

Mini-Open Versus All-Arthroscopic Rotator Cuff Repair: Comparison of the Operative Costs and the Clinical Outcomes

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ABSTRACT

Introduction: Rotator cuff injury is one of the most frequently encountered problems of the shoulder in the daily practice of orthopaedic surgeons. This study compared all-arthroscopic cuff repair (ARCR) and mini-open rotator cuff repair (MORCR) methods in regard to clinical outcomes and costs.

Methods: Fifty patient charts and operative repairs were analysed (25 ARCR and 25 MORCR). Pre- and postoperative Constant–Murley and UCLA scores along with factors such as tear size, tear type, pre-operative physical therapy, motion and satisfaction levels were compared for the two procedures. Cost–benefit analysis was also performed for comparison between procedures. The duration of follow-up was 31.20 and 21.56 months for MORCR and ARCR groups, respectively.

Results: Tear sizes ($P=0.68$), pre- and postoperative Constant–Murley and UCLA scores ($P=0.254$) and satisfaction levels were not significantly different between groups. However, the differences between pre- and postoperative Constant–Murley and UCLA scores were statistically significant within both groups ($P<0.01$). The MORCR group stayed 1 day longer in hospital than the ARCR group, which was statistically significant ($P=0.036$). The differences regarding mean pain scores, abductions, internal and external rotations in Constant–Murley scores and forward flexion scores in UCLA scores were not significant. The ARCR group cost more, leaving less profit.

Conclusion: Results suggest that ARCR yields similar clinical results but at a higher cost compared with MORCR.

Keywords: arthroscopic repair; clinical outcome; cost analysis; mini-open repair; rotator cuff tear

INTRODUCTION

Rotator cuff injury is among the most frequently encountered problems of the shoulder in the daily practice of orthopaedic surgeons. The first rotator cuff repair was performed by Codman in 1909¹ and methods of repair have evolved since then, with a shift towards less invasive and arthroscopic means in the last 15 years.

Open, arthroscopic, arthroscopic-assisted open and mini-open methods can all be used to treat cuff tears.^{2,3} Although

long-term data are lacking, recent short-term results suggest that arthroscopic procedures offer a possible alternative to traditional means.^{2,3}

One technique is arthroscopic cuff repair (ARCR). However, this procedure can be a challenge for even the most experienced of arthroscopic surgeons as it requires both familiarity with three-dimensional orientation to the pathoanatomy and skillful use of various instruments for suture passage, bone trimming or anchorage.

ARCR also requires special instrumentation and electronic equipment, which need to be available in the hospital inventory. Additionally, there are implants (such as suture anchors) and single-use instruments (shavers, burrs, radiofrequency ablaters, cannulae, etc) which can increase the costs.

In contrast, the use of the mini-open rotator cuff repair (MORCR) technique can offer a much cheaper option and can also provide experience in many of the skills necessary to make the transition to an entirely arthroscopic procedure. Research has also shown that when MORCR and arthroscopic debridement and acromioplasty are compared in partial rotator cuff ruptures there is an increased re-operation rate in the arthroscopic group. However, patients who have undergone MORCR surgery tend to have a longer hospital stay and an increased need for analgesics in the early postoperative period when compared to patients who had undergone arthroscopic repair.⁴

The purpose of our study was to discuss the clinical results of patients treated using ARCR and MORCR and to compare the costs of these two operations from a developing country's standpoint.

MATERIALS AND METHODS

Patient charts and operative reports were reviewed for 123 patients who underwent rotator cuff-related surgery between 2001 and 2005.

Inclusion criteria were that the patient had required rotator cuff repair (either MORCR or ARCR) and that the tear was also confirmed intraoperatively. Patients were excluded from the study if they had less than 1 year of follow-up or no regular

follow-up, if they had arthroscopically assisted mini-open repairs, traditional open repairs, cuff debridements and subacromial decompressions without repair, revision procedures, or concomitant stiffness.

All patients meeting the inclusion criteria were called to follow-up. The demographic data, pre-operative Constant–Murley⁵ and UCLA⁶ scores, duration of complaints, systemic diseases and need for physical therapy (in the pre- and postoperative periods) were gathered from the patient charts.

The Constant–Murley scoring system has a maximum score of 100 points comprising subjective (35%) and objective (65%) components. The former includes the degree of pain and ability to perform activities of daily living, and the latter includes active forward and lateral elevation measured by a goniometer, internal/external rotation assessed by body landmarks reached in composite movements and the strength of abduction measured using a spring balance. Higher scores indicate a better outcome and lower scores indicate a poorer outcome.⁵

The self-report section of the UCLA Shoulder Scale consists of two single-item subscales, one for pain and one for functional level. The items are rated on a Likert-type scale and scored from 1 to 10, with higher scores indicating less pain and greater function.⁶

Operative records were scanned to ensure that the patient had undergone an all-ARCR or an all-MORCR procedure. Data about the type/size of the tear (greatest width of the tear at the greater tuberosity [cm]) were gathered from the operative records. To report patient satisfaction, patients who came to final follow-up were

asked “How satisfied are you with your treatment?”, and answered either satisfied, cannot decide or not satisfied. At the time of follow-up, informed consent was obtained. The patients were re-examined in regard to range-of-motion (ROM), power, and presence of remaining symptoms of impingement syndrome. The UCLA and Constant–Murley scorings were repeated. All physical examinations were performed by an orthopaedic specialist who knew which patients had undergone ARCR and which MORCR.

While measuring active ROM, the shoulders were kept in forward flexion. External rotation was measured with the arm at the side and internal rotation with the arm behind the back. We used a manual dynamometer for strength testing (Lafayette Manual Muscle Test System; Lafayette Instrument Co USA, Lafayette, Ill, USA) for forward flexion and external rotation. The patient was asked to maximally elevate against the dynamometer and to remain in that position for 5 seconds. This test was done three times on each shoulder, and the average of the results at the latest follow-up was recorded. External rotation strength was tested with the arm at the side while the elbow was flexed to 90°, and the shoulder was in neutral rotation. The patient was again asked to externally rotate against the dynamometer and hold it for 5 seconds. Again, the average of three measurements was recorded. The lift-off test was used to assess the subscapularis.

Surgical Procedure

For MORCR, the incision started at the lateral edge of the acromion continuing to a maximum of 5 cm distally. The deltoid was

split in line with its fibres (not completely detached). Tendon repairs were performed using sutures passed through bone tunnels.

All ARCRs were performed using three portals (anterior, posterior and lateral). Suture anchors were used for fixation and repair of the rotator cuff.

All patients underwent anterior acromioplasty and bursectomy regardless of the tear size, which was measured by a calibrated probe in both MORCR and ARCR cases.

All patients were given a sling (patients with large tears were given an abduction pillow for 3 weeks) and passive ROM exercises for the first 6 weeks following the operation. After 6 weeks, active motion was also started under supervision of a physiotherapist. Rehabilitation protocols were standard for both groups.

Cost Analysis

Both groups were analysed to measure total costs of the operations for the hospital and individual costs for each patient. In Turkey, the Social Security Institution (SSI) pays a fixed amount of money for certain operations including all expenses except for the hardware, which is paid separately. The SSI pays the hospitals US\$900 for a single case of ARCR and US\$600 for a single case of MORCR. The surgeon's fee is about US\$150 which is the same for both operations.

The total in-hospital cost for each patient was assessed and a mean value for the MORCR and for ARCR was calculated.

Statistical Analysis

The data regarding the functional scores and the operation costs were analysed using SPSS for Windows statistical software

(version 10.0; SPSS, Chicago, Ill). Mann–Whitney *U* test, Chi-square test, Wilcoxon signed rank test and Spearman’s rank correlation test were also used for assessment.

RESULTS

Demographics

Of those patients who agreed to participate in the study after inclusion and exclusion criteria were applied ($n=57$), 50 were successfully tracked and completed the study. Twenty-five of these patients had un-

dergone MORCR and 25 had undergone ARCR. There were four (16%) men and 21 (84%) women in the MORCR group, with a mean age of 62 years (range, 32–75 years) and seven (28%) men and 18 (72%) women in the ARCR group, with a mean age of 55 years (range, 34–72 years). The durations of follow-up were 31.20 months (range, 13–82 months) and 21.56 months (range, 12–34 months) for the MORCR and ARCR groups, respectively. Twenty-three patients (92%) in the MORCR and 20 (80%) patients in the ARCR group received pre-operative physical therapy.

Table 1. Demographic data, pre-operative physical therapy (PPT) prevalence, tear types and tear sizes for both study groups.

	MORCR	ARCR	<i>P</i>
Age, years, mean±SD	62±10.02	55±7.57	0.62
Gender, <i>n</i> (%)			
Female	21 (84)	18 (72)	0.35
Male	4 (16)	7 (28)	
PPT, <i>n</i> (%)			
Yes	23 (92)	20 (80)	0.76
No	2 (8)	5 (20)	
	MORCR	ARCR	Total
Tear type, <i>n</i>			
Crescentic	12	11	23
Longitudinal	7	9	16
‘L’ shaped	2	5	7
Reverse ‘L’ shaped	4	0	4
Tear size, cm			
Small	8	8	16
Moderate	11	14	25
Large	6	3	9
Average tear size*	2.89	2.71	2.8

* $P=0.68$.

ARCR=arthroscopic rotator cuff repair; MORCR=mini-open rotator cuff repair; SD=standard deviation.

Table 2. Analysis of pre-operative and postoperative Constant–Murley and UCLA scores in both groups.

	MORCR preop	ARCR preop	P	MORCR postop	ARCR postop	P
Constant–Murley score						
Total	45.6±12.4	46.2±11.8	0.62	79.56±13.64	83.56±11.45	0.24
Pain	6.8±2.17	5.6±1.82	0.36	12±3.81	12.8±3.55	0.60
Forward elevation	4.5±1.74	5.3±2.16	0.23	8.72±2.3	9.28±1.4	0.22
UCLA score						
Total	10.6±4.5	11.2±5.6	0.67	28.8±3.42	29.76±4.5	0.63
Pain	2.6±2.1	3.9±2.1	0.58	7.8±3.29	8.4±2.76	0.35
Forward elevation	2.3±1.10	2.6±1.0	0.66	4.40±1.15	4.64±0.7	0.54
Lateral elevation (abduction)	3.9±2.45	4.2±1.62	0.21	8.40±2.64	8.72±1.98	0.34
Internal rotation	3.5±2.87	3.7±2.98	0.65	7.04±2.83	7.20±2.64	0.74
External rotation	4.6±3.02	5.2±2.56	0.56	8.32±2.92	8.48±2.18	0.46
Forward flexion power	2.5±0.95	2.7±1.64	0.71	4.28±1.13	4.32±0.8	0.44

Data are mean±standard deviation. Both groups show remarkable changes between pre- and postoperative values of both scoring systems. Preop–postop change in the Constant–Murley score: $P<0.01$ in both the ARCR and MORCR groups. Preop–postop change in the UCLA score: $P<0.01$ in both the ARCR and MORCR groups.
 ARCR=arthroscopic rotator cuff repair; MORCR=mini-open rotator cuff repair.

Demographic data along with the tear types and tear sizes are shown in Table 1. The average tear size was 2.8 cm (mean, 2.89 cm in the MORCR and 2.71 cm in the ARCR group). Tear sizes were not significantly different between groups ($P=0.68$).

Shoulder Scores and Subjective Assessment

The mean pre-operative Constant–Murley score was 45.6 ± 12.4 in the MORCR and 46.2 ± 11.8 in the ARCR group. The mean postoperative Constant–Murley scores was 79.6 ± 13.64 in the MORCR and 83.6 ± 11.45 in the ARCR group. The pre- and postoperative Constant–Murley scores were not significantly different between groups ($P=0.254$) but the difference was statistically significant within each group ($P<0.01$) (Table 2).

When pain scores of the Constant–Murley scoring system were evaluated independently, the difference between groups was not significant (Table 2). In MORCR, the correlation tests revealed a negative correlation between age and pain factors ($r=-0.475$; $P=0.016$; $P<0.05$) and this shows that as age increases, pain decreases.

The UCLA shoulder evaluation revealed a mean pre-operative score of 10.6 ± 4.5 in the MORCR and 11.2 ± 5.6 in the ARCR group. Postoperatively, both groups had an increase with a mean score of 28.8 ± 3.4 in the MORCR and 29.76 ± 4.5 in the ARCR group. The pre- and postoperative UCLA scores were not significantly different between groups but the difference was statistically significant within each group ($P<0.01$) (Table 2).

The average duration of hospital stay was 3.4 days (range, 2–5 days) for the

MORCR group and 2.4 days (range, 1–4 days) for the ARCR group. The difference was statistically significant ($P=0.036$).

The forward elevations of the patients were evaluated separately and there was no statistically significant difference between groups (Table 2).

Abductions, internal and external rotations in Constant–Murley scores and forward flexion scores in UCLA scores were separately analysed and again there was no statistical significance between groups (Table 2).

Satisfaction evaluation revealed 22 (88%) satisfactory and three (12%) unsatisfactory results in each group. These dissatisfied patients all had large retracted tears (3–5 cm) and a long symptomatic period of a mean of 15 months (range, 12–28 months). These patients also had remaining impingement signs and decreased ROM.

Cost Analysis

The hospital was paid a total of US\$22,500 (US\$900 per case) for 25 ARCR operations. The single-use instruments of 25 ARCRs (including shavers, cannulae, drape set, pump set, saline solution) cost US\$10,000 (44% of total income) leaving the hospital US\$8250 after extracting the surgeon's fee of US\$3750 (for 25 operations). The hardware needed for these procedures (camera, scope, monitor, motor, cold light source, video recorder and the casing) cost roughly between US\$30,000 and US\$50,000.

The hospital was paid US\$15,000 (US\$600 fixed rate per case) for 25 MORCRs. As non-absorbable sutures were passed through bone tunnels for repair, no suture anchors were used and therefore

there was no need for a special set-up to do these operations. The total cost of these sutures was US\$750. Patients in the MORCR group stayed on average 1 day longer (US\$10 a day) than the ARCR group adding US\$250 onto the cost. The surgeon's fee was the same as for ARCR (approximately US\$150 per case; a total of US\$3750). After all expenses the hospital profit was US\$9750. The difference in total costs was US\$2150 in favour of the MORCR treatment.

When evaluated from the SSI perspective, the cost of ARCR was even higher as the cost of special hospital equipment is not accounted for in the amount the hospital is paid. A total of US\$8000 was paid separately for the suture anchors (on average two suture anchors were used in this group) raising the total cost of the 25 ARCR patients to US\$30,500. This is twice the cost of MORCRs for the SSI (Table 3).

As all patients received the same amount of physical therapy, associated costs were not taken into account during cost analysis.

DISCUSSION

The classical surgical treatment of rotator cuff tear consists of the elevation of anterior deltoid origin from the acromion followed by cuff repair with or without acromioplasty. Excellent results (up to 88%–90%) have been reported with this procedure.^{7–9} Arthroscopic methods have also been used in the last 15 years with increasing success.^{3,10} Mini-open surgical techniques have been developed after the introduction of arthroscopy in shoulder surgery, attempting to combine

the advantages of open and arthroscopic methods with comparable success to open repairs.^{11–13}

There are a few studies in the literature comparing MORCR and ARCR. Such studies have shown the ARCR group to have a decreased need for analgesics in the short term. In addition the length of hospital stay and return to pre-operative activities was shortened.³ When the clinical outcomes were reassessed in the midterm, no significant differences were found regarding pain, function, ROM and patient satisfaction.^{14–17} Our study supported previous research and no statistically significant differences were identified relating to functional scores, ROM, power scores and patient satisfaction in 21–31 months' follow-up.

Pre-operative factors have been reported to be associated with clinical outcome.^{11,12,18} Many authors have suggested that the most important determinant of long-term success of surgery is the dimensions of the rupture.^{19–22} Although there are researchers who have suggested that the clinical outcome of surgery was not dependent on the size of tears,^{12,18} we had six unsatisfactory results all of which were in patients with massive tears.

In our study the patients with bad results also all had a long history of symptoms, which may point to tendinous degeneration. This finding is supported by Cofield et al., who demonstrated that early surgical intervention (within 3 weeks) following the initial trauma gives better clinical results when compared with the patients who underwent late intervention (6–12 weeks).¹⁹

In terms of complications, only one patient in the MORCR group had a post-operative infection, which healed with oral antibiotics. In a previous study by Severud et al., who performed a retrospective comparison between ARCR and MORCR, a culture-negative sinus tract originating from a local reaction to the suture material (which healed following debridement) and a rupture of the long head of biceps was reported in the ARCR group and four fibrous ankyloses were reported in the MORCR group.¹⁵

Statistical tests performed on scores revealed that patient satisfaction correlated with Constant–Murley and UCLA scores, indicating that higher scores lead to higher activity and lower pain, and thus a higher degree of satisfaction. This is a finding supported by Motycka et al.,²³ who reported a strong correlation between Constant–Murley score and subjective assessment.

We did not find any correlation between age and Constant–Murley scores in either the MORCR ($P=0.984$) or ARCR group ($P=0.315$). Romeo et al. found a negative correlation between age and Constant–Murley scores in women. Also the size of the rupture and clinical outcomes (Constant–Murley scores) were found to be negatively correlated in women. However, there was no correlation between age and scores reported in men but there was a negative correlation between size of rupture and Constant–Murley scores and degree of abduction.²⁴

The advantages of arthroscopic surgery are not only less pain owing to the integrity of deltoid attachment to the acromion, shortened duration of hospital stay and earlier rehabilitation. It

also enables assessment and treatment of glenohumeral intra-articular pathologies, assessment of the rupture type and configuration of dimensions at the same time.⁷ We also performed concurrent assessments but these did not significantly alter the treatment method used.

Although arthroscopic or arthroscopically assisted repairs are less invasive than classical open surgery, they require surgical experience, familiarity with the vision through the camera and a lengthened operative time. From this perspective, mini-open repair methods offer a better alternative in terms of similarity to classical open surgical methods, shortened operative time and less invasiveness (when compared with classical open surgery).²⁵ The arthroscopic operations in our study left less profit for the hospital and created a greater economic burden for the SSI, doubling the price of mini-open repairs.

This study has some drawbacks. Although all measurements including ROM, strength, pain and function scores and UCLA and Constant–Murley scores were prospectively recorded in the patient charts, this was a retrospective study. In addition, a power analysis was not performed as this was not a prospective study.

In conclusion, ARCR yields only comparable and similar results to MORCR yet with a much higher cost. Surgical outcome seems to be dependent on the size of tear rather than method of repair. Mini-open repair may be the preferred option due to its low cost, high patient satisfaction and experience provided for surgeons of other complicated surgical techniques, while also providing similar results to arthroscopic surgery.

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