

# Long-term Outcomes of Arthroscopic Acromioplasty for Chronic Shoulder Impingement Syndrome: A Prospective Cohort Study With a Minimum of 12 Years' Follow-up

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**Purpose:** The purpose of this study was to evaluate long-term outcomes of arthroscopic acromioplasty for shoulder impingement syndrome. **Methods:** This was a prospective cohort study of 31 shoulders (24 men) that underwent arthroscopic acromioplasty for shoulder impingement syndrome during 1992 and 1993. The mean age at surgery was 49 years (range, 33 to 68 years). A group of 29 shoulders (22 men) operated on consecutively with open acromioplasty from 1985 through 1991 served as controls. The patients were evaluated with the University of California, Los Angeles (UCLA) score (range, 0 to 35 points) at baseline and at 2 follow-up times performed at a mean of 1 and 13 years after surgery, respectively. At the second follow-up, the Disabilities of the Arm, Shoulder and Hand score, the Short Form-36 bodily pain score, and the EQ-5D health utility index also were obtained. **Results:** After arthroscopic acromioplasty, the mean improvement in UCLA score from baseline to long-term follow-up was 13 points (95% confidence interval, 11 to 15 points), and the scores indicated an excellent or good result in 77% of shoulders. The mean UCLA score was 32 points (SD, 5 points) for the patients treated with arthroscopic acromioplasty and 28 points (SD, 8 points) for those treated with open acromioplasty; the mean difference was 4.3 points (95% confidence interval, 0.4 to 8.2 points;  $P = .03$ ). In a mixed-model analysis adjusting for age, sex, duration of symptoms, preoperative UCLA score, dominance of operated side, rotator cuff status at surgery, and time since surgery, the rate of change from baseline in UCLA score over time was significantly better after arthroscopic surgery than after open surgery. **Conclusions:** Good results of arthroscopic acromioplasty were maintained at 12 to 14 years after surgery with excellent or good results shown in 77% of shoulders, and the long-term outcomes were superior to those after open acromioplasty. **Level of Evidence:** Level III, therapeutic case-control study. **Key Words:** Acromioplasty—Shoulder impingement—Arthroscopic subacromial decompression—Long-term outcomes—UCLA score.

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Arthroscopic acromioplasty is an effective treatment for shoulder impingement syndrome.<sup>1,2</sup> It yields similar short-term and midterm results as compared with open acromioplasty.<sup>1,2</sup> The advantages of arthroscopic acromioplasty include the ability to thoroughly examine the shoulder joint (whereas the open procedure does not allow evaluation of the glenohumeral joint), better cosmetic appearance, preservation of the deltoid muscle origin, and faster postoperative rehabilitation.<sup>3</sup> Although most prospective studies comparing arthroscopic and open acromioplasty have reported similar results for the 2 methods,<sup>4,5</sup> 1 study reported shorter operating time and faster rehabilitation and return to work after arthroscopic surgery.<sup>3</sup> However, most previous studies have reported short-

TABLE 1. Outcome Measures

Measure	Type	No. of Items	Components/Domains	Item Levels	Best/Worst Final Score
UCLA shoulder scale	Shoulder-specific composite score	5	Shoulder pain	6	35*/0
			Arm function	6	
			Range active forward flexion	6	
			Strength active forward flexion	6	
			Patient satisfaction	2	
DASH	Arm-related disability scale	30	Severity of activity limitations, symptoms	5	0/100
SF-36 pain	Pain scale	2	Pain severity	5	100/0
EQ-5D	General health, quality of life, utility measure	5	Pain interference with activities	6	1.0/−0.11
			Mobility, usual activities, pain/discomfort, self-care, anxiety/depression	3	

\*Maximum of 10 points for each of the first 2 components and 5 points for the last 3 components.

term or midterm results, with follow-up times of up to 5 years, and only a few studies had longer follow-up times.<sup>2,6-10</sup> The purpose of this study was to report the long-term results of arthroscopic acromioplasty compared with open acromioplasty. The hypothesis was that arthroscopic acromioplasty yielded similar long-term outcomes to open acromioplasty.

## METHODS

### Study Design

A prospective cohort study was designed to assess the outcomes of arthroscopic acromioplasty in patients with shoulder impingement syndrome by use of the University of California, Los Angeles (UCLA) shoulder rating scale<sup>11</sup> (Table 1) as the primary outcome measure. The inclusion criteria were a clinical diag-

nosis of shoulder impingement syndrome diagnosed based on positive Neer and Hawkins impingement signs<sup>12,13</sup> and a positive impingement test,<sup>12,14</sup> shoulder pain at least with heavy activities, and a lack of improvement after at least 6 months of nonoperative treatment (physical therapy, anti-inflammatory medication, and subacromial steroid injection).

The study included all patients with shoulder impingement syndrome treated with arthroscopic acromioplasty from February 5, 1992, through November 16, 1993, at a single orthopaedic department. Arthroscopic acromioplasty was performed in 31 shoulders of 27 patients (Table 2). For comparison, 29 shoulders in 24 consecutive patients who had been operated on with open acromioplasty at the same department up to 1991 served as controls. Patient characteristics were similar to those for the study population except for the

TABLE 2. Patient Characteristics

	Arthroscopic	Open	P Value
No. of patients (shoulders) at baseline and first follow-up	27 (31)	24 (29)	
No. of patients (shoulders) at final follow-up*	23 (26)	23 (28)	
Sex (male/female)	24:7	22:7	.88
Age at surgery [mean (range)] (yr)	51 (36-65)	47 (33-68)	.09
Symptom duration [mean (range)] (mo)	51 (8-204)	45 (8-168)	.51
Side			
Dominant only	17	14	
Nondominant only	6	5	.86
Both	4	5	
Working before surgery	25	27	.26
UCLA score at baseline [mean (SD)]	17.4 (2.5)	16.9 (3.1)	.50
Operative time [mean (SD)]	45 (10)	57 (21)	<.01
Duration of first follow-up [mean (range)] (mo)	13 (2-20)	44 (6-90)	<.01
Duration of second follow-up [mean (range)] (mo)	157 (144-165)	197 (154-239)	<.01

\*Four patients (one bilateral surgery) in the arthroscopy group had died, and one patient could not be traced.

longer follow-up time (Table 2). Similar diagnostic criteria and indications for surgery had been used, and the preoperative treatment used in both groups was similar. No patient had a history of shoulder trauma, and no patient was involved in Workers' Compensation or medical legal claims. Radiographs were obtained preoperatively in all patients to rule out osteoarthritis of the glenohumeral joint. Magnetic resonance imaging was not performed in any patient (according to standard management at the time the study was started). The patients were operated on consecutively, and no patients were excluded from the study.

The first follow-up was performed from June 2, 1993, through December 7, 1993. In 2005 the decision was made to conduct a second follow-up evaluation to assess the long-term outcomes with the addition of the Disabilities of the Arm, Shoulder and Hand (DASH) score,<sup>15,16</sup> the Short Form (SF)-36 bodily pain score,<sup>17</sup> and the EQ-5D health utility index<sup>18</sup> (Table 1). The second follow-up was performed from March 30, 2005, through April 11, 2006, with an observation time of 12 to 14 years.

The study was conducted in accordance with the local ethical guidelines for clinical studies, and informed consent was obtained from the patients in 1991.

### Surgical Procedures

Three experienced surgeons performed arthroscopic acromioplasty as described by Ellman.<sup>2</sup> The surgeons had learned the technique through participating in workshops and visits to a clinic to study arthroscopic shoulder surgery. Surgery was done with the patient under general anesthesia in the lateral decubitus position and the arm in traction. No additional procedures were done, and no shoulder was converted to open acromioplasty. The operative time ranged from 27 to 69 minutes. After arthroscopic acromioplasty, active flexion was begun on the first postoperative day. Light load on the arm was started 6 weeks after surgery and was gradually increased up to 3 months postoperatively.

In the control group open anterior acromioplasty (according to Neer et al.<sup>1,14</sup>) was performed by 2 of the same surgeons and 2 other surgeons. In 1 patient the procedure was combined with a distal clavicle excision, and in 1 patient lateral clavicle excision had been done 9 months before open acromioplasty. One patient had a short full-thickness cuff tear, which was repaired. The operative time ranged from 32 to 145 minutes. After open acromioplasty, passive motion

exercises were begun on the first postoperative day and active flexion on the third postoperative day. Light load was started 6 weeks after surgery, gradually increasing up to 3 months.

### Evaluations and Outcome Measures

At the baseline and 2 follow-up evaluations (Table 2), a physical examination was performed and the UCLA shoulder score<sup>11</sup> was recorded. The evaluations were done by the same experienced orthopaedic surgeon, who was not blinded to the surgical procedure. At the second follow-up, the patients also completed the DASH questionnaire, the SF-36 bodily pain scale, and the EQ-5D health utility measure. These measures were not administered before surgery because they did not exist at the start of the study. Radiographic evaluation was not performed at follow-up.

### Statistical Analysis

The mean baseline and follow-up UCLA scores were calculated, and the mean differences (and 95% confidence intervals) were computed and tested with the paired-samples *t* test. The long-term follow-up scores after arthroscopic acromioplasty were compared with those recorded after open surgery by use of the independent-samples *t* test. These analyses were performed based on patients rather than shoulders because shoulders of bilaterally operated patients cannot be considered as independent. In our analysis of the change from baseline in UCLA scores, a linear mixed-effects model was used. All shoulders were included in this analysis because the mixed model allows for consideration of the within-subject correlation of data from bilaterally operated patients. Because there are a number of effects to consider in relation to the UCLA score, a model was developed containing several covariates believed to influence the UCLA score. Covariates included elapsed time since surgery along with a covariate indicating interaction between elapsed time and type of surgery. The random intercept and slope terms were also incorporated to account for correlations among repeated observations in a given subject due to unmeasured factors. The model parameters were estimated by use of the linear mixed effects procedure in the R statistical program (R Foundation for Statistical Computing, Vienna, Austria).

The mean values for the DASH score, the SF-36 bodily pain score, and the EQ-5D index at the long-term follow-up were computed and compared in a similar way as described for the long-term UCLA

**TABLE 3.** Long-term Results of Acromioplasty

Outcome Measure	Mean (SD)		Difference (95% CI)	P Value
	Arthroscopic (n = 23)	Open (n = 23)		
UCLA	32.1 (5)	27.8 (8)	4.3 (0.4 to 8.2)	.03
DASH	24 (22)	29 (22)	-5 (-18 to 8)	.44
SF-36 pain	59 (30)	52 (31)	7 (-12 to 25)	.47
EQ-5D	0.82 (0.2)	0.75 (0.2)	0.08 (-0.04 to 0.19)	.20

NOTE. For the UCLA score in bilaterally operated patients, the results for the dominant side only are included; the other measures are not side specific.  
Abbreviation: CI, confidence interval.

score. A multiple linear regression analysis with the DASH score for all patients as the dependent variable and age, sex, unilateral or bilateral surgery, dominance of surgery side, time since surgery (months), and type of surgery as independent variables.

All statistical tests were 2-sided, and  $P < .05$  was considered to indicate statistical significance.

## RESULTS

### Arthroscopic Findings

In 7 shoulders superficial fraying of the cuff was found, and in 1 shoulder, deeper fraying and partial rupture at the undersurface of the cuff were observed. No full-thickness cuff rupture was found. In the glenohumeral joint, superficial fibrillation of the glenoid cartilage was found in 1 shoulder and slight synovitis was observed in 4. No labral pathology was found.

### Reoperations and Complications

In the arthroscopic acromioplasty group, revision acromioplasty was done arthroscopically in 6 shoulders after 6 months, 7 months, 2 years, 3 years, 5 years, and 6 years, respectively. No surgical complications occurred. In the open acromioplasty group, revision acromioplasty was done arthroscopically in 3 shoulders after 6 months, 1 year, and 2 years, respectively, and in an open manner in another shoulder after 3 years, followed by revision acromioplasty performed arthroscopically 5 years after the primary acromioplasty. One patient had long-lasting postoperative scar pain.

### UCLA Shoulder Score

The mean UCLA score improved significantly from baseline to the short-term follow-up, and the improvement was maintained at the long-term follow-up eval-

uation. After arthroscopic acromioplasty, the mean UCLA score at the short-term follow-up was 29 points (SD, 6 points). The mean difference (improvement) from baseline was 17 points (95% confidence interval, 11 to 15 points;  $P < .001$ ). At the long-term follow-up, the patients in the arthroscopic acromioplasty group had a significantly better mean UCLA score than those in the open acromioplasty group (Table 3). Excluding the patients who had undergone revision acromioplasty yielded similar results, with a mean UCLA score of 33.2 points (SD, 4 points) in the arthroscopic group and 28.5 points (SD, 7 points) in the open group ( $P = .02$ ).

In the linear mixed-model analysis, significant effects were detected only for the interaction term of type of operation and elapsed time since surgery, implying a significant difference in the rate of change in UCLA score since baseline between patients in the arthroscopic and open surgery groups. The rate of change for the arthroscopic patients was better than that for the open group by 0.02 UCLA points per month (Table 4). The result is based on the assumption that the rate of change in UCLA score from baseline is constant.

At the long-term follow-up, UCLA scores classified as excellent or good result were recorded in 20 (77%) of the 26 shoulders that had been treated with arthroscopic acromioplasty. The final UCLA score did not differ significantly between the 23 shoulders with no cuff pathology and the 7 shoulders with superficial fraying on the rotator cuff (the score for the remaining shoulder that was reported as having a partial tear was 23 points).

### Shoulder Pain

At the long-term follow-up, no pain was reported in 14 shoulders, occasional slight pain in 5, pain during

**TABLE 4.** *Adjusted Effects of a Number of Factors on Change in UCLA Shoulder Score From Baseline Through Short-term to Long-term Follow-up (Data From 60 Shoulders)*

Factor	UCLA Score Change	
	Estimate*	95% CI
Age at surgery (yr)	0.09	-0.10 to 0.29
Sex (male)	-0.05	-3.80 to 3.70
Duration of symptoms (mo)	-0.03	-0.08 to 0.01
Preoperative UCLA score†	0.29	-0.25 to 0.83
Side of surgery (dominant)	-0.85	-3.24 to 1.54
Cuff status at surgery (cuff tear)	1.68	-2.61 to 5.96
Type of surgery (arthroscopic)	0.26	-3.57 to 4.08
Time since surgery (mo)	-0.01	-0.02 to 0.01
Type of surgery and time since surgery‡	0.02	0.001 to 0.05§

Abbreviation: CI, confidence interval.

\*For continuous variables, the mean change in the UCLA score per unit is shown; for binary variables, the mean difference in the change in UCLA score between the category within parentheses and the referent category is shown.

†Preoperative UCLA score (range, 0 [worst] to 35 [best]).

‡Interaction term for type of surgery and time since surgery.

§ $P = .04$ .

heavy activities only in 3, and pain during light activities in 4.

### Shoulder Muscle Strength

At the long-term follow-up, the strength of the rotator cuff muscles was judged to be normal in 25 of 26 shoulders.

### Patient-Reported Outcomes Measures

The median DASH score for the arthroscopic group was 17 points (range, 0 to 81 points) compared with 28 points (range, 9 to 81 points) for the open group. The mean DASH score, SF-36 bodily pain score, and EQ-5D index were better for the arthroscopic group than the open group, by 5 points, 7 points, and 0.07 point, respectively, but the differences did not reach statistical significance (Table 3). Among all patients, moderate correlations were found between the DASH score and the UCLA score ( $r = 0.59$ ), and in the multivariate analysis, the mean DASH score was significantly worse among women than among men ( $P = .008$ ).

## DISCUSSION

This prospective cohort study of arthroscopic acromioplasty for shoulder impingement syndrome

showed that good short-term results are maintained after a minimum of 12 years and that arthroscopic acromioplasty appears to yield better long-term results than open acromioplasty. Acromioplasty is still the treatment of choice for shoulders with chronic impingement syndrome that failed nonoperative treatment, and although there may not be adequate data to support arthroscopic treatment as standard, the arthroscopic procedure is now the dominating method.<sup>19</sup> However, in previous studies comparing open and arthroscopic acromioplasty, no differences in the results could be detected as early as 3 months after surgery.<sup>4</sup>

In a systematic review of 4 prospective randomized studies comparing open and arthroscopic acromioplasty at a mean follow-up time of up to 2 years in 3 of the studies and a maximum follow-up of 8 years in the remaining study that included 34 shoulders,<sup>20</sup> the authors concluded that there were no clinically significant differences in the outcomes concerning pain relief, UCLA shoulder score, range of motion, or strength. One of the studies was a randomized controlled trial of 62 patients (32 arthroscopic and 30 open) blindly assessed at a mean of 2 years (range, 1 to 4 years) after surgery, showing slightly better improvement in visual analog scores for pain and function in the open group (1.4 on a 10-point scale) but no differences in UCLA score or patient satisfaction.<sup>5</sup> The study, however, had a 28% dropout and postrandomization exclusion rate.

In our study, arthroscopic surgery was associated with a significantly better UCLA score at follow-up beyond 10 years postoperatively. In the mixed-model analysis of the UCLA score change over time, with adjustment for the effects of a number of factors, arthroscopic surgery was associated with a significantly better rate of change from baseline than open surgery. This analysis assumed a constant rate of change from baseline in UCLA score over time, which might not be applicable to the change from baseline to the short-term follow-up<sup>21</sup> but would be a reasonable assumption regarding the change from the short-term to the long-term follow-up, which is of primary interest.

Most previous studies have reported results with a follow-up time ranging from 1 to 5 years and a proportion of good and excellent results ranging from 64% to 89% based on the UCLA, Constant, or American Shoulder and Elbow Surgeons scores; a 4-category pain scale; or a visual analog scale.<sup>2,3,5-7,22</sup> In our study good or excellent results, based on the UCLA score, were recorded in 77% of shoulders at a mean of

13 years postoperatively, without deterioration from the 1-year follow-up to the 13-year follow-up. Chin et al.<sup>10</sup> reported good long-term results at a mean of 8 and 25 years after open acromioplasty, with 5 of 32 shoulders requiring additional surgery including 1 revision anterior acromioplasty. In our study, 6 shoulders required a second arthroscopic subacromial decompression compared with 4 shoulders in the open acromioplasty group. The reoperations did not influence the results because the analysis excluding these patients yielded similar results.

In a study with a mean follow-up time of 9 years, good and excellent results, based on the Constant score, were reported in 72% of shoulders with an initially intact rotator cuff, but acromioplasty did not prevent subsequent rotator cuff tears.<sup>23</sup> In a recent retrospective study of 33 consecutive patients who had arthroscopic acromioplasty and debridement of partial rotator cuff tears, the mean Constant score for 26 patients at a mean follow-up time of approximately 8 (range, 5 to 11 years) was 65 points for the operated side compared with 84 points for the contralateral side.<sup>24</sup> In our study, 1 patient in the control group who had a small full-thickness cuff rupture achieved an excellent result. In a previous study, the functional result 6 years after arthroscopic subacromial decompression was not obviously related to preoperative cuff status even in the presence of small full-thickness tears.<sup>25</sup>

A recent study that used the DASH score before and 6 months after arthroscopic acromioplasty found an improvement of 10 points or more in 38 of 50 patients (76%) and a median postoperative score of 18 points, but 2 of 19 women and 6 of 31 men showed no improvement.<sup>26</sup> In our study, a median DASH score of 17 points was recorded at the long-term follow-up, indicating some degree of disability in this group of patients. The discrepancy between the UCLA score and the DASH score may suggest that the disability could be related to other arm disorders in some of the patients. The correlation between the UCLA score and the DASH score was moderate.

The UCLA and DASH scales are different types of outcome measures. The arthroscopic group had better scores on the shoulder-specific UCLA scale that incorporated shoulder symptoms, function, motion, and strength, and the differences were statistically significant. Although the arthroscopic group also had better scores on the DASH scale, SF-36 pain scale, and EQ-5D index, the differences did not reach statistical significance, which may suggest inadequate power for these outcome variables (as observed from the 95%

confidence intervals for the differences). The difference in median DASH score was greater than 10 points, which may be clinically important despite statistical nonsignificance.<sup>27</sup> In shoulder disorders, the DASH scale, a regional measure of disability (with few items on symptoms), and the generic health measures would be expected to be somewhat less sensitive than a shoulder-specific score and would thus require larger samples to detect statistically significant differences. The DASH score was significantly worse among women than among men, and although the exact cause of this finding is unclear and not necessarily shoulder related, it is in agreement with previous studies of upper extremity disorders.<sup>28</sup>

Our study has limitations, mainly the nonrandomized comparison with open acromioplasty and the difference in follow-up time. However, the patients in the open group had been treated in the same department with similar indications for surgery and, most importantly, before the introduction of arthroscopic acromioplasty in the department. Furthermore, the difference in follow-up times is relatively small in relation to the length of follow-up, and it was dealt with in the statistical modeling. These factors together with the similarity of the 2 groups with regard to patient characteristics suggest that the risk of possible bias may not be substantial. The strengths of the study include the prospective design, the use of relevant outcome measures, and the long follow-up time.

## CONCLUSIONS

In this longitudinal study, good short-term results of arthroscopic acromioplasty were maintained up to a minimum of 12 years postoperatively with excellent or good results shown in 77% of shoulders. Arthroscopic acromioplasty seems to yield a better outcome over time than open acromioplasty.

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