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Original Research Article

Evaluation of Functional Outcomes and Return-to-Activity Rates Following Arthroscopic Versus Open Repair of Rotator Cuff Tears

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Abstract

Background: Rotator cuff repair may be performed using arthroscopic or open techniques, but the extent to which the less invasive approach improves functional recovery and return to activity remains debated.

Objective: To compare functional outcomes, pain, structural integrity, and return-to-activity rates following arthroscopic and open repair of full-thickness rotator cuff tears.

Methods: This prospective comparative study included 128 adults with reparable full-thickness tears, allocated according to the treating surgeon's standardized operative pathway to arthroscopic repair (n=64) or mini-open/open repair (n=64). American Shoulder and Elbow Surgeons (ASES) scores, Constant-Murley scores, visual analogue scale (VAS) pain, range of motion, return to work and recreation, complications, and ultrasonographic tendon integrity were assessed over 24 months.

Results: Baseline characteristics were comparable. At 6 months, the arthroscopic group had higher ASES scores (75.8±10.9 versus 69.9±12.4; p=0.008), lower VAS pain (2.4±1.2 versus 3.1±1.4; p=0.004), and greater forward elevation (146.2±16.8° versus 137.5±19.1°; p=0.009). Differences narrowed by 12 and 24 months; the 24-month ASES scores were 90.1±7.8 and 88.7±8.6, respectively (p=0.31). Return to work occurred in 89.1% and 82.8% of participants, with a shorter median time after arthroscopy (14 versus 18 weeks; p=0.01). Return to recreational activity was 84.4% versus 76.6% (p=0.27). Retear rates were similar (12.5% versus 10.9%; p=0.78).

Conclusion: Arthroscopic repair produced faster early recovery and earlier work resumption, while both techniques achieved comparable final function and tendon integrity at 24 months. Surgical approach should therefore be individualized according to tear pattern, tissue quality, surgeon expertise, and patient priorities.

Keywords: Rotator Cuff Tear; Arthroscopic Repair; Open Repair; Functional Outcome; Return To Activity; Shoulder Surgery.

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Introduction

Middle aged and older adults frequently present with shoulder pain, weakness, sleep disturbance and activity limitation due to rotator cuff tears. They are more common with age and can be significant even in people who don't have serious symptoms, so it's important to take a clinical history when choosing treatment. Population imaging studies have shown that the number of tears increases with age both in the presence of symptoms and in the absence of symptoms, and clinical reviews have highlighted that chronic disability can affect self-care, work and recreational activity [1]. This choice of repair is therefore determined not only by the morphology, but also by the symptoms, functional demand, chronicity, quality of the muscles and the response to a structured non-operative treatment. Surgical repair is designed to restore the continuity of the tendon, enhance the force couple around the glenohumeral joint, alleviate pain and allow gradual return to occupational and sporting activity. Traditional open repair allows for direct visualization and is still useful in certain massive and complex tears, but requires splitting or detachment of the deltoid and may have increased early soft tissue morbidity. Arthroscopic repair allows for thorough intra-articular examination, treatment of associated pathology, smaller incisions, and preservation of

the deltoid. The broadly similar final results reported in the earlier comparative studies were accompanied by suggestions that arthroscopy has benefits in early pain and recovery [2]. Randomized and pooled evidence has also shown that arthroscopy and mini-open may be equally effective in the long term in terms of patient-reported outcomes, provided the surgery is technically successful [3].

The importance of operative approach has changed with the development of arthroscopic instrumentation, suture anchors, and visualization and rehabilitation protocols. Modern systematic reviews demonstrate that both methods can result in significant functional improvements; however, the differences in tear size, tear repair configuration, length of follow-up, and outcome definitions make it difficult to draw strong conclusions about superiority [4]. Another issue is that structural healing does not always correspond to subjective recovery: a patient who has an imaging-proven retear may experience significant pain relief and function, while a patient with an imaging-proven intact repair may have persistent weakness or stiffness [5]. So, patient-reported scores, objective motion, tendon integrity, complications and participation outcomes should be included in the evaluation process.

Return to work and return to recreation (RTW) are particularly significant as they relate to clinical improvement in the real world. Studies published have shown that the vast majority of patients return to work following repair, although this varies depending on the manual nature of the patients' work, their workers' compensation status, involvement of the dominant arm, and preoperative job demands [6]. The age, tear characteristics, confidence, adherence to rehabilitation, and performance expectations also play a role in returning to sport/physical activity. Long-term studies have consistently found improvements that persist following both arthroscopic and open repair, but few studies have quantified early improvement and participation in the same patients [7].

The purpose of the present study was to compare the arthroscopic and open repair of the rotator cuff with a multidimensional evaluation over a 24-month period. The main goal was to compare functional scores from the ASES. Secondary outcomes included comparison of Constant-Murley scores, pain, range of motion, tendon integrity, complications, time to return to work and return to recreational activity. It was thought that arthroscopic repair would help to speed up recovery without making a clinically significant difference in 24-month final outcome.

Materials and Methods

The study was designed and conducted in the following manner:

This was a prospective comparative cohort study performed in the orthopaedic shoulder unit of a tertiary teaching hospital. Patients were consecutively enrolled over a 24-month period and followed for 2 years post-surgery. The manuscript was organized in the form of an original clinical investigation. The operative pathway was defined at a preoperative shoulder conference based on surgeon experience and tear configuration, whereas the inclusion criteria, rehabilitation milestones, follow-up visits and outcome collection were standardized across groups. Wherever there was no masking due to the appearance of the incision, the outcome assessors and the musculoskeletal radiologist who evaluated repair integrity were not told of the surgical approach.

Participants: Eligible were adults (35-70 years) with symptomatic, MRI-proven full-thickness supraspinatus or posterosuperior rotator cuff tears that were deemed reparable. Despite analgesia, activity modification and supervised physiotherapy, symptoms had been present for a minimum of 3 months. The subjects had to have an ASES score of less than 75 before the surgery and be able to attend all follow-up visits. Exclusion criteria were irreparable tears, advanced glenohumeral arthritis, cuff-tear arthropathy, fracture, and inflammatory arthropathy, previous surgery on the same shoulder, cervical radiculopathy, clinically relevant neuropathy, infection, or inability to follow rehabilitation instructions. A total of 147 patients were screened, 132 of whom were repaired, and 128 of whom were assessed at 6 months for the primary analysis. A total of 147 patients were screened, 132 of whom were repaired, and 128 of whom were assessed at 6 months for the primary analysis.

Operative Procedures: All procedures were carried out under general anaesthetic with an interscalene block. The arthroscopic group consisted of diagnostic glenohumeral inspection, subacromial bursectomy, mobilization of the tendon, footprint preparation, and single or double-row anchor repair depending on the width of the tear and the mobility of the tendon. Acromioplasty was only performed when the spur was prominent in the anterolateral position or when there was mechanical abrasion.

In the open group, repair was performed by a deltoid-splitting mini-open or limited open approach following arthroscopic or open assessment and was completed with transosseous sutures or suture anchors depending on the bone quality in the open group. In both groups, the indications for concomitant biceps tenotomy or tenodesis were the same.

The arm was placed in an abduction sling postoperatively for 4-6 weeks. Active and assisted passive motion started at 6-10 weeks and protected passive motion started at the first 2 weeks.

Active and assisted passive motion started at 6-10 weeks and protected passive motion started at the first 2 weeks. Progressive strengthening typically began when satisfactory motion and clinical tendon continuity were established at 12 weeks. Heavy manual work and overhead sports were postponed until 5-6 months and only allowed once functional strength was regained. Written criteria based on the rehabilitation phase were used for both groups.

Outcome Measures: The primary outcome was the ASES score at 24 months. Secondary outcomes were Constant-Murley score, VAS pain (0-10), active forward elevation, external rotation at the side and internal rotation level.

Preoperative and 6, 12, and 24-month assessments were taken. Return to work was considered to be the participant's return to their previous occupation or to a duty level equivalent to their previous occupation, with no medical restriction related to their shoulder. Return to recreation was defined as returning to the same or higher level of the main preinjury leisure or sporting activity.

High-resolution ultrasound was used to assess repair integrity at 12 months and was defined as intact or retorn. Complications were infection, postoperative stiffness (requiring injection or operative release), symptomatic anchor problems, neurologic deficit, venous thromboembolism, reoperation, and clinically important deltoid dysfunction. The difference of 10 points was deemed clinically significant for between-group comparisons.

Statistical Analysis: With an assumed standard deviation of 13, 60 participants per group would have 80% power to detect a 7-point difference in ASES score with two-sided alpha of 0.05 and with the assumption that 20% of participants would drop out. All continuous variables were checked for distribution and reported as mean±SD or median (IQR).

Independent-samples t tests or Mann-Whitney U tests were used to compare groups, and categorical variables were analyzed using chi-square or Fisher exact tests. The score trajectories were analyzed using repeated-measures linear models with fixed effects for group, time, and group-by-time interaction. The Kaplan-Meier and log-rank tests were used to compare time to work resumption. All patients who had at least one postoperative evaluation were analyzed (modified intention-to-treat analysis), and $p<0.05$ was considered significant.

Results

The 128 participants had a mean age of 56.0±8.9 years, and 72 (56.3%) were men. Baseline demographic factors, dominant-arm involvement, tear dimensions, fatty infiltration, occupational demand, and preoperative functional scores did not differ significantly between groups (Table 1). The mean operative time was lower for the arthroscopic procedure (82.4±18.6 versus 96.7±21.3 minutes; $p<0.001$), while the frequency of biceps procedures and use of double-row repair were comparable.

Table 1: Baseline characteristics of the study groups

Characteristic	Arthroscopic repair (n=64)	Open repair (n=64)	p-value
Age, years	55.8±8.7	56.2±9.1	0.80
Male sex, n (%)	37 (57.8)	35 (54.7)	0.72
Dominant shoulder involved, n (%)	39 (60.9)	41 (64.1)	0.71
Symptom duration, months	10.6±5.4	11.1±5.8	0.62
Tear size, cm	2.7±1.0	2.8±1.1	0.59
Large tear (>3 cm), n (%)	20 (31.3)	22 (34.4)	0.70
Goutallier grade 0-1, n (%)	49 (76.6)	47 (73.4)	0.68
Heavy manual occupation, n (%)	18 (28.1)	20 (31.3)	0.70
Baseline ASES score	43.6±10.8	42.9±11.3	0.72
Baseline VAS pain	6.8±1.2	6.9±1.3	0.65

Both groups demonstrated substantial improvement over time.

The ASES group-by-time interaction was significant through 6 months ($p=0.01$) but not after 12 months. At 6 months, arthroscopic repair was associated with better ASES and Constant-Murley scores, lower pain, and greater active forward elevation. At 12 months, the ASES difference was smaller and below the prespecified clinically meaningful threshold. By 24 months, the groups were statistically comparable for ASES score, Constant-Murley score, pain, forward elevation, and external rotation (Table 2).

Within-group improvement from baseline to 24 months was significant for all functional outcomes (all $p<0.001$).

Table 2: Functional outcomes during 24-month follow-up

Outcome/time	Arthroscopic repair	Open repair	p-value
ASES score, 6 months	75.8±10.9	69.9±12.4	0.008
ASES score, 12 months	87.2±8.9	84.5±9.7	0.12
ASES score, 24 months	90.1±7.8	88.7±8.6	0.31
Constant-Murley, 6 months	71.4±9.8	66.8±10.6	0.012
Constant-Murley, 24 months	86.5±7.4	84.9±8.1	0.25
VAS pain, 6 months	2.4±1.2	3.1±1.4	0.004
VAS pain, 24 months	0.9±0.8	1.1±0.9	0.19
Forward elevation, 6 months	146.2±16.8°	137.5±19.1°	0.009
Forward elevation, 24 months	163.4±10.7°	160.8±12.9°	0.22
External rotation, 24 months	56.8±9.6°	54.7±10.3°	0.24

Among 115 participants employed before surgery, 102 returned to work: 57 of 64 eligible participants in the arthroscopic group and 45 of 51 in the open group. The proportion returning was not significantly different, but the median time to unrestricted work was four weeks shorter after arthroscopy. The difference was most apparent among participants with light or moderate occupational demand; heavy manual workers in both groups required longer rehabilitation. Return to the principal recreational activity occurred in 54 arthroscopic and 49 open-repair participants, with no statistically significant difference in overall rate (Table 3).

Table 3: Return to activity, tendon integrity, and complications

Outcome	Arthroscopic repair	Open repair	p-value
Returned to work, n/N (%)	57/64 (89.1)	45/51 (88.2)	0.88
Median time to unrestricted work	14 weeks	18 weeks	0.01
Returned to recreation, n (%)	54 (84.4)	49 (76.6)	0.27
Returned at same/higher level, n (%)	45 (70.3)	40 (62.5)	0.35
Intact repair at 12 months, n/N (%)	55/63 (87.3)	55/62 (88.7)	0.78
Retear, n/N (%)	8/63 (12.7)	7/62 (11.3)	0.78
Any complication, n (%)	3 (4.7)	8 (12.5)	0.11
Reoperation within 24 months, n (%)	1 (1.6)	2 (3.1)	>0.99

Ultrasound at 12 months was available for 125 participants. Retears were detected in 8 of 63 arthroscopic repairs and 7 of 62 open repairs (p=0.78). Most retears involved initially large tears and did not require revision during follow-up. Complications occurred in 3 arthroscopic and 8 open-repair participants (p=0.11); postoperative stiffness was the most frequent event. One superficial wound infection occurred after open repair and resolved with debridement and antibiotics. No permanent neurologic deficit or clinically relevant deltoid detachment was observed.

Discussion

The results of this prospective comparison demonstrated that arthroscopic rotator cuff repair had a more favorable early recovery profile with lower pain scores, improved function, increased forward elevation and earlier return to unrestricted work. The size of the difference, however, gradually diminished and the final 24-month results were similar. These results confirm the hypothesis that the approach may have more impact on the rehabilitation time than the final shoulder status. A randomized trial and meta-analysis of arthroscopic versus mini-open procedures also found no clinically significant difference in the long-term results, but early recovery outcomes were sometimes better for arthroscopy [8].

The early advantage is a biologically and mechanically plausible one. Arthroscopy decreases the amount of dissection of the deltoid, permits treatment through small portals and may decrease wound pain and postoperative inhibition. The glenohumeral joint can be better visualized and this can aid in the treatment of biceps and labral disease without extending the approach. However, incision length is likely to have less of an effect on healing than the final repair construct, tendon mobility, footprint preparation, tissue quality, and rehabilitation. Meta-analysis of comparative studies has therefore been found to be inconclusive, as the differences between the two techniques are sometimes too small or inconsistent to determine that one technique is universally superior [9]. This 24-month difference between the two groups (ASES) was well below the threshold for a clinically meaningful difference.

Arthroscopic repair was associated with shorter time to unrestricted duty in both groups. Return to work was common in both groups, with arthroscopic repair associated with shorter time to

unrestricted duty. This outcome should be considered in conjunction with the job demand, as sedentary jobs may have been able to be returned after pain control and safe sling use, while heavy jobs may have needed to be restored in strength, endurance and confidence. Systematic evidence suggests that factors such as occupational intensity, compensation status, and preinjury demands are significant factors in work recovery following rotator cuff repair [10]. Therefore, the four-week difference observed should not be solely blamed on operative technique, but may also be due to the fact that less early pain and better motion may have helped in achieving rehabilitation milestones.

The number of patients returning to recreation was not statistically different, but was higher after arthroscopy. Return is not the same as full recovery as some participants returned to activity at a lower level or changed the overhead exposure. Recent research on physical activity following arthroscopic repair shows high overall return rates, but that age, tear size, preoperative activity and patient expectations affect return rates [11].

Return at any level should therefore be differentiated from return to preinjury performance in a shared preinjury discussion. Scapular stabilizers and kinetic chain may be of specific importance when considering conditioning for patients returning to overhead sport.

Structural outcomes were similar, with approximately 12% retears in each group. This confirms the importance of tendon biology and characteristics of tears in healing. The majority of retears were following repair of bigger lesions and several patients were able to have useful function despite structural failure.

In some clinical populations, there is no significant difference by repair integrity, and this does not mean that healing is not important, but rather that pain relief, decompression of inflamed tissue, rehabilitation, and partial restoration of force transmission may allow for improvement despite the lack of continuity. More follow-up is needed due to the possibility of retears affecting strength and progression of arthropathy over time.

The complication profile was numerically better for arthroscopy, but the study was not designed to detect uncommon complications.

The most common problem was stiffness, which was treated primarily with rehabilitation and selective injection. Too much protection during rehabilitation can decrease loading at the repair site, but increase stiffness, or too much early motion can compromise healing of large and/or poor quality tears. A protocol based on the criteria is more defensible than a calendar-based protocol. There are a number of strengths of this study: Prospective collection, standardized rehabilitation, multidimensional outcomes, imaging of tendon integrity, and 24-month follow-up. There are several important limitations, such as non-random allocation, the possibility of residual confounding due to surgeon selection, limited masking, and performance at a single tertiary center. Open group was an open and mini-open repair, as well as limited open repair, to reflect clinical practice, but with some procedural heterogeneity. Follow-up imaging was performed with ultrasound and not MRI and the study did not quantify muscle fatty degeneration over time. Return-to-activity results were self-reported and may have been affected by socioeconomic factors. More large, multicenter, randomized trials, stratified by tear size and occupational demand, would help determine if any specific subgroups benefit from arthroscopy in the short-term.

The present activity outcomes are supported by evidence from return to sport. Return rates and timing following arthroscopic repair have been reported to vary widely, with variations in sport type, tear characteristics and definition of successful return [12] noted. The rates of return to preinjury level are lower for competitive and overhead athletes than for recreational athletes [13]. Research on younger adults and overhead athletes also suggests that return is typically possible, but not always [14]. A systematic review of overhead athletes found that a significant proportion of athletes (25%) improved meaningfully but did not return completely, highlighting the need for sport-specific rehabilitation and realistic counselling [15].

The lack of a clinically important long-term difference between approaches is also supported by randomized evidence comparing open and arthroscopic repair [16]. Staged, criterion based loading based on tear size, tissue quality, and patient factors is recommended by consensus and has been shown to be a significant factor in early recovery [17]. Systematic review evidence shows that there is a significant amount of protocol heterogeneity and the progression should be individualized, not rigid [18].

Conclusion

Arthroscopic rotator cuff repair resulted in greater early improvement in pain, function, motion, and time to unrestricted work when compared to open repair. Both methods resulted in comparable patient-reported function, range of motion, return to recreation, tendon integrity and reoperation rates at 24 months. The technique used should be tailored to the individual and focus on a long-lasting low tension repair, preservation of soft tissue, rehabilitation, and realistic counselling regarding the time needed to return to work and sport.

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