A commentary by Michael Khazzam, MD, is linked to the online version of this article.

Arthroscopic Rotator Cuff Repair with and without Acromioplasty in the Treatment of Full-Thickness Rotator Cuff Tears

Long-Term Outcomes of a Multicenter, Randomized Controlled Trial

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Background: The aim of this study was to reevaluate patients from a previous randomized controlled trial at a long-term follow-up to determine the long-term efficacy of subacromial decompression in patients with full-thickness rotator cuff tears.

Methods: This is a secondary study based on a previous, multicenter, randomized controlled trial with patients allocated to arthroscopic rotator cuff repair with or without acromioplasty. The original study was conducted between 2003 and 2011, and the secondary study was conducted between 2015 and 2021. Patients were invited by a blinded assessor to return to complete the Western Ontario Rotator Cuff (WORC) index and a questionnaire about reoperation and to undergo a clinical assessment. If participants were unable to return, they were asked to complete the questionnaires by mail. A chart review on all participants in the original study was conducted.

Results: Eighty-six patients were randomized in the original trial, with 31 of 45 from the group without acromioplasty and 25 of 41 from the acromioplasty group returning for long-term follow-up. The mean duration (and standard deviation) of follow-up was 11.2 ± 2.4 years for the group without acromioplasty and 11.5 ± 2.6 years for the acromioplasty group. There was no significant difference in WORC scores between the groups with and without acromioplasty at the time of the long-term follow-up ($p = 0.30$). Seven (16%) of the 45 patients in the group without acromioplasty underwent reoperation. One (2%) of the initial 41 patients allocated to acromioplasty underwent reoperation. All patients who underwent a reoperation had a Type-2 or 3 acromion.

Conclusions: Patients who underwent rotator cuff repair with or without acromioplasty experienced improvement of outcomes from their preoperative level at a long-term follow-up (mean, 11 years), and there were no differences in patient-reported outcomes, specifically WORC scores, between these groups. However, a significantly higher reoperation rate was observed in patients who had rotator cuff repair without acromioplasty, specifically in those with a Type-2 or 3 acromion.

Level of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Shoulder pain due to rotator cuff pathology affects approximately 22% of the general population[1-3]. Disability associated with rotator cuff pathology can impose a substantial impact on patients' daily functioning and work as well as considerable socioeconomic impacts to the health-care system[4-6]. When conservative measures fail to improve pain and function, patients often elect to undergo surgical repair of the rotator cuff. A definitive etiology of rotator cuff tendinopathy remains unclear, with both intrinsic and extrinsic theories being proposed[7]. Some studies have suggested that the aging process and intrinsic pathological tendon degeneration due to eccentric overload play a role in rotator cuff disease. According to this perspective, performing

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subacromial decompression does not address this degenerative process, and thus, performing acromioplasty is not beneficial[8,9].

In contrast, the extrinsic theory of rotator cuff pathology proposes that factors causing mechanical compression (subacromial or acromioclavicular joint spurs, a hooked acromion, or a thickened coracoacromial ligament) on the bursal side of rotator cuff tendons lead to their dysfunction and eventual tearing[10].

Subacromial decompression, described as bursectomy, coracoacromial ligament release, and acromioplasty, is believed to eliminate the extrinsic mechanical impingement on rotator cuff tendons. Some studies have shown good outcomes after performing acromioplasty alone, and others failed to show any additional benefit of performing acromioplasty[11-14]. Thus, the role of concomitant acromioplasty at the time of the rotator cuff repair remains controversial. Five systematic reviews and/or meta-analyses have been published on this topic over the past decade, and all concluded that no clinically important differences exist between rotator cuff repair with or without acromioplasty with respect to patient-reported outcomes, function, and further surgical procedures[15-19]. Our previous published study supports these findings, as there was no significant difference in functional outcomes between patients who underwent rotator cuff repair with or without acromioplasty[20]. However, a higher rate of reoperation was reported among the group without acromioplasty at 2 years postoperatively compared with those who underwent acromioplasty.

The aim of this study was to reevaluate these same patients to determine the long-term efficacy of acromioplasty in cases of full-thickness rotator cuff tears. The null hypothesis was that arthroscopic repair of full-thickness rotator cuff tears with arthroscopic acromioplasty would result in similar patient-reported outcomes compared with arthroscopic rotator cuff repair without acromioplasty at a long-term (>8 years) follow-up. A secondary hypothesis was that there would be more reoperations in those who did not undergo an acromioplasty at the time of the primary rotator cuff repair.

Materials and Methods

This is a secondary study based on a previous, multicenter, double-blinded, randomized trial with patients allocated to arthroscopic rotator cuff repair with or without acromioplasty. The initial trial was registered at ClinicalTrials.gov (NCT00290888), and the methodology was described in an earlier article[20]. The original study recruitment was conducted between June 2003 and February 2009, with 24-month follow-ups taking place between 2005 and 2011. Two fellowship-trained upper-extremity surgeons from 2 sites performed all surgical procedures. This secondary study was conducted between April 2015 and March 2021, with all patients randomized in the main study comprising the sample. Additional exclusion criteria were inability or unwillingness to provide informed consent.

Patients from the original study were invited by a blinded assessor (physical or athletic therapist) to return for a follow-up visit that included recording any history of repeat operations or complications, completion of the Western Ontario Rotator Cuff (WORC) index, and a clinical assessment with range of motion and isometric strength measurement using a hand-held dynamometer. If participants were unable to return for a clinical evaluation, they were asked to complete the WORC index by mail and asked whether they had undergone a reoperation on the involved shoulder at any point since the index procedure. As part of the standard of care, the determination to undertake a reoperation was based on clinic follow-up with a surgeon. If a surgical procedure was deemed potentially beneficial, it was standard practice at that time for a radiograph to be made to evaluate arthritic progression or for a magnetic resonance imaging (MRI) scan to be conducted to identify rotator cuff retear. However, these images were not consistently available across all patients who responded in the current study due to geography, changes in health-care provider, and/or access to medical records not held at the site of the index surgical procedure. The indications for a reoperation were recorded as part of the clinical visits if conducted at the same site as the index surgical procedure. Follow-ups were not standardized, and decision-making was based on surgeon acumen, with rotator cuff revision being undertaken if the rotator cuff was retorn, reverse total shoulder arthroplasty (TSA) if the rotator cuff was retorn with progression to rotator cuff arthropathy, and acromioplasty in those who had not yet undergone the procedure in an attempt to manage pain. Only patients with clinical symptoms were evaluated by radiographs, ultrasound, and/or MRI to evaluate the integrity of the rotator cuff as part of ongoing clinical care. No imaging was undertaken as part of the study. The rate of reoperation was based on those who had a reoperation or were recommended to undergo a reoperation since the time of the index surgical procedure.

The WORC index is a previously validated disease-specific tool consisting of 21 questions with the score converted to a percentage resulting in a maximum possible positive score of 100%[21]. Descriptive statistics are presented for all variables based on those who returned for long-term follow-up visit. A comparison of reoperation rate was conducted between groups using the Fisher exact test; a 1-tailed p value of <0.05 was considered significant. An exploratory descriptive comparison of patients who underwent a reoperation and those who did not is provided, including age, initial tear size, years from the initial surgical procedure to the first reoperation, and mean (and standard deviation) WORC scores preoperatively and at the long-term follow-up.

Source of Funding

There was no external funding source for this study.

Results

Eighty-six patients were randomized in the original trial (Fig. 1). Fifty-six patients (65%) completed the long-term follow-up: 31 of 45 patients from the group without acromioplasty and 25 of 41 patients from the acromioplasty group. Demographic variables were comparable between groups (Table I). There was no significant difference in the WORC

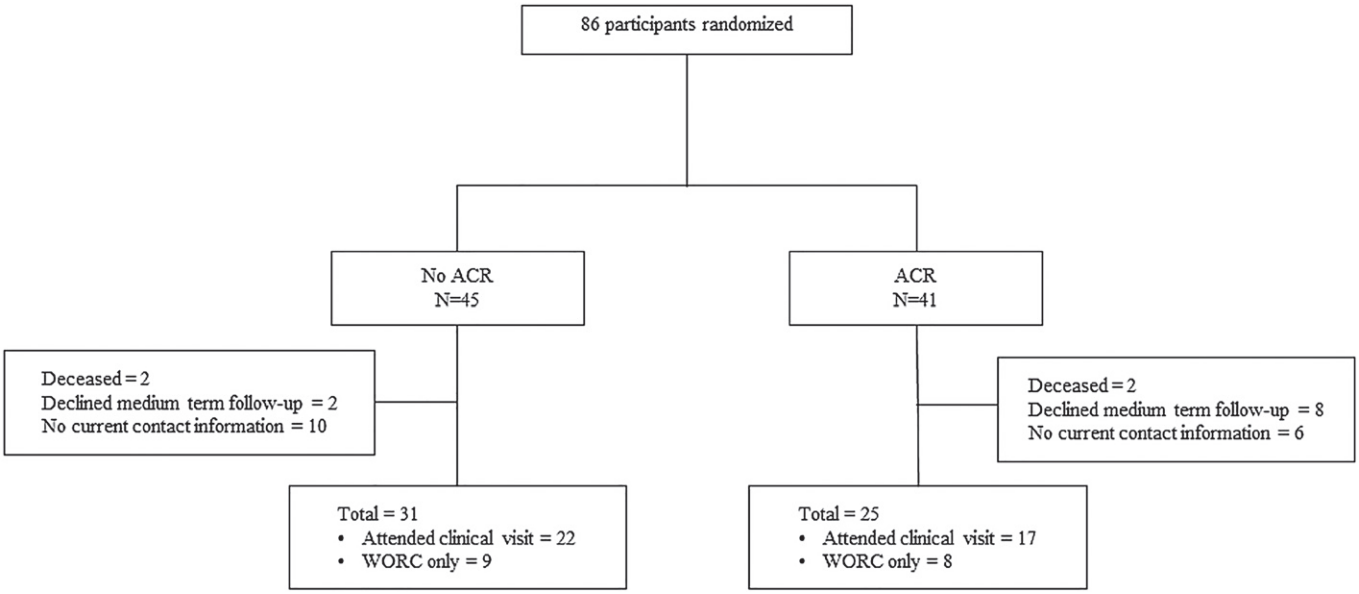

Fig. 1
Patient flowchart for the study. ACR = acromioplasty.

scores between the groups with and without acromioplasty at the time of long-term follow-up ($p = 0.30$) (Table II). Significant improvement in the WORC score from the preoperative values was maintained in both groups ($p < 0.001$). There were no differences in the range of motion between groups (Table III).

At the long-term follow-up, 7 (16%) of the 45 patients originally allocated to the group without acromioplasty underwent or were recommended to undergo a reoperation (Table IV). This included 4 patients from the original study who had a reoperation within 24 months postoperatively. With regard to the group without acromioplasty, 5 (56%) of 9 patients with a Type-3 acromion and 2 (11%) of 19 patients with a Type-2 acromion underwent a reoperation. None of the 4 patients with a Type-3 acromion in the acromioplasty group underwent a reoperation, and 1 (6%) of 16 patients with a Type-2 acromion underwent a reoperation. The difference in reoperation rate was significant ($p = 0.029$) between groups. Not all reoperations were performed by the surgeon who performed the initial procedure or were performed at the same center. The mean initial patient age was 59.1 years for patients who underwent a reoperation compared with 56.8 years for patients who did not. The mean initial tear size for patients who underwent a reoperation was the same as those who did not, 2.3 cm (1 initial tear size in a patient who underwent a reoperation was not available in the original study records). Patients in the group without acromioplasty who underwent a reoperation had a mean preoperative WORC score of 38.1% ± 14.0% compared with 29.5% in the 1 patient in the acromioplasty group. For

TABLE I Demographic Characteristics by Group of Patients Who Returned for Long-Term Follow-up

Characteristic	Group without Acromioplasty	Acromioplasty Group
Time since index surgery* *(yr)*	11.2 ± 2.4	11.5 ± 2.6
Age at time of surgery* *(yr)*	58.5 ± 8.4	56.2 ± 7.8
Age at time of long-term follow-up* *(yr)*	69.0 ± 9.3	67.6 ± 7.7
Sex†		
Male	19	16
Female	12	9
Acromion type‡		
1	3 (10%)	5 (20%)
2	19 (61%)	16 (64%)
3	9 (29%)	4 (16%)

*The values are given as the mean and the standard deviation. †The values are given as the number of patients. ‡The values are given as the number of patients, with the percentage in parentheses.

TABLE II WORC Scores by Study Group and Time Point for the Entire Group (Original Study) and Those Patients Who Participated in the Long-Term Follow-up*

Time Point	Group without Acromioplasty†		Acromioplasty Group†		P Value	
	Long-Term Cohort (N = 31)	Entire Group (N = 45)	Long-Term Cohort (N = 25)	Entire Group (N = 41)	Long-Term Cohort	Entire Group
Preoperative	33.1 ± 17.6	36.8 ± 21.1	38.6 ± 21.2	34.5 ± 15.7	0.307	0.583
24 months	83.4 ± 19.7	87.5 ± 15.3	89.6 ± 13.6	80.7 ± 21.3	0.233	0.135
Long-term	76.1 ± 24.2	NA	82.2 ± 19.2	NA	0.304	NA

*NA = not applicable. †The values are given as the mean and the standard deviation.

the patients who did not undergo a reoperation, the preoperative score was 32.1% ± 18.4% for the group without acromioplasty and 39.0% ± 21.6% for the acromioplasty group. At the long-term follow-up, the mean WORC scores for patients who had a reoperation were 59.3% ± 23.3% in the group without acromioplasty and 71.0% in the 1 patient in the acromioplasty group. In comparison, the scores for patients who did not undergo a reoperation were 79.3% ± 23.5% in the group without acromioplasty and 82.7% ± 19.4% in the acromioplasty group.

Discussion

The key finding of this study is that patients who did not undergo acromioplasty had more reoperations than those with acromioplasty. There was no difference in patient-reported outcome, as measured using the WORC score, between groups, thus supporting the null hypothesis. However, this outcome was based on 7 participants in the group without acromioplasty undergoing a reoperation, ranging from arthroscopy and acromioplasty to reverse TSA, and only 1 patient of those who had acromioplasty as part of the index surgical procedure required a reoperation. Furthermore, reoperations were performed exclusively in patients with a Type-2 or 3 acromion. In both study groups, current patient-reported outcomes were comparable with outcomes at 24 months postoperatively and were significantly improved from preoperative status.

During the past 30 years, the incidence of arthroscopic acromioplasty has dramatically increased[22]. However, the long-term efficacy of acromioplasty is not well understood. To date, only 1 randomized trial has evaluated the long-term efficacy of acromioplasty in patients with full-thickness rotator cuff tear[23]. Waterman et al. found no difference in patient-reported outcomes between those who underwent rotator cuff repair with or without acromioplasty at 7.5 years postoperatively, which is consistent with the present study[23]. However, no differences in the rates of retear and reoperation were found, which diverge from the current findings. This may be attributable to their small number of patients with a Type-3 acromion and the consequent underpowered analysis to verify the therapeutic benefit of acromioplasty in cases of impingement.

Acromioplasty combined with rotator cuff repair has been extensively evaluated at a short-term (2-year) follow-up, raising concerns over its efficacy[11,20,24]. In a prospective study evaluating small to medium-sized rotator cuff tears, Shin et al. found no significant differences between groups with or without acromioplasty in pain, functional outcomes, or retear rates[24]. Similarly, Abrams et al. performed a randomized controlled trial of patients with a full-thickness rotator cuff tear with or without acromioplasty and found no significant differences between groups with regard to pain and functional outcomes[11]. Interestingly, the rate of reoperation was significantly higher in patients who did not undergo a concomitant acromioplasty, which is consistent with our original randomized controlled trial findings[20].

TABLE III Range of Motion for the Study and Contralateral Shoulders by Study Group at the Long-Term Follow-up

	Group without Acromioplasty*		Acromioplasty Group*		
	Non-Study	Study	Non-Study	Study	P Value†
Forward flexion *(deg)*	163 ± 27	152 ± 31	164 ± 22	165 ± 19	0.16
Abduction *(deg)*	161 ± 31	148 ± 39	165 ± 25	164 ± 23	0.16
External rotation in abduction *(deg)*	71 ± 22	64 ± 24	78 ± 14	76 ± 13	0.10
Internal rotation in abduction *(deg)*	48 ± 25	52 ± 21	58 ± 22	54 ± 20	0.77

*The values are given as the mean and the standard deviation. †The p values represent the difference in range of motion of the study shoulders between the group without acromioplasty and the group with acromioplasty.

TABLE IV Patients Who Underwent Reoperation Following the Initial Study Group Procedure*

Group	Age at Initial Surgery *(yr)*	Sex	Acromion Type	Indications for Surgery	Reoperation(s) Performed†	WORC Score		
						Preoperative	24 Months	Long-Term
Group without acromioplasty	77‡	M	3	Pain, decreased strength	Scope and acromioplasty (1)	30.9%	69.8%	47.1%
	67‡	M	3	Pain, decreased range of motion	Scope and acromioplasty (1)	30.1%	50.8%	NA
	43‡	M	3	Pain, decreased strength	Rotator cuff repair revision and acromioplasty recommended but declined (<2)	31.3%	13.5%	NA
	44	M	2	Pain, decreased range of motion, progression to rotator cuff tendinopathy	Revision rotator cuff repair (7); reverse TSA (14)	23.8%	75.2%	90.7%
	73‡	F	2	Pain, decreased strength	Revision rotator cuff repair (1)	45.3%	56.4%	43.9%
	63	M	3	Progression to rotator cuff tendinopathy	Reverse TSA (10)	31.6%	92.7%	37.6%
	56	M	3	Pain, decreased strength	Revision rotator cuff repair, acromioplasty, debridement (9)	58.8%	85.5%	77.3%
Mean of group without acromioplasty§	60.4					38.1% ± 14.0%	73.5% ± 15.0%	59.3% ± 23.3%
Acromioplasty group	50	M	2	No details available	Revision rotator cuff repair (14)	29.5%	67.0%	71.0%

*NA = not applicable. †The values in parentheses are given as the number of years since the initial surgical procedure was performed. ‡Reported in the initial publication. §The values are given as the mean and the standard deviation.

Earlier evidence of the importance of acromial morphology for rotator cuff tears was demonstrated by Bigliani et al. in 1986, who classified acromia into Type 1 (flat), Type 2 (curved), and Type 3 (hooked), according to their shapes on a sagittal view[25]. A Type-3 or hooked acromion has been found to be associated with rotator cuff tearing in many studies[26-28]. Interestingly, Henkus et al. compared patients who underwent bursectomy alone with patients who underwent bursectomy and decompression for primary impingement without a rotator cuff tear[29]. A Type-3 acromion had a negative impact on the Constant score, Simple Shoulder Test score, and visual analog scale (VAS) score for pain when compared with a Type-1 acromion. The inability to identify a definitive association between acromion type and rotator cuff tearing in previous similar studies could be related to the limited number of patients with a Type-1 or 3 acromion. Thus, analyses within and between these subgroups were likely underpowered. The current study may suggest support for the extrinsic theory because 7 patients (16%) with rotator cuff repair without acromioplasty required a reoperation. All patients who underwent a reoperation in the group without acromioplasty had a Type-2 acromion (2 of 7) or Type-3 acromion (5 of 7), and no patients with a Type-1 acromion underwent a reoperation in either cohort. This is in the context that the distribution of acromion types did not change between the original study and the long-term follow-up. In the original study, the distribution of acromion type was 14% for Type 1, 57% for Type 2, and 29% for Type 3 in the group without acromioplasty and 15% for Type 1, 65% for Type 2, and 20% for Type 3 in the acromioplasty group. For the long-term study, the distribution was 10% for Type 1, 61% for Type 2, and 29% for Type 3 for the group without acromioplasty and 20% for Type 1, 64% for Type 2, and 16% for Type 3 for the acromioplasty group. Furthermore, age, initial tear size, and preoperative WORC scores were comparable between patients who did and did not have reoperations. At 24 months postoperatively and at long-term follow-up, patients who had reoperations demonstrated clinically lower WORC scores than those who did not. This is difficult to interpret because patients were at different points in time relative to the reoperation, which may have influenced their scores. Performing an acromioplasty may have provided a protective effect on the rotator cuff repair in patients with an amorphous acromion (Type 2 or 3), and this effect may have been cumulative, with increasing failures over time from the index surgical procedure. This finding is speculative, as statistical comparisons could not be made because of the small number of patients who underwent a reoperation.

The current study had several limitations. Only 56 patients (65%) from the original cohort of 86 patients were available for the final follow-up evaluation. However, this proportion of

patients was consistent with other studies with similar follow-up duration from the index surgical procedure. It was likely that there were reoperations in the original study group that were not captured in this study; therefore, these rates may be an underestimation in either group. In addition, given the number of patients in the current study and the limited event rate, there was the potential for the study to be underpowered for secondary effects and interactions as a result. Thus, the study was not definitive or prescriptive in nature, but provided a basis for future hypothesis generation. This was also the case with respect to the exploratory analyses, which were conducted to provide a description of those who underwent reoperation and those who did not. No statistical comparisons were carried out because of the limited number of participants and the risk of finding a result that was significant only due to chance. Second, not all patients underwent postoperative physical examination because some surveys were conducted by mail or telephone due to patient availability (e.g., they no longer lived in the vicinity). Third, postoperative evaluation leading to reoperation was not standardized between surgeons, which could have been a source of bias. However, decision-making with regard to reoperations spanned several years following randomization, and the 2 contributing surgeons were unaware of the outcomes of patients who did not undergo a surgical procedure at their site or saw a different surgeon for a reoperation; therefore, bias was likely minimal. Lastly, postoperative imaging for purposes of this study was not feasible because of cost and patient availability. As a result, it is unknown how many patients underwent failed rotator cuff repairs or had retears at the final follow-up and how many remained intact.

In conclusion, patients who underwent rotator cuff repair with or without acromioplasty experienced improved outcomes from their preoperative level at a long-term follow-up (mean, 11 years), and there were no differences in patient-reported outcomes, specifically WORC scores, between these groups. However, a significantly higher reoperation rate was observed in patients who had rotator cuff repair without acromioplasty, specifically in those with a Type-2 or 3 acromion. ■

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