Current concepts in the management of irreparable rotator cuff tears

Irreparable rotator cuff tears can be painful and cause significant limitation of shoulder function. Treatment protocols have been proposed but there is no current gold standard for their management. This article summarizes the evidence for current practice in their treatment.

Irreparable rotator cuff tears (*Figure 1*) can be a source of significant pain and can result in marked limitation of shoulder function. Once the rotator cuff tear occurs, there is usually continuous progression over time, resulting in tendon retraction and fatty infiltration of the associated muscle. One theory which has been proposed to explain the pathophysiology of fatty infiltration is loss of muscle tension, which may alter tendon physiology and increase susceptibility to pathological changes that induce fatty infiltration (Chaudhury et al, 2012). Treatment options for such tears are limited (Bigliani et al, 1992; Adamson and Tibone, 1993; Gazielly et al, 1994) and a high rate of re-rupture (up to 40%) is likely following surgical repairs of large and massive rotator cuff tears (Miller et al, 2011; Kim et al, 2014; Le et al, 2014).

Several factors affect the outcome of a tendon repair including the patient's age (Hattrup and Ariz, 1995), the size and chronicity of the tear, degree of muscle atrophy and the tension applied during the repair (Burkhart et al, 1997; Romeo et al, 1999; Gimbel et al, 2007; Cho and Rhee, 2009; Kim et al, 2014; Le et al, 2014). In the presence of these factors, there is a high probability that the tendons will not heal even if mobilization and repair is technically feasible. Current options to treat an irreparable rotator cuff tear include physical therapy, arthroscopic debridement, biceps tenotomy, muscle transfers, patch repair and shoulder arthroplasty.

Physical therapy

Physical therapy has been considered an important treatment option for irreparable rotator cuff tears. In shoulders where there is no anterosuperior escape, the first line of treatment should be physical therapy with or without the use of steroid injections. Various approaches have been used.

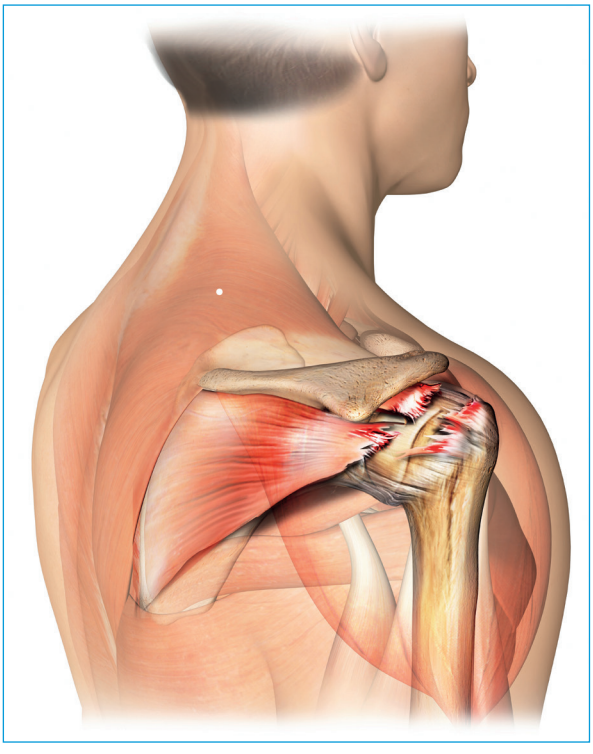
A multimodal approach

A multimodal physical therapy programme incorporating patient education and patient postural exercises linked with muscle strengthening and stretching, targeted muscle recruitment and improved proprioception has been demonstrated to have positive results (Ainsworth, 2006).

Anterior deltoid rehabilitation

Levy et al (2008) prospectively assessed 17 patients who had been clinically and radiologically diagnosed with irreparable rotator cuff tears. They underwent an anterior

Figure 1. Posterolateral view showing a massive right shoulder rotator cuff tear of the infraspinatus and supraspinatus muscles and tendons.



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deltoid training programme. By 9 months the Constant scores and forward flexion improved, and in 90% of patients the effect of recruiting the anterior deltoid for shoulder stabilization was sufficient to improve pain and function.

Long-term studies of patients with irreparable rotator cuff tears treated conservatively have shown progression of gleno-humeral arthritis, an increase in the size of the tendon tear and fatty infiltration, but many patients were able to maintain satisfactory shoulder function. This treatment option was chosen in patients with low functional demand, mild to moderate symptoms and where surgical intervention was refused (Zingg et al, 2007).

Arthroscopic procedures

Arthroscopic procedures have the potential to provide effective symptom control by eliminating various pain generators, but they have little effect on improvement in strength. These procedures include simple debridement, partial repair, biceps tenotomy or tenodesis.

Arthroscopic debridement

The outcomes of arthroscopic debridement have been looked at in several studies. Significant pain relief has been reported in the short term (Gartsman, 1997) but with worsening results over a period of 1–3 years (Zvijac et al, 1994). However, favourable results in terms of pain relief and improvement in shoulder function can be achieved with multi-modal treatment where arthroscopic debridement is combined with an anterior deltoid training programme (Rockwood et al, 1995).

The long head of biceps

The long head of biceps is thought to be of limited benefit in terms of function and may be a source of pain generation. Walch et al (2005) demonstrated an improvement in functional outcomes and improvement in pain scores following biceps tenotomy.

Partial repair of the rotator cuff

Partial repair has been advocated in patients where arthroscopic evaluation has deemed the remaining tendon to be of good quality. Partially repairing the tendon aims to recreate the stable fulcrum of the glenohumeral joint and achieve improved function. If the tendon can be partially repaired using the technique of margin convergence, the biomechanical balance of the shoulder can be restored (Burkhart et al, 1996). However, care should be taken not to overload the tension on the tendon repair as this can cause early failure (Burkhart et al, 1997).

Clinical consideration of the suprascapular nerve

The role of the suprascapular nerve in the pain and weakness associated with irreparable rotator cuff tears remains unclear. Retracted rotator cuff tears can cause tension on the nerve causing neuropathy. Studies have suggested that partial repair of these tears could improve pain and weakness with recovery of the suprascapular nerve demonstrated on nerve conduction studies (Vad et al, 2003; Mallon et al, 2006; Costouros et al, 2007). If patients with irreparable rotator cuff tears are symptomatic but decline surgical intervention, suprascapular nerve blocks using steroid and bupivacaine can be temporarily effective in reducing pain and improving their range of motion. These injections can be performed in an outpatient setting (Vecchio et al, 1993).

Muscle transfers

Latissimus dorsi transfer

In high demand patients presenting with irreparable rotator cuff tears where the chief complaint is of weakness there may be some benefit from a latissimus dorsi transfer. If the subscapularis muscle is intact and there is an irreparable posterosuperior rotator cuff tear, latissimus dorsi transfer can help improve external rotation and to some degree elevation (Gerber et al, 1988; Gerber, 1992; Aoki et al, 1996; Miniaci and MacLeod, 1999).

Pectoralis major transfer

Conversely, for isolated irreparable subscapularis tears a pectoralis major tendon transfer can help patients regain internal rotation of the shoulder. This procedure may not work as well where there is a ipsilateral irreparable supraspinatus tear (Jost et al, 2003). The procedure can also be used as a viable option for patients with anteroposterior subluxation as a result of rotator cuff insufficiency producing better functional outcome and improved humeral head containment (Galatz et al, 2003).

Arthroplasty

Reverse total shoulder arthoplasty

Pseudo paralysis of the shoulder, i.e. inability to abduct the arm, is commonly noted in patients with irreparable rotator cuff tears. Reverse total shoulder arthroplasty (*Figure 2*) is a reliable procedure to improve elevation of the arm, producing an improvement in pain, better postoperative outcome scores, and better mobility and strength (Wall et al, 2007). Other studies have reinforced the overall conclusion that there is usually an improvement in pain, more than 50° of improvement in elevation and higher functional outcome scores following reverse total shoulder arthroplasty (Frankle et al, 2005; Werner et al, 2005; Boileau et al, 2006).

Hemiarthroplasty

Previously, shoulder hemiarthroplasty was common practice for a non-pseudoparalytic rotator cuff deficient shoulder (albeit with an intact subscapularis tendon) and was reserved for patients with low demands and functional goals (Bedi et al, 2010). An earlier study conducted by Williams and Rockwood (1996) concluded that hemiarthroplasty in a shoulder with an irreparable rotator cuff had inferior results when compared with patients

with glenohumeral arthritis (the previously used term for patients with rotator cuff arthropathy). There is evidence for a decrease in pain scores following hemiarthroplasty but no difference in the strength of shoulder abduction or flexion (Sanchez-Sotelo et al, 2001).

Newer procedures

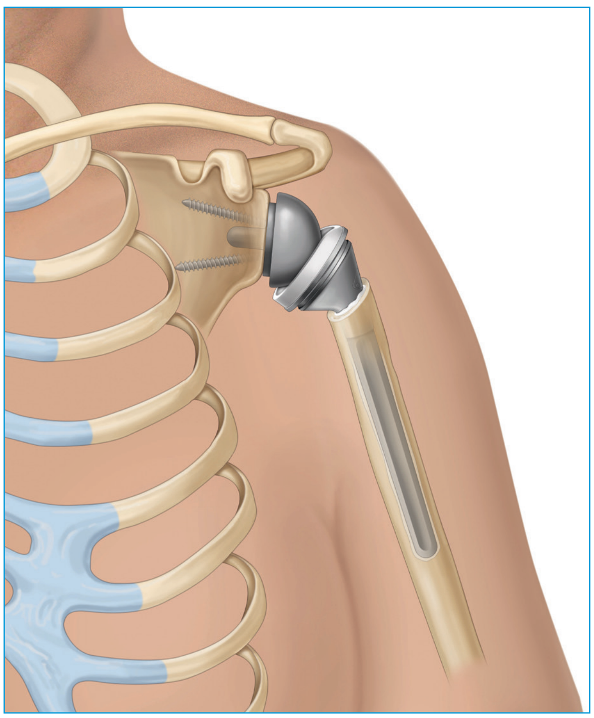
Patch usage

Advances in development of biological and synthetic materials for use as scaffolds (Clark et al, 2012) have led to these being considered as a treatment option for irreparable rotator cuff tears. Cadaveric studies have shown a possible benefit of these patches (McCarron et al, 2012). Their lack of popularity may be attributed to the relative recent advancements in this field and the lack of evidence from large-scale trials. Human skin grafts currently appear to be the favoured option rather than synthetic patches.

Arthroscopic superior capsular reconstruction

The shoulder capsule is the main static stabilizer of the glenohumeral joint. Ishihara et al (2014) looked at the biomechanical contribution of the superior shoulder joint capsule to passive stability of the glenohumeral joint. A tear in the superior capsule significantly increased anterior and inferior translations of the humeral head compared with those with an intact capsule. Mihata et al (2013) investigated the clinical and radiological outcomes following arthroscopic superior capsule reconstruction for symptomatic irreparable rotator cuff tears. Mean active elevation and external rotation increased significantly with no cases of progression of osteoarthritis or rotator cuff muscle atrophy. In their series arthroscopic superior capsule reconstruction restored glenohumeral stability and function of the shoulder joint in irreparable rotator cuff tears. However, these studies demonstrate only short-term results in small series of patients. Further research is needed to determine whether arthroscopic superior capsule reconstruction is a reliable and useful alternative treatment for irreparable rotator cuff tears.

Figure 2. An anterior view of a reverse shoulder prosthesis.



KEY POINTS

- Management of irreparable rotator cuff muscles can be challenging.
- A multimodal approach of patient education and physiotherapy with or without surgical intervention is required.
- In high demand patients muscle transfers can be considered depending on the integrity of the subscapularis tendon.
- In patients with no pseudoparalysis of the shoulder, arthroscopic debridement with or without biceps tenotomy and partial repair can be considered.
- In patients with pseudoparalysis of the shoulder, reverse total shoulder arthroplasty should be considered.

Conclusions

Treatment strategies for the management of irreparable rotator cuff tears should be multimodal as determining the correct treatment option can be challenging. Khair and Gulotta (2011) provide an excellent algorithm for their management. All patients and especially those with weak deltoids should receive a course of anterior deltoid training. It is also important to ascertain whether the chief complaint is pain or weakness and whether the shoulder is pseudoparalytic or not. In patients with pain, a trial of steroid injection or suprascapular nerve blocks can provide temporary pain relief and a clinical assessment of shoulder elevation can be made. If the patient has good elevation, then arthroscopic procedures including debridement, biceps tenotomy or tenodesis and partial repair could be considered. Latissimus dorsi tendon or pectoralis major muscle transfer can be discussed in patients with intact or deficient subscapularis tendon respectively. Patients with pseudoparalysis of the shoulder in the presence of an irreparable rotator cuff tear should be treated with a reverse total shoulder arthroplasty. The use of patches and arthroscopic superior capsule reconstruction are upcoming alternative treatment options and their use is on the rise. **BJHM**

Conflict of interest: none.

Adamson GJ, Tibone JE (1993) Ten-year assessment of primary rotator cuff repairs. *J Shoulder Elbow Surg* **2**(2): 57–63. https://doi.org/10.1016/1058-2746(93)90001-W

Ainsworth R (2006) Physiotherapy rehabilitation in patients with massive, irreparable rotator cuff tears. *Musculoskeletal Care* **4**(3): 140–151. https://doi.org/10.1002/msc.85

Aoki M, Okamura K, Fukushima S, Takahashi T, Ogino T (1996) Transfer of latissimus dorsi for irreparable rotator-cuff tears. *J Bone Joint Surg Br* **78**(5): 761–766

Bedi A, Dines J, Warren RF, Dines DM (2010) Massive tears of the rotator cuff. *J Bone Joint Surg Am* **92**(9): 1894–1908. https://doi.

org/10.2106/JBJS.I.01531
Bigliani LU, Cordasco FA, Mcllveen SJ, Musso ES (1992) Operative repair of massive rotator cuff tears: Long-term results. *J Shoulder Elbow Surg* **1**(3): 120–130. https://doi.org/10.1016/1058-2746(92)90089-L
Boileau P, Watkinson D, Hatzidakis AM, Hovorka I (2006) Neer Award 2005: The Grammont reverse shoulder prosthesis: Results in cuff tear arthritis, fracture sequelae, and revision arthroplasty. *J Shoulder Elbow Surg* **15**(5): 527–540. https://doi.org/10.1016/j.jse.2006.01.003
Burkhart SS, Athanasiou KA, Wirth MA (1996) Margin convergence: A method of reducing strain in massive rotator cuff tears. *Arthroscopy* **12**(3): 335–338. https://doi.org/10.1016/S0749-8063(96)90070-5
Burkhart SS, Johnson TC, Wirth MA, Athanasiou KA (1997) Cyclic loading of transosseous rotator cuff repairs: Tension overload as a possible cause of failure. *Arthroscopy* **13**(2): 172–176. https://doi.org/10.1016/S0749-8063(97)90151-1
Chaudhury S, Dines JS, Delos D, Warren RF, Voigt C, Rodeo SA (2012) Role of fatty infiltration in the pathophysiology and outcomes of rotator cuff tears. *Arthritis Care Res* **64**(1): 76–82. https://doi.org/10.1002/acr.20552
Cho NS, Rhee YG (2009) The factors affecting the clinical outcome and integrity of arthroscopically repaired rotator cuff tears of the shoulder. *Clin Orthop Surg* **1**(2): 96–104. https://doi.org/10.4055/cios.2009.1.2.96
Clark RR, Dierckman BD, Bahk MS, Ghodadra NS, Snyder SJ, Burns JP (2012) Patch augmentation for rotator cuff repair: indications, techniques, and outcomes. *Oper Tech Sports Med* **20**(3): 224–232. https://doi.org/10.1053/j.otsm.2012.07.001
Costouros JG, Porramatikul M, Lie DT, Warner JJP (2007) Reversal of suprascapular neuropathy following arthroscopic repair of massive supraspinatus and infraspinatus rotator cuff tears. *Arthroscopy* **23**(11): 1152–1161. https://doi.org/10.1016/j.arthro.2007.06.014
Frankle M, Siegal S, Pupello D, Saleem A, Mighell M, Vasey M (2005) The Reverse Shoulder Prosthesis for glenohumeral arthritis associated with severe rotator cuff deficiency. A minimum two-year follow-up study of sixty patients. *J Bone Joint Surg Am* **87**(8): 1697–1705
Galatz LM, Connor PM, Calfee RP, Hsu JC, Yamaguchi K (2003) Pectoralis major transfer for anterior-superior subluxation in massive rotator cuff insufficiency. *J Shoulder Elbow Surg* **12**(1): 1–5. https://doi.org/10.1067/mse.2003.128137
Gartsman GM (1997) Massive, irreparable tears of the rotator cuff. Results of operative debridement and subacromial decompression. *J Bone Joint Surg Am* **79**(5): 715–721. https://doi.org/10.2106/00004623-199705000-00011
Gazielly DF, Gleyze P, Montagnon C (1994) Functional and anatomical results after rotator cuff repair. *Clin Orthop Relat Res* (304): 43–53
Gerber C (1992) Latissimus dorsi transfer for the treatment of irreparable tears of the rotator cuff. *Clin Orthop Relat Res* (275): 152–160
Gerber C, Vinh TS, Hertel R, Hess CW (1988) Latissimus dorsi transfer for the treatment of massive tears of the rotator cuff. A preliminary report. *Clin Orthop Relat Res* (232): 51–61
Gimbel JA, Van Kleunen JP, Lake SP, Williams GR, Soslowsky LJ (2007) The role of repair tension on tendon to bone healing in an animal model of chronic rotator cuff tears. *J Biomechanics* **40**(3): 561–568. https://doi.org/10.1016/j.jbiomech.2006.02.010
Hattrup SJ, Ariz S (1995) Rotator cuff repair: Relevance of patient age. *J Shoulder Elbow Surg* **4**(2): 95–100. https://doi.org/10.1016/S1058-2746(05)80061-8
Ishihara Y, Mihata T, Tamboli M et al (2014) Role of the superior shoulder capsule in passive stability of the glenohumeral joint *J Shoulder Elbow Surg* **23**(5): 642–648. https://doi.org/10.1016/j.jse.2013.09.025
Jost B, Puskas GJ, Lustenberger A, Gerber C (2003) Outcome of pectoralis major transfer for the treatment of irreparable subscapularis tears. *J Bone Joint Surg Am* **85**(10): 1944–1951. https://doi.org/10.2106/00004623-200310000-00012
Khair MM, Gulotta LV (2011) Treatment of irreparable rotator cuff tears. *Curr Rev Musculoskelet Med* **4**(4): 208–213. https://doi.org/10.1007/s12178-011-9098-3
Kim JH, Hong IT, Ryu KJ, Bong ST, Lee YS, Kim JH (2014) Retear rate in the late postoperative period after arthroscopic rotator cuff repair. *Am J Sports Med* **42**(11): 2606–2613. https://doi.org/10.1177/0363546514547177
Le BTN, Wu XL, Lam PH, Murrell GAC (2014) Factors predicting rotator cuff retears: an analysis of 1000 consecutive rotator cuff repairs. *Am J Sports Med* **42**(5): 1134–1142. https://doi.org/10.1177/0363546514525336
Levy O, Mullett H, Roberts S, Copeland S (2008) The role of anterior deltoid reeducation in patients with massive irreparable degenerative rotator cuff tears. *J Shoulder Elbow Surg* **17**(6): 863–870. https://doi.org/10.1016/j.jse.2008.04.005
Mallon WJ, Wilson RJ, Basamania CJ (2006) The association of suprascapular neuropathy with massive rotator cuff tears: A preliminary report. *J Shoulder Elbow Surg* **15**(4): 395–398. https://doi.org/10.1016/j.jse.2005.10.019
McCarron JA, Milks RA, Mesiha M, Aurora A, Walker E, Iannotti JP, Derwin KA (2012) Reinforced fascia patch limits cyclic gapping of rotator cuff repairs in a human cadaveric model. *J Shoulder Elbow Surg* **21**(12): 1680–1686. https://doi.org/10.1016/j.jse.2011.11.039
Mihata T, Lee TQ, Watanabe C, Fukunishi K, Ohue M, Tsujimura T, Kinoshita M (2013) Clinical results of arthroscopic superior capsule reconstruction for irreparable rotator cuff tears. *Arthroscopy* **29**(3): 459–470. https://doi.org/10.1016/j.arthro.2012.10.022
Miller BS, Downie BK, Kohen RB et al (2011) When do rotator cuff repairs fail? Serial ultrasound examination after arthroscopic repair of large and massive rotator cuff tears. *Am J Sports Med* **39**(10): 2064–2070. https://doi.org/10.1177/0363546511413372
Miniaci A, MacLeod M (1999) Transfer of the latissimus dorsi muscle after failed repair of a massive tear of the rotator cuff. A two to five-year review. *J Bone Joint Surg Am* **81**(8): 1120–1127. https://doi.org/10.2106/00004623-199908000-00007
Rockwood CA Jr, Williams GR Jr, Burkhead WZ Jr (1995) Débridement of degenerative, irreparable lesions of the rotator cuff. *J Bone Joint Surg Am* **77**(6): 857–866. https://doi.org/10.2106/00004623-199506000-00006
Romeo AA, Hang DW, Bach BR Jr, Shott S (1999) Repair of full thickness rotator cuff tears. Gender, age, and other factors affecting outcome. *Clin Orthop Relat Res* (367): 243–255
Sanchez-Sotelo J, Cofield RH, Rowland CM (2001) Shoulder hemiarthroplasty for glenohumeral arthritis associated with severe rotator cuff deficiency. *J Bone Joint Surg Am* **83**(12): 1814–1822. https://doi.org/10.2106/00004623-200112000-00008
Vad VB, Southern D, Warren RF, Altchek DW, Dines D (2003) Prevalence of peripheral neurologic injuries in rotator cuff tears with atrophy. *J Shoulder Elbow Surg* **12**(4): 333–336. https://doi.org/10.1016/S1058-2746(03)00040-5
Vecchio PC, Adebajo AO, Hazleman BL (1993) Suprascapular nerve block for persistent rotator cuff lesions. *J Rheumatol* **20**(3): 453–455
Walch G, Edwards TB, Boulahia A, Nové-Josserand L, Neyton L, Szabo I (2005) Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: Clinical and radiographic results of 307 cases. *J Shoulder Elbow Surg* **14**(3): 238–246. https://doi.org/10.1016/j.jse.2004.07.008
Wall B, Nové-Josserand L, O'Connor DP, Edwards TB, Walch G (2007) Reverse total shoulder arthroplasty: a review of results according to etiology. *J Bone Joint Surg Am* **89**(7): 1476–1485
Werner CM, Steinmann PA, Gilbart M, Gerber C (2005) Treatment of painful pseudoparesis due to irreparable rotator cuff dysfunction with the Delta III reverse-ball-and-socket total shoulder prosthesis. *J Bone Joint Surg Am* **87**(7): 1476–1486
Williams GR Jr, Rockwood CA Jr (1996) Hemiarthroplasty in rotator cuff-deficient shoulders. *J Shoulder Elbow Surg* **5**(5): 362–367. https://doi.org/10.1016/S1058-2746(96)80067-X
Zingg PO, Jost B, Sukthankar A, Buhler M, Pfirrmann CW, Gerber C (2007) Clinical and structural outcomes of nonoperative management of massive rotator cuff tears. *J Bone Joint Surg* **89**(9): 1928–1934
Zvijac JE, Levy HJ, Lemak LJ (1994) Arthroscopic subacromial decompression in the treatment of full thickness rotator cuff tears: A 3- to 6-year follow-up. *Arthroscopy* **10**(5): 518–523. https://doi.org/10.1016/S0749-8063(05)80006-4