Massive rotator cuff tear; irreparable rotator cuff tear; rotator cuff tear; superior capsular reconstruction; latissimus dorsi transfer

Introduction

Centralization and balance of the humeral head are provided by the coupling force of the rotator cuff tendons: the supraspinatus superiorly and the inferior vector of the subscapularis and teres minor act on the vertical plane, while the coronal and axial

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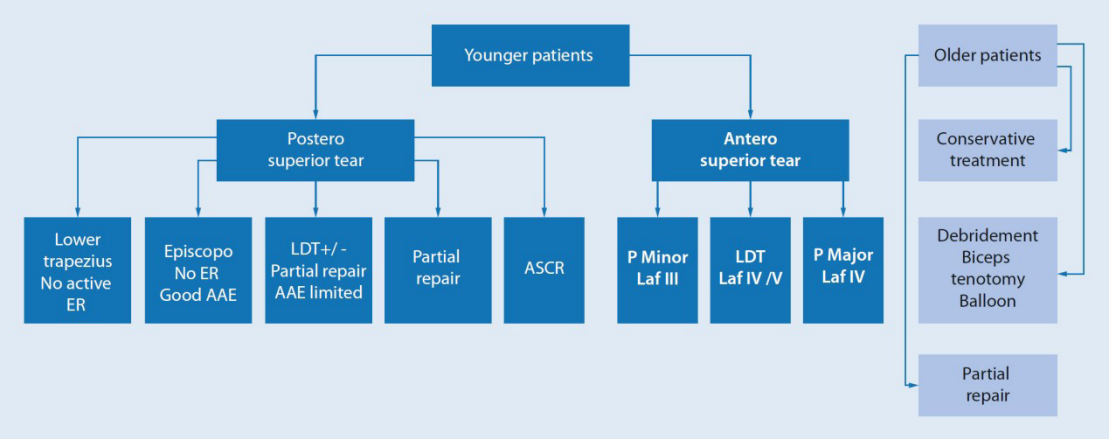

Figure 1: *Treatment algorithm for MIRCT proposed by prof P. Valenti (2018) [5] (ER: external rotation, LDT: Latissimus dorsi transfer, AAE: active anterior elevation, ASCR: arthroscopic superior capsule reconstruction, Laf: Lafosse classification, P Minor: pectoralis minor, P Major: pectoralis major).*

vector of the subscapularis and both infraspinatus and teres minor constitute of the power couple on the axial and horizontal plane.[1] Loss of stability in these force couples can result in superior humeral head migration, inability to maintain a centered humeral head in the glenoid and subsequent rotator cuff (RCT) tearing.[1] These alterations can cause several functional impairments in the shoulder joint with a broad spectrum of clinical presentation such as pain syndromes (subacromial bursitis, suprascapular nerve entrapment, long head of biceps pathology), humeral head impingement on the acromion, or pseudoparalysis leading finally to severe rotator cuff arthropathy.[2] The prevalence of RCT in the general population has been estimated to be from 21 to 34%, with one-fourth of the cases characterized as massive and irreparable.[3] The terms massive and irreparable suggest two different clinical entities often confused and sometimes co-existing. Massive RCTs have been described in the literature as follows; a) tears involving >2 tendons (Gerber), b) total length on the anteroposterior and medial-lateral dimensions >5cm (Cofield), c) coronal length and sagittal width on MRI >2cm (Davidson) d) tendon retraction to the glenoid rim (Patte), e) tendons retracted to the glenoid rim or 67% of the greater tuberosity exposed in the sagittal plane (Neer Consensus Circle).[2-4] Massive RCT, however, are reparable in most cases, depending on tendon quality, retraction, mobilization, surgical technique and other factors.[2-4] Massive Irreparable tears (MIRCT) implies a vaguer definition in the literature. In general, a RCT is considered irreparable if a tension-free repair of the tendon stump in the anatomical footprint or just medial to the articular surface is not possible, still after attempting meticulous tissue mobilization.[2,5] Other definitions include acromiohumeral distance less than 7 mm, and Goutallier muscle atrophy >grade 2, while numerous other factors have been associated with poor prognosis.[2,4-5] Clinically, a MIRCT ranges from having no symptoms to provoke severe shoulder disability while a typical case will demonstrate incapacitating symptoms. Another common accompanying entity is shoulder pseudoparalysis, consisting of 0° active forward elevation while retaining a full passive one, anterior humeral head escape and no improvement with intraarticular lidocaine injection; disruption of the rotator cable and loss of the fulcrum mechanism is the pathophysiological mechanism.[2] There is a wide variety of treatment options and guiding algorithms in the literature consisting of physiotherapy and exercise training, subacromial decompression, partial repair, subacromial spacer balloon, SCR, tendon transfers and RSA which will be analysed further (Figure 1).[3,5]

Classification: The MIRCT is mainly classified ac-

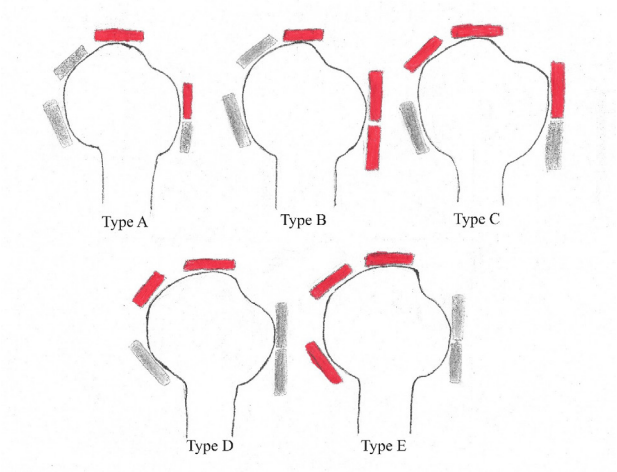

Figure 2: *Classification proposed by Colin utilizing five components: superior/inferior subscapularis, supraspinatus, infraspinatus, and teres minor.*[4]

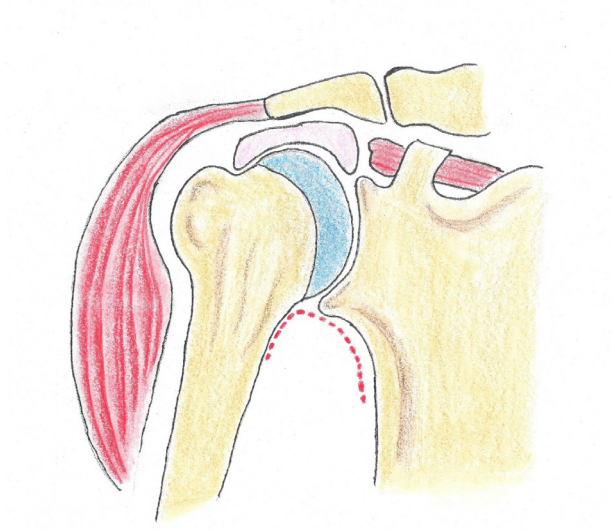

Figure 3: *Illustration of subacromial balloon spacer placed in the case of a massive irreparable rotator cuff tear, restoring the humeral head in its normal position.*

cording to its location to posterosuperior (supraspinatus, infraspinatus, and teres minor) and anterosuperior (subscapularis and supraspinatus); the humeral head escapes accordingly posterosuperior or anterosuperior. Collin et al.[2] have classified the MIRCT into five types depending on specific anatomic regions (superior/inferior subscapularis, supraspinatus, infraspinatus, teres minor) and correlated type B and C with pseudoparalysis, highlighting the importance of an intact subscapularis (Figure 2). The Patte classification describes the RCT according to tendon retraction, whereas Goutalier has proposed another common classification depending on fatty tendon infiltration as seen on MRI.[2] Hamada radiographic classification (grades 1-5) is commonly used to assess osteoarthritic changes and guide the decision between reverse shoulder arthroplasty or joint-preserving procedures.[4] A variety of radiological signs and clinical tests have also been described to assess the prognosis and guide the treatment, with the critical shoulder angle, the tangent sign, the acromiohumeral distance (>7mm), the Hornblower sign and a positive belly press test being the most important.

Conservative treatment

Conservative modalities include physical therapy, pharmacological pain management (NSAIDs, intra-articular injections) and strength training. MIRCT have a high prevalence among older patients, with many comorbidities and high frailty index, rendering the surgical options a risky choice in most cases.[6,7] The reported high failure rates after massive rotator cuff repairs do not always correlate with worse patient outcomes.[6] The cornerstone of conservative treatment is the physiotherapy concept termed "anterior deltoid re-education" (ADR), while other protocols focus mainly on scapular re-training.[6,7] The ADR protocol shows promising results when accompanied by systematic NSAIDs and local injections. However, patients should be informed that a residue of reduced ROM and pain might persist; thus, patients with higher functional demands might want to consider other treatment choices.[6] Poor prognostic factors for failure of conservative treatment are considered the inferior subscapularis tear, the teres minor atrophy, the presence of glenohumeral osteoarthritis, the superior humeral head mitigation, the decreased passive ROM and the weakness of external rotation or abduction.[7]

Partial Repair

By definition, MIRCT are amenable to complete closure. However, numerous studies have shown

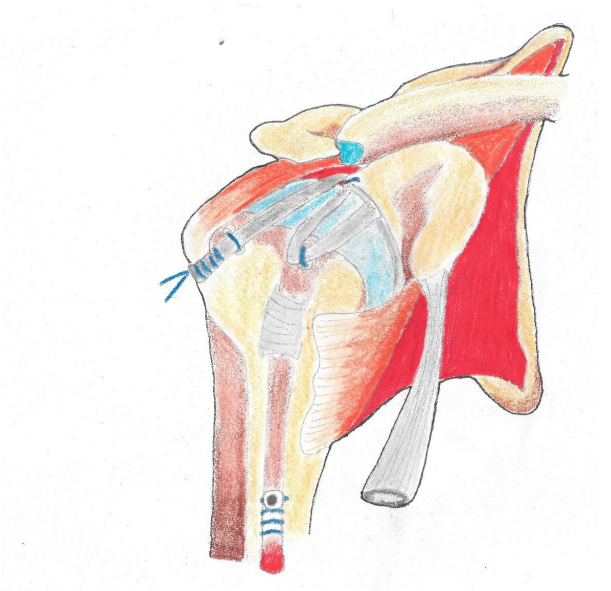

Figure 4: *Superior capsular reconstruction with the long head of biceps is illustrated. Numerous techniques have been described, mainly differentiated in the course given to the biceps tendon in order to cover as much area as possible.*

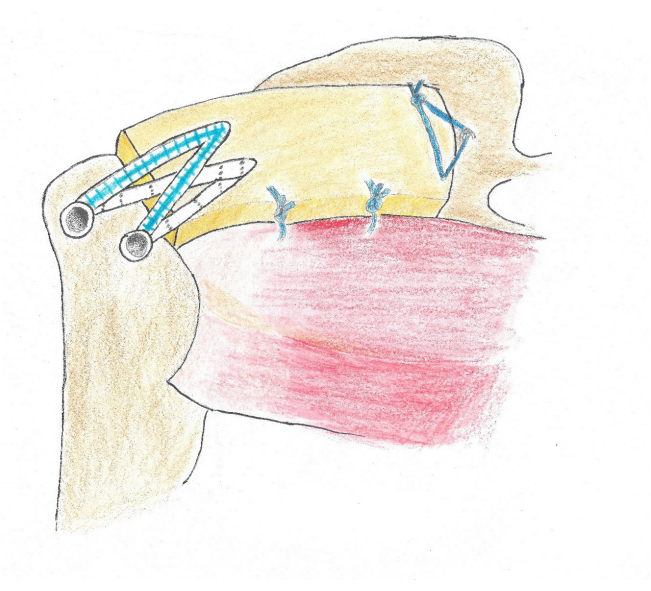

Figure 5: *Superior capsular reconstruction utilizing acellularized dermal allograft. The allograft is stabilized with 2-3 anchors in the glenoid and the greater tuberosity. Side to side sutures with the remaining rotator cuff tendons might be performed or not.*

that complete anatomic repair of the rotator cuff is not a prerequisite for an excellent clinical outcome.[6] Partial rotator cuff repair was first introduced by Burkhart et al. in 1994.[1] Biomechanically, the concept was to restore the forces' transverse vector and the fulcrum mechanism to enable shoulder abduction.[1,5-6] A systematic review by Malahias et al.[8] noted recently that all studies evaluating partial tendon repairs showed better postoperative outcomes regarding pain levels, ROM, function, and strength.[8] Clinically, the reported symptoms and recurrence rates remain low, although retears can reach up to 50%, indicating that other parts of the procedure (suprascapular nerve release, debridement, acromioplasty) might contribute to the alleviation of symptoms.[8] Despite the lack of high-quality prospective studies and the deterioration of symptoms over time, there seems to be a significant role for partial cuff repair in young patients, with no subscapularis lesion (posterosuperior tears) and muscle atrophy Goutalier <4.[5-6,8-9] Various surgical techniques have been described regarding margin convergence, medialized repairs, rotator cable restoration and combination with other procedures, according to surgeon preference.[4-5]

Arthroscopic Debridement / LHBT Tenotomy

Arthroscopic debridement and LHBT tenotomy are standard procedures used alone or in combination with others. Debridement can include bursectomy, debridement of rotator cuff edges, reverse acromial decompression (tuberoplasty), acromioplasty and acromioclavicular joint resection. LHBT has been found to have little clinical significance with no adverse events after tenotomy. The efficacy of this procedure in patients with persistent pain is well described in the literature and therefore is utilized consistently to manage MIRCT.[4-6] Anterior acromioplasty might pose the risk of superior humeral head migration, so lateral acromioplasty (if CSA> 35°) or tuberoplasty might be a more suitable alternative for MIRCT.[4-6] The advantages of the above procedures are the acceptable clinical outcomes, especially regarding pain and functional status, and the short rehabilitation period. Patients must be acknowledged that the results might deteriorate, and the

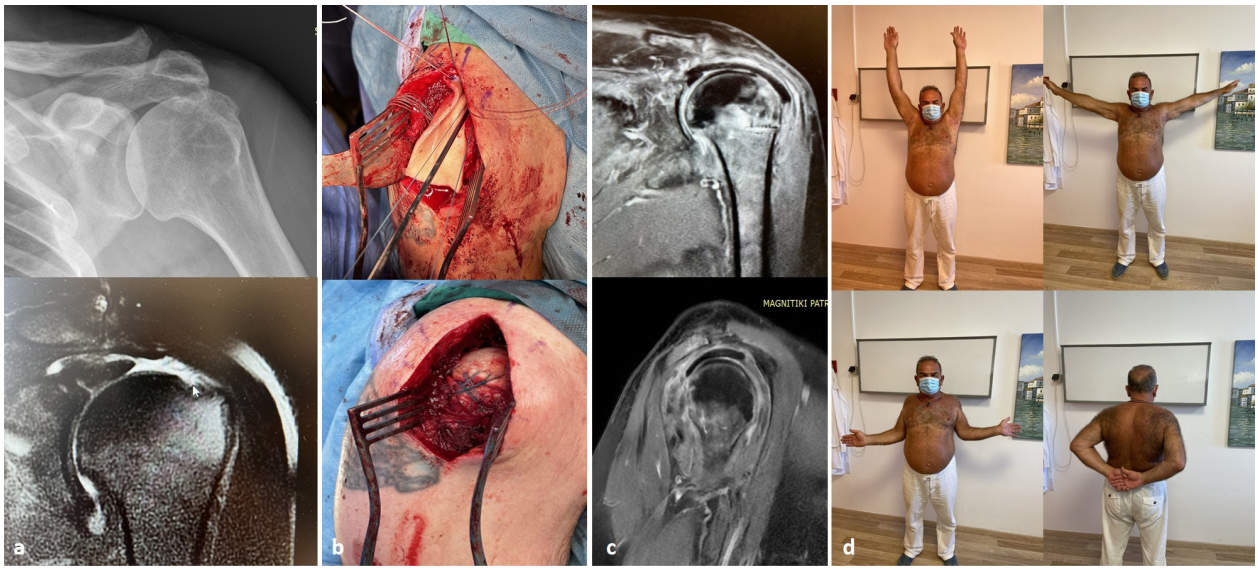

Figure 6: *a) Preoperative x-ray (with no arthritis) and MRI (showing MIRCT) in a 57-year-old patient with pseudoparalysis, b) intraoperative photos showing the fixation of the dermal allograft in the glenoid and the final suture bridge configuration; site to site repair has also been accomplished with the remain tendons, c) 1-year follow-up MRI showing maintenance of the allograft and suppression of the humeral head and d) the final clinical outcome at one year (Constant score 84).*

final ROM and strength levels would be restricted again.[5,9] Older patients with painful active forward shoulder elevation but full passive ROM are good candidates for these procedures, whose complaints improve after subacromial corticosteroid injection.[5]

Subacromial Biodegradable Spacer/Balloon

The Inscpace™ Balloon spacer (Stryker) is a medical FDA-approved device, first launched in 2012, consisting of a saline (25ml) filled copolymer-balloon which biodegrades within the first year and is available in 3 sizes.[10-11] [Figure 3]. Biomechanically, the hypothesis is that the deployment of the balloon in the subacromial space depresses the humeral head and increases the deltoid lever arm.[5,10] Indications include a superior migrated humeral head with MIRCT with intact subscapularis and teres minor to restore couple forces. Patients with shoulder pseudoparalysis, as described earlier, should be excluded from this treatment option as an isolated procedure; other contraindications are glenohumeral OA, active joint infection, axillary nerve palsy and allergy to material device.[10] Although there have been biomechanical studies confirming the depression effect of the device, few clinical studies have radiographically tested this without overall agreement.[10] Ideal patients are substantially old with low functional demands and fulfil the abovementioned criteria.[5] A precise technique of implantation to avoid balloon migration and adequate saline filling (25ml) has been described to improve the outcome, among other factors. Despite a decade of various clinical trials, there is no definitive recommendation, mainly because of the low evidence and the short-term follow-up of the current studies.[11] However, most studies present good functional outcomes and few complications, making the technique a viable adjunct treatment for short-term symptomatic pain relief.[5,10-11]

Superior Capsular Reconstruction

Hamada et al. first described an open Superior Capsular Reconstruction (SCR) technique using fascia lata autograft in 1993. Mihata et al. described, in 2013, the superior humeral head migration in posterosuperior tears due to a defect in the superior capsule, which they first tried to reconstruct it arthroscopically, showing excellent results.[12] Biomechanically, the SCR is a physical restraint to superior

humeral head migration, restoring the couple forces and thus shoulder functionality. The technique has since gained popularity as it provides good results in some cases. The graft is inserted medial to the superior glenoid tubercle and lateral to the greater tuberosity, and side-to-side sutures are placed with infraspinatus and subscapularis to replace the rotator cable.[5,12-13] Numerous grafts have been described in the literature, including mid/proximal thigh fascia lata autograft, dermal allograft, synthetic patches, hamstring autograft, xenograft, patellar-tendon-bone autograft, Achilles tendon and long head of biceps tendon autograft.[13] [Figure 4] The most used, however, are the fascia lata autograft and the dermal allograft [Figure 5], with similar clinical outcomes.[14] Graft thickness of 8 mm and graft tensioning (30-35N) at 15°-45° shoulder abduction have been shown to play a decisive role in an effective SCR.[13]

Regarding the suture technique, a double-row or transosseous equivalent on the GT has shown the lowest retear rates.[12,14] The indications for the procedure are MIRCT in young patients with preserved cartilage, intact deltoid, and intact/repairable subscapularis.[15] No rotator cuff arthropathy (Hamada <3) and no evidence of glenohumeral arthritis are a prerequisite for the procedure.[15] Young patients with pseudoparalysis or Goutalier stage 4 might also be good candidates for SCR if they scarce other treatment options.[15] A systematic review by Kooistra et al. summarizing all treatment options for MIRCT showed that SCR had the most remarkable improvement in Constant score among all techniques.[16] Figure 6 shows an open technique of SCR using dermal allograft in a 57 year-old male with MIRCT and pseudoparalysis treated in our hospital. MRI appearance of the graft and clinical outcome were excellent at one year follow up.

Tendon Transfers

Tendon transfers have been proposed in young patients with irreparable tears, atrophy and fatty infiltration, high functional demands, good deltoid, absence of pseudoparalysis or stiffness but no active elevation or external rotation and painful shoulder.[5-6,17] A low degree of teres minor fatty infiltration and intact subscapularis have also been associated with better outcomes.[6] Latissimus dorsi or lower trapezius are the most used tendons in posterosuperior MICT, but techniques utilizing the pectoralis major/minor and teres major have also been described.[5] Rerouting the latissimus dorsi on the infraspinatus stump will restore external rotation, whereas fixation on the supraspinatus insertion will restore active elevation.[5,17] Several studies have shown excellent results, resulting in a similar decrease in pain but better strength and shoulder function compared to partial repair.[5-6,9] A lower trapezius tendon transfer and a hamstring autograft to bridge the gap have also been described, especially in cases with teres minor tears.[5,17] The lower trapezius is an infraspinatus and external rotation agonist as they share the same vector, leading to good functional status; the only drawback being the reduced strength.[5,17] Although tendon transfers show favorable outcomes in the literature, a major drawback of the technique remains the long and complex post-operative rehabilitation along with the procedure's invasive and technical character. Patient motivation and cooperation are essential prerequisites.[5-6,9]

Reverse Shoulder Arthroplasty

First introduced by Paul Grammont in 1985, reverse shoulder arthroplasty has received significant recognition among shoulder surgeons because of its predictable results regarding pain and function. Biomechanically, the concept of the prosthesis is an increasing lever arm of the deltoid resulting in better ROM and functional outcome[4,18]. The reported excellent results even after 10 years of follow-up has expanded its indications from rotator cuff arthropathy, to MIRCT, glenohumeral OA and complex fractures in older adults.[18-20] In older patients with osteoarthritic changes of the glenohumeral joint (Hamada >=3) and MIRCT, RSA is considered an absolute indication.[6,18] Recently however, it has been proposed that older patients with modifiable risk factors (smoking, diabetes etc.) and a chronic, retracted MIRCT who present with loss of function (active forward elevation <90°, pseudoparalysis) might

also be excellent candidates for RSA even on the absence of OA.[6,18] Patients with deltoid dysfunction, younger patients or patients with preserved shoulder function are not ideal candidates as they demonstrate the worse outcomes.[6,18]

Conclusions

MIRCT remain a challenge in shoulder surgery. Many therapeutic options are available to the modern surgeon, but the indications often overlap. Medical committees and shoulder pioneers have proposed a few therapeutic algorithms to help guide the treating surgeon, but the final decision requires a personalized approach for everyone (Table 1). Age, subscapularis condition, pseudoparalysis, lack of external rotation and functional demands can be guiding this decision. Older patients with osteoarthritis or pseudoparalysis can benefit from RSA, older patients with preserved subscapularis and no evidence of OA might benefit from debridement and subacromial balloon, whereas in younger patients, SCR and tendon transfers can be utilized in intact or absent subscapularis, in respect. Despite the current research interest, a lack of high-quality studies is noted among all treatment modalities, producing guidelines of low evidence.

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