Clinical research

A comparison of partial repair with arthroscopic margin convergence suture and open superior capsular reconstruction in patients with massive rotator cuff tear

Anil Gulcu[1], Recep Dincer[2]

[1]Medical School of Alanya, Alaaddin Keykubat University, Antalya, Turkey
[2]Department of Orthopaedics and Traumatology, Medical School of Suleyman Demirel University, Isparta, Turkey

Corresponding author:
Anil Gulcu MD
Medical School of Alanya
Alaaddin Keykubat University
Antalya, Turkey
E-mail: anilgulcu@gmail.com

Abstract

Introduction: Massive rotator cuff tears (MRCTs) remain a controversial problem for clinicians. There are several recommendations in the literature, from various surgical techniques to the effectiveness of conservative treatment. In this study, we aimed to compare clinical outcomes and functional results of open superior capsular reconstruction for massive rotator cuff tear and arthroscopic partial rotator cuff repair with margin convergence.

Material and methods: This study included 40 patients with massive rotator cuff tears that could not be treated with arthroscopic partial repair with margin convergence or open superior capsular reconstruction. The patients were divided into 2 groups according to the treatment method. Patient assignments for each group were not randomized. Group 1 consisted of 20 patients who underwent open superior capsular reconstruction, and Group 2 comprised 20 patients who underwent arthroscopic partial repair. UCLA (University of California Los Angeles), CS (Constant shoulder score) scores, and the visual analogue pain scale (VAS) were used to evaluate the clinical outcomes of the patients.

Results: At the time of the latest follow-up evaluation, both groups showed significant improvements in clinical outcomes ($p < 0.05$). There were no significant differences in the clinical outcomes between groups. The preoperative tear size was statistically significantly higher in the superior capsular reconstruction group ($p < 0.05$).

Conclusions: Our results supported the benefits of arthroscopic and open surgical technique with similar clinical results in the treatment of massive rotator cuff tear. We think that arthroscopic partial repair may be preferred by surgeons because it is minimally invasive compared to open superior capsular reconstruction.

Key words: shoulder arthroscopy, arthroscopic partial repair, massive rotator cuff tear, superior capsular reconstruction.

Introduction

Massive rotator cuff tears (MRCTs) are a common source of pain and disability in the shoulder. Massive rotator cuff tears account for 10 to 40 of all tears and approximately 80 of recurrent tears. Massive rotator cuff tears of the rotator cuff present a challenging problem for the shoulder surgeon [1]. Although rotator cuff tears have been successfully treated

arthroscopically, there is still controversy regarding the repair of massive and chronic tears due to muscle atrophy, fatty degeneration, and advanced retraction [2]. The definition of massive rotator cuff tears was proposed by Cofield as "a tear size of 5 cm or more" [3]. According to Gerber, it was defined rather as "the complete rupture of 2 or more tendons" [4]. Typically, patients have pain, loss of strength, and limited abduction, and while physical therapy provides relief of pain and some functional improvement in patients over 70 years of age, surgical treatment is more prominent in active and young patients. The treatment of massive rotator cuff tears includes conservative and different surgical approaches, and it is not always possible to completely repair these injuries. In the repair of MRCTs, partial repair, tendon transfer, biologic augmentation, superior capsular reconstruction, and reverse shoulder prosthesis can be applied. The type of tear in the rotator cuff, poor tendon compliance, tendon retraction, the age of the patient, and the amount of fatty degeneration all affect the functional results for the patient [2]. Although partial or incomplete repair seem to point to less functional results, satisfactory results have been reported in the literature with the suspension bridge concept described by Burkhart, because a re-create force couple is produced with a partial repair [5]. In MRCTs, superior capsular reconstruction, as defined by Mihata, prevents the translation of the humeral head and improves shoulder functions by reducing the glenohumeral compression force [6].

We aimed to compare clinical outcomes and functional results of open superior capsular reconstruction for massive rotator cuff tear and arthroscopic partial rotator cuff repair with margin convergence.

Material and methods

Patients and demographics

Patients who underwent partial repair with arthroscopic margin convergence suture and open superior capsular reconstruction for massive rotator cuff tears between January 2016 and January 2020 were retrospectively reviewed. The study was conducted in accordance with ethical rules, and ethical approval was obtained from the Clinical Research Ethics Committee of Süleyman Demirel University Faculty of Medicine. This study included 40 patients with large to massive contracted rotator cuff tears of 4 cm or with involvement of at least 2 tendons. The diagnosis of the patients was made by clinical, physical examination and magnetic resonance imaging (Figure 1). The patients were divided into 2 groups according to the treatment method. Patient assignments for each group were not randomized: Group 1, consisting of 20 patients who underwent open superior capsular reconstruction, and Group 2, consisting of 20 patients who underwent arthroscopic partial repair. The UCLA (University of California Los Angeles), CS (Constant shoulder score) scores, and the visual analogue pain scale (VAS), were used to evaluate the clinical outcomes of the patients. In the preoperative magnetic resonance imaging of the patients, fatty infiltration of the rotator cuff and the degree of retraction were classified according to Goutalier and Patte, respectively. Postoperative complications of the patients were recorded; no bilateral procedures were performed. As per inclusion criteria, patients who did not benefit from conservative treatment following MRCT, who underwent arthroscopic partial repair or superior capsular reconstruction, and who had at least 1-year follow-up were included in the study. A rotator cuff tear with an anterior-posterior diameter of > 4 cm or at least 2-tendon involvement noted in the preoperative MRA and intraoperative period the diagonisis of Massive RCT was done by using a hand-held ruler. All patients had preoperative magnetic resonance imaging. Type c, type d, and type e tears were included in the study, in accordance with the Collin classification. Consistent with the Hamada classification, patients with stage 4 or 5 rotator cuff arthropathy in Hamada were excluded from the study. Patients with previous shoulder fracture sequelae or neurological deficit were excluded from the study.

Surgical procedure

Partial repair of massive rotator cuff tear

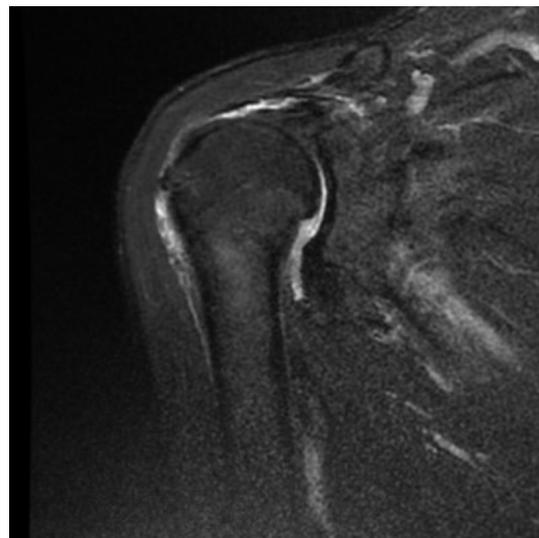All patients were operated in the sunbed position under general anaesthesia. Tendons were

Figure 1. Massive rotator cuff tear in magnetic resonance imaging

mobilized by applying release to the adherent tissues for retraction in the massive rotator cuff tear. Subsequently, a single-row primary repair was performed by covering the humeral head with a margin convergence suture. Patients who underwent partial repair were arthroscopically operated through the posterior, posterolateral, lateral, and anterior portals. Partial repair after the footprint was identified at the greater tuberosity through a shaver, and a partial repair of the irreparable lesion was performed according to the technique previously described by Burkhart *et al.* [5]. All patients underwent routine acromioplasty without damaging the deltoid insertion. Slap repair with suture anchor was applied to those with slap lesions. An arm sling was applied to postoperative patients for 6 weeks. Postoperative rehabilitation was started with pendular exercises at the end of the 3rd week. Passive exercises were started in the 6th week and active assisted exercises in the 8th week. Patients who underwent partial repair were operated in Alanya Alaaddin Keykubat University Alanya Training and Research Hospital.

Open superior capsular reconstruction

All patients underwent a transverse skin incision of approximately 4 to 5 cm, starting from 2 cm inferior to the lateral anterior edge of the acromion and extending medially towards the coracoid process, in the sunbed position, and under general anaesthesia. To prepare a cancellous bone bed that would provide tendon attachment, the lateral side of the humeral head articular cartilage was debrided until a haemorrhagic surface

Figure 2. Open superior capsular reconstruction

was obtained, starting from the level at which the articular cartilage ends. A tensor fascia lata graft with a width of at least 4 cm and twice the length from the ipsilateral lateral thigh extremity was obtained by measuring the glenoid superior border and humeral footprint. The graft taken was folded in half in the middle and sutured with polyethylene mastic. Reconstruction was performed by applying 2 anchors from the Neviaser portal to the glenoid side and 2 anchors per humerus. From the anterior region, the subscapularis tendon was sutured primarily to the graft (Figure 2).

By measuring the glenoid superior rim and humeral footprint, a tensor fascia lata graft twice the size measured from the ipsilateral extremity was taken. The graft taken was folded in half and sutured with a polyethylene mesh. Reconstruction was performed by applying 2 anchors to the glenoid rim and 2 anchors to the humeral head. An arm sling was applied to postoperative patients for 6 weeks. Postoperative rehabilitation was started with pendular exercises at the end of the 3rd week. Passive exercises were undertaken at 6 weeks and active assisted exercises at 8 weeks. Patients who underwent open superior capsular reconstruction were operated in Suleyman Demirel University Hospital.

Statistical analysis

All the statistical analyses of the obtained clinical and demographic data were performed using the Statistical Package for the Social Sciences (SPSS) v.25 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation and median (minimum and maximum values), while categorical variables are given as the number and percentage. The suitability of the data for normal distribution was examined by the Shapiro-Wilk test. The independent samples t test was used for comparing the independent group differences when the parametric test assumptions were provided, and the Mann-Whitney U test was used for comparing the independent group differences when the parametric test assumptions were not provided. The paired samples t test was used for comparing the dependent group differences when the parametric test assumptions were provided, and the Wilcoxon Signed Rank test was used when the parametric test assumptions were not provided. Differences between categorical variables were analysed by χ^2 analysis. In all analyses, $p < 0.05$ was accepted as statistically significant.

Results

The patients were divided into 2 groups: Group 1 consisted of patients who underwent partial repair due to massive rotator cuff tear, and Group 2

consisted of patients who underwent open superior capsular reconstruction, all of whom suffered a massive rotator cuff tear. Demographic and clinical data of the patients are presented in Table I. There was no significant difference between the groups in terms of gender and side ($p = 0.519$ and $p = 0.519$, respectively). There was no significant difference between the groups in terms of shoulder slap lesion. The average age was 67.85 ±9.44 years in Group 1 and 65.3 ±6.19 years in Group 2 ($p = 0.243$). The mean follow-up time in Group 1 was 19.85 ±2.18, and the mean follow-up time in Group 2 was 18.5 ±3.49 months. There was no statistically significant difference between the groups ($p = 0.121$).

There was no statistically significant difference between the groups in terms of glenohumeral arthritis, Collin classification, fatty infiltration, and tendon retraction (0.443, 0.399, 1 α, 0.916, 1 α, respectively). The distribution of tear size and number of tendons is presented in Table II. The tear size was measured as 5.19 ±0.23 cm in Group 1 (PR) and as 4.55 ±0.58 in Group 2 (OSCR), and there was a statistically significant difference between the groups ($p = 0.05^*$). Clinical outcome measures are presented in Table III. The preop-

Table I. Patient demographics

Parameter		Group		Total n (%)	P-value
		PR n (%)	SCR n (%)		
Gender	Female	11 (55)	13 (65)	24 (60)	0.519 (cs = 0.417)
	Male	9 (45)	7 (35)	16 (40)	
Hamada classification	1.00	10 (50)	12 (60)	22 (55)	0.443 (cs = 1.627)
	2.00	9 (45)	8 (40)	17 (42.5)	
	3.00	1 (5)	0 (0)	1 (2.5)	
Collin classification	c	0 (0)	1 (5)	1 (2.5)	0.399 (cs = 1.837)
	d	19 (95)	17 (85)	36 (90)	
	e	1 (5)	2 (10)	3 (7.5)	
Acromion type	1.00	4 (20)	0 (0)	4 (10)	0.023* (cs = 7.562)
	2.00	4 (20)	9 (45)	13 (32.5)	
	3.00	12 (60)	11 (55)	23 (57.5)	
Patte classification	2.00	3 (15)	4 (20)	7 (17.5)	1 α
	3.00	17 (85)	16 (80)	33 (82.5)	
Fatty infiltration	Mild	1 (5)	1 (5)	2 (5)	0.916 (cs = 0.176)
	Moderate	16 (80)	15 (75)	31 (77.5)	
	Severe	3 (15)	4 (20)	7 (17.5)	
side	Right	13 (65)	11 (55)	24 (60)	0.519 α
	Left	7 (35)	9 (45)	16 (40)	
Dominant side	Right	20 (100)	20 (100)	40 (100)	–
Comorbidity	–	11 (55)	11 (55)	22 (55)	1 α
	+	9 (45)	9 (45)	18 (45)	
Re-rupture	–	19 (95)	19 (95)	38 (95)	1 α
	+	1 (5)	1 (5)	2 (5)	
SLAP	–	16 (80)	15 (75)	31 (77.5)	1 α
	+	4 (20)	5 (25)	9 (22.5)	

$p < 0.05$ statistically significant, cs – χ^2 test, α – Fisher exact test.

Table II. Distribution of tear size and number of tendons

Parameter	Group PR Mean ± SD	Group SCR Mean ± SD	P-value
Age	67.85 ±9.44	65.3 ±6.19	0.121 ($z = -1.558$)
Tear size	5.19 ±0.23	4.55 ±0.5	0.0001* ($z = -3.925$)
Tendon involvement	2.9 ±0.45	2.5 ±0.51	0.043 ($z = -2.44$)
Follow up	19.85 ±2.18	18.5 ±3.49	0.121 ($z = -1.61$)

$p < 0.05$ statistically significant, SD – standard deviation, z – Mann-Whitney U test.

Table III. Clinical outcome measures

Variable	Group PR		Group SCR		Inter group *p*
	Mean ± SD	Med. (min.–max.)	Mean ± SD	Med. (min.–max.)	
Preop. anteflexion	57 ±9.23	60 (40–70)	57.5 ±7.16	60 (50–70)	0.968 (z = −0.058)
Postop. anteflexion	127 ±13.42	130 (100–150)	127.5 ±27.51	130 (70–160)	0.445 (z = −0.794)
Intra Group *p*	0.0001* (t = −24.122)		0.0001* (z = −3.936)		
Flex difference	−70 ±12.98	−70 (−90 − −40)	−70 ±27.53	−70 (−110 − −20)	0.529 (z = −0.666)
Preop. Constant	40.3 ±5.86	39.5 (30–50)	40.9 ±5.97	42 (30–50)	0.75 (t = −0.321)
Postop. Constant	79.2 ±8.19	80 (50–92)	78.1 ±8.39	78 (50–92)	0.495 (z = −0.708)
Intra Group *p*	0.0001* (t = −24.3)		0.0001* (t = −22.964)		
Constant difference	−38.9 ±7.16	−39 (−51 − −20)	−37.2 ±7.24	−37 (−48 − −20)	0.46 (t = −0.746)
Preop. UCLA	9.85 ±1.18	10 (8–12)	9.15 ±1.23	9 (7–12)	0.074 (t = 1.838)
Postop. UCLA	24.8 ±2.04	25 (21–27)	24.75 ±2.4	25 (20–29)	0.883 (z = −0.166)
Intra Group *p*	0.0001* (t = −34.598)		0.0001* (t = −36.141)		
UCLA difference	−14.95 ±1.93	−15 (−18 − −10)	−15.6 ±1.93	−15.5 (−18 − −11)	0.294 (t = 1.064)
Preop. VAS	8.1 ±0.97	8 (7–10)	8.45 ±0.89	8.5 (7–10)	0,231 (z = −1.277)
Postop. VAS	1.65 ±0.59	2 (1–3)	1.85 ±0.67	2 (1–3)	0,414 (z = −0.943)
Intra Group *p*	0.0001* (z = −3.97)		0.0001* (z = −3.97)		
VAS difference	6.45 ±1	6 (5–9)	6.6 ±0.88	7 (5–8)	0,529 (z = −0.673)
Preop. AHD	6.1 ±0.45	6 (5–7)	6 ±0.56	6 (5–7)	0.659 (z = −0.607)
Postop. AHD	8.65 ±0.49	9 (8–9)	8.45 ±0.69	9 (7–9)	0.478 (z = −0.848)
Intra Group *p*	0.0001* (z = −4.008)		0.0001* (z = −4.021)		
AHD difference	−2.55 ±0.69	−3 (−4 − −1)	−2.45 ±0.6	−2.5 (−3 − −1)	0.698 (z = −0.439)

*p < 0.05 statistically significant, SD – standard deviation, Med. (min.–max.) – median (minimum – maximum), for inter-group p-values; t – independent samples t test, z – Mann-Whitney U test; for intra-group p-values: t – paired samples t test; z: Wilcoxon signed rank test. UCLA – University of California Los Angeles, CS – Constant shoulder score) scores, AHD – acromiohumeral distance, VAS – visual analogue pain scale.

erative anteflexion of the patients in Group 1 (PR) was 57 ±9.23, and in Group 2 (OSCR) it was 57.5 ±7.16. The mean postoperative ante flexion of Group 1 (PR) was 127 ±13.42°, and the mean postoperative anteflexion of Group 2 (OSCR) was 127.5 ±27.51°. Preoperative and postoperative anteflexion of both groups increased statistically. There was no statistically significant difference in preoperative and postoperative anteflexion between the 2 groups.

Preoperative Constant Score, UCLA, and VAS scores of patients in Group 1 (PR) were measured (40.3 ±5.86, 9.85 ±1.18, 8.1 ±0.97, respectively). Preoperative Constant Score, UCLA, and VAS scores of patients in Group 1 (PR) were measured (40.9 ±5.97, 9.15 ±1.23, 8.45 ±0.89, respectively).

Postoperative Constant, UCLA, and VAS scores of the patients in Group 1 (PR) were measured (79.2 ±8.19, 24.8 ±2.04, 1.65 ±0.59, respectively). Postoperative Constant Score, UCLA, and VAS scores of the patients in Group 2(OSCR) were measured (78.1 ±8.39, 24.75 ±2.4, 1.85 ±0.67, respectively). There was no statistically significant difference between the groups in Constant Score , UCLA, and VAS scores. A statistically significant difference was found between the groups in terms of preoper-

ative and postoperative constant score, UCLA and VAS scores. Visual analogue scale (VAS) improved significantly from pre- to postoperative time in both groups. Although both groups benefited from the surgical treatment, no statistically significant difference was found between the 2 groups.

Complications

In the follow-up of patients who underwent open superior capsular reconstruction due to massive rotator cuff tear, anchors applied to the glenoid in one patient in the 2nd month were pullout. In the follow-up of patients who underwent partial repair due to a MRCT, shoulder stiffness developed in one patient.

Discussion

The principal finding of our study was that the arthroscopic partial rotator cuff tear repair and the open superior capsule reconstruction technique have similar results in patients with a massive rotator cuff tear. Because open superior reconstruction requires additional autograft transfer, it may cause comorbidity. Preservation of other treatment options in patients undergoing partial repair

may be considered as a priority compared to other treatment methods. Although statistically significant, the tear size in open superior capsular reconstruction group was found to be larger than in the arthroscopic partial repair group. Furthermore, both techniques have similar clinic tolerability for longer periods. To the best of our knowledge, this is the first study that compares 2 techniques in the same patient group.

There is no consensus on the treatment of massive rotator cuff tears. In their definition of MRCTs, Cofield defined it as 5 cm or more in anterior-posterior or medial-lateral in dimension [3]. According to Gerber et al., it is defined as a complete tear of at least 2 tendons [4]. In our study, it was shown that arthroscopic partial repair of MRCTs gives good results in the evaluation of functional outcomes. In their study, Paribelli et al. compared both treatment methods with partial repair and latissimus dorsi tendon transfer in massive tears, and the average follow-up period was 2.8 years. Both techniques are effective in reducing patients' symptoms, and the LDTT represents a valid treatment option with better modified UCLA score improvement and strength [7]. In their study, Porcellini et al. reported that in their 5-year follow-up of 67 patients after partial repair of the irreparable supraspinatus tear, the mean Constant Score increased from 44 to 73, and the mean Simple Shoulder Test score increased from 4.6 to 9.0 [8]. In our study, a statistically significant increase was observed in the Constant Score and UCLA score of the patients in both groups after the treatment, although there are studies reporting poor clinical outcomes in patients with fatty infiltration and muscle atrophy [9]. There are studies reporting that partial repair or open superior capsular reconstruction results are good in these patients. We think that muscle atrophy and fatty degeneration regressed after partial repair in these patients. In a retrospective study by Kim et al. in which 27 patients underwent arthroscopic partial repair and margin convergence of irreparable large to massive rotator cuff tears, the mean tear size was 42.1 ±6.2 mm, and they followed the patients for 2 years. Patients' Constant Score improved from 43.6 ±7.9 to 74.1 ±10.6, and the Simple Shoulder Test improved from 5.1 ±1.2 to 8.8 ±2.1 [10]. Arthroscopic partial repair showed satisfactory short-term outcomes in irreparable large to massive rotator cuff tears without severe atrophy of the rotator cuff muscles or fatty degeneration [10]. In our study, arthroscopic partial repair and margin convergence of massive tears Constant Score improved from 40.3 ±5.86 to 79.2 ±8.19, and the UCLA score improved from 9.85 ±1.18 to 24.8 ±2.04. The size of the tear in our partial repair group was 51.9 ±2.3 mm.

Occasionally, partial repair is not possible in massive rotator cuff tears, because of poor tendon quality and excessive retraction. The tendon can be very tight, and repair is not possible under these circumstances due to degeneration after loosening. In this case, tendon transfer, superior capsular reconstruction, and reverse shoulder arthroplasty or arthroscopic debridement are among the surgical options that can be applied. Superior capsular reconstruction can be performed with fascia lata autograft or humeral dermal allograft in MRCTs. In the review of the treatment of massive rotator cuff repairs, it was found that there were no studies comparing SCR with other treatment methods [11]; thus, in our study, we sought to compare 2 treatment methods. Godenèche et al. reported an equal increase in Constant Score in their study, in which they compared the results of complete or partial repair of massive rotator cuff tears [12]. In massive rotator cuff tears, in particular in irreparable tears, superior capsular reconstruction defined by Mihata has become popular, and functional scores have been reported to be good in the literature. It has been shown that after the treatment of an irreparable rotator cuff tear with fatty degeneration of stage 3–4 according to Goutallier, and below the tangent line in magnetic resonance imaging according to Gerber, shoulder pain is reduced and functional improvement is achieved after superior capsular reconstruction [6]. In their prospective study, Ulstrup et al. reported a Constant Score and Western Ontario Rotator Cuff (WORC) index increase and functional improvement with a low number of patients after 2-year follow-up of their arthroscopic repair using Extracellular DX Reinforcement Matrix Mesh (Arthrex) in patients under 70 years of age [13]. de Campos Azevedo et al. performed arthroscopic superior capsular reconstruction with fascia lata graft in 22 patients with irreparable massive rotator cuff tears. They found a significant increase in the patients' ROM, the Simple Shoulder Test and Constant Score [14]. In our study, we found that the functional results of the superior capsular reconstruction performed with the fascia lata, as described by Mihata's original technique, were good. In a recent review, arthroscopic SCR for massive, irreparable rotator cuff tears using both fascia lata allograft and human dermal allograft led to improvement in clinical outcomes and radiologic outcomes [15]. The reason we use fascia lata while performing superior capsular reconstruction is because we think that there is a lower repair rate, as stated in this review. Jeong et al. compared the results of partial and complete repair in massive tears. As a result of the 5-year follow-up of the patients, partial rotator cuff repair may be preferred, instead of aggressive release in

large and massive rotator cuff tears. Because in the postoperative MRI results, re-ruptures were reported to be more common in the group that underwent the complete repair [16]. The results of repair of massive rotator cuff tears in both surgical techniques are clinical and radiological outcomes similar. The difference in tear sizes between the 2 groups is an important limitation of our study. The lack of a standard treatment modality for the treatment of massive rotator cuff tears among surgeons is a clear indication that more studies are needed. Longer follow-ups with a larger number of patients are also required.

Because our study was retrospective and we did not perform routine MRIs in all postoperative patients, we have no knowledge of the postoperative re-rupture rates. The low number of patients in both study groups is among the limitations of our study. No randomization was performed in this study is due to the different treatment approaches of 2 different surgeons for massive rotator cuff tears.

In conclusion, arthroscopic partial repair might be a safe and effective alternative treatment for irreparable contracted MRCT, for which a complete repair cannot be performed. However, open superior capsular is a good treatment method that can be used in reconstruction, also in patients with larger ruptures. Although it is advantageous that arthroscopic partial repair is more minimally invasive, long-term comparative studies of both surgical treatments in large series are needed.

Conflict of interest

The authors declare no conflict of interest.

References

1. Lo IK, Burkhart SS. Arthroscopic revision of failed rotator cuff repairs: technique and results. Arthroscopy 2004; 20: 250-67.
2. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Rel Res 1994; 304: 78-83.
3. Cofield RH. Rotator cuff disease of the shoulder. J Bone Joint Surg 1985; 67: 974-9.
4. Gerber C, Fuchs B, Hodler J. The results of repair of massive tears of the rotator cuff. J Bone Joint Surg Am 2000; 82: 505-15.
5. Burkhart SS, Esch JC, Jolson RS. The rotator crescent and rotator cable: an anatomic description of the shoulder's "suspension bridge". Arthroscopy 1993; 9: 611-6.
6. Mihata T, McGarry MH, Pirolo JM, Kinoshita M, Lee TQ. Superior capsule reconstruction to restore superior stability in irreparable rotator cuff tears: a biomechanical cadaveric study. Am J Sports Med 2012; 40: 2248-55.
7. Paribelli G, Boschi S, Randelli P, Compagnoni R, Leonardi F, Cassarino AM. Clinical outcome of latissimus dorsi tendon transfer and partial cuff repair in irreparable postero-superior rotator cuff tear. Musculoskelet Surg 2015; 99: 127-32.
8. Porcellini G, Castagna A, Cesari E, Merolla G, Pellegrini A, Paladini P. Partial repair of irreparable supraspinatus tendon tears: clinical and radiographic evaluations at long-term follow-up. J Shoulder Elbow Surg 2011; 20: 1170-7.
9. Gladstone JN, Bishop JY, Lo IK, Flatow EL. Fatty infiltration and atrophy of the rotator cuff do not improve after rotator cuff repair and correlate with poor functional outcome. Am J Sports Med 2007; 35: 719-28.
10. Kim SJ, Lee IS, Kim SH, Lee WY, Chun YM. Arthroscopic partial repair of irreparable large to massive rotator cuff tears. Arthroscopy 2012; 28: 761-8.
11. Galvin JW, Kenney R, Curry EJ, et al. Superior capsular reconstruction for massive rotator cuff tears: a critical analysis review. JBJS Rev 2019; 7: e1.
12. Godenèche A, Freychet B, Lanzetti RM, Clechet J, Carrillon Y, Saffarini M. Should massive rotator cuff tears be reconstructed even when only partially repairable? Knee Surg Sports Traumatol Arthrosc 2017; 25: 2164-73.
13. Ulstrup A, Reinhold M, Falster O. Superior capsular reconstruction: 2-year follow-up results. JSES Int 2020; 4: 893-9.
14. de Campos Azevedo CI, Ângelo ACLPG, Vinga S. Arthroscopic superior capsular reconstruction with a minimally invasive harvested fascia lata autograft produces good clinical results. Orthop J Sports Med 2018; 6: 2325967118808242.
15. Abd Elrahman AA, Sobhy MH, Abdelazim H, Omar Haroun HK. Superior capsular reconstruction: fascia lata versus acellular dermal allograft: a systematic review. Arthrosc Sports Med Rehabil 2020; 2: e389-97.
16. Jeong JY, Kim SJ, Yoon TH, Eum KS, Chun YM. Arthroscopic repair of large and massive rotator cuff tears: complete repair with aggressive release compared with partial repair alone at a minimum follow-up of 5 years. J Bone Joint Surg Am 2020; 102: 1248-54.