Rotator cuff repair in a district hospital setting: Outcomes and analysis of prognostic factors

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In a prospective study of 58 complete rotator cuff tears, 54 patients underwent surgery by a single surgeon for chronic, symptomatic, full-thickness rotator cuff defects. An independent observer performed the evaluation. Fifty-two of 58 patients reported marked relief of pain and rated themselves as having mild or no deficit in their ability to perform daily activities. The study evaluated preoperative and intraoperative factors that influenced postoperative outcome. Eighty-three percent of patients had good or excellent results according to the modified Constant scoring system and 76% with the UCLA system. There was no pain or minimal pain in 90%, and 92% reported overall improvement after the surgery. It is concluded that in a patient with a full-thickness rotator cuff tear, pain and shoulder function can be improved by acromioplasty and cuff repair, but a slight decrease in the range of motion and muscle strength will probably remain. (J Shoulder Elbow Surg 2001;10: 236-41.)

INTRODUCTION

Full-thickness rotator cuff tears are a common problem in orthopedic practice, with an estimated prevalence of 5% to 33%.[7,10,16,18] Neer et al[17] have attributed the vast majority of tears (up to 95%) to chronic attritional changes from impingement, with the incidence of tears increasing with age. Although a great deal has been written on the subject, there is still controversy about the indications for surgical repair.[2,12,14,15,22] The goals of open rotator cuff repair are to decrease pain, improve function, and prevent subsequent extension of the defect. Previous studies[3,7,10,11,17] have reported pain relief in 71% to 100% of patients, with functional improvement in 72% to 82%.[5,7,9,19]

The literature related to prognostic factors in rotator cuff repairs is confusing. Younger patients have done better in some reports.[1] Early repair after an injury has been associated with increased strength and decreased pain.[2,5] Small tears have tended to do better.[3,11] Patients with weak abduction and limited movement have done poorly.[7] In most of the above series, however, statistical significance of these relations was not achieved.

The purpose of this prospective study was to look at the results of rotator cuff repair done at a district hospital by a single orthopaedic surgeon and to determine prognostic factors such as age, duration of symptoms, preoperative treatment, size of tear, and quality of the tendon. The study was designed to minimize variability in operative technique or postoperative rehabilitation, and we used standardized assessment criteria and follow-up time to limit their influence on the final outcome.

MATERIALS AND METHODS

This prospective study reviews 60 consecutive patients who were brought to surgery for a full-thickness tear of the rotator cuff. All patients were treated between 1994 and 1997 in Princess Alexandria Hospital, Napier, New Zealand, by one surgeon. An independent observer performed their final assessment in July 1999. Of the 60 initially enrolled, only those 54 patients (58 tears) with a complete full-thickness tear confirmed at operation were included in the study. Five cases were excluded because of inadequate follow-up, and there was one death that was unrelated to surgery.

At the time of repair, the mean age of the patients was 65 years (range, 32 to 82 years). Eight operations were performed on patients between the ages of 32 and 50 years, 25 on patients who were between 50 and 70 years of age, and 21 on patients older than 70 years. There were 34 men and 20 women. The mean duration of pain before surgical intervention was 9 months (range, 3 to 24 months). The dominant arm was affected in 40. In 4 cases, rupture was bilateral.

At the time of surgery, 66% of the patients had night pain, 100% had pain with activities of daily living, and 25% had pain at rest. Thirty-one complained of weakness, and 43% had clicking or grinding. Forty-seven (81%) of the patients had an injury to the shoulder (a fall in 18, exertion such as lifting in 26, a direct blow to the shoulder in 3). Many of these patients reported that they had had mild symptoms in the shoulder before injury. There were no associated fractures in the patients with an injury, but one patient had had a dislocated shoulder.

The impingement sign described by Neer[18] or Hawkins et al[11] was consistently present (Table I). The "drop arm sign"

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Table I Symptoms and signs (58 shoulders)

Preoperative symptoms		Preoperative signs	
Pain			
Rest pain	15	Impingement sign	57
Night pain	38	Drop arm sign	15
Work limitation			
Moderate	57	Active ROM (flexion/abduction/both)	
Severe	7	<60	5
		60-90	8
		90-120	5
		120-150	8
ADL and recreation limited	42	>150	32
Weakness	18	Pain on resisted movement (ER)	58
H/O injury	47	Painful arc	
		60-90	12
		90-120	37
		120-160	5
		Biceps tendon rupture	7

Table II Operation and findings

Type of surgery		Surgical findings	
Acromioplasty (Neer)	58	Size of tear (at insertion)	
Excision of lateral end of clavicle	11	<1 cm	17
		1-3 cm	20
		3-5 cm	8
Repair coraco-acromial ligament	6	>5 cm	13
Mobilization of cuff		Tendons involved	
None	14	SS	41
Mild to moderate	23	SS + SSc	5
Significant	21	SS + IS	5
		All 3 tendons	7
Rotator cuff repair			
Trough	37		
Side to side	19		
Irreparable	2		

SS, Supraspinatus; *SSc,* subscapularis; *IS,* infraspinatus.

was present in only 15 patients. Passive shoulder motion was usually well-maintained, whereas active elevation was less than 90° in 13 patients. All patients had pain on resisted abduction or external rotation. A painful arc was present in the coronal plane between 60° to 120° in 49 patients. In 7, there was clinical evidence of biceps tendon rupture.

Radiologic examination was performed on all patients. The study was normal in 22 (38%) patients, and in the rest more than one of the following findings were present: sclerosis of greater tuberosity, cystic changes, squaring, decreased acromio-humeral space, and osteo-arthritis of the acromioclavicular joint. Preoperative scapular outlet views were not done in any of the patients; therefore the acromial architecture as described by Morrison and Bigliani[16] was not evaluated.

In most cases, diagnosis was confirmed by ultrasound (56 patients), arthrogram (20 patients), or both. In 2 patients, clinical evidence of cuff tear was sufficient, and further imaging was not performed. There were 4 false-negative results with ultrasound and 1 with arthrogram in this series.

Each patient received a minimum of 3 months' nonoperative treatment, which included physical therapy, emphasizing stretching and rotator cuff strengthening exercises, anti-inflammatory medication, selective steroid injection, and avoidance of pain-inducing activities. The primary indication for surgery was relief of pain. Functional improvement of patients was a secondary goal.

A superior incision and a deltoid-splitting approach, with the patient in a beach chair position, was used in all cases. An anterior acromioplasty as described by Neer[18] was always performed, combined with the excision of any bony prominence on the undersurface of the acromioclavicular joint (Table II). Ancillary procedures included distal clavicle excision in 11 patients, biceps tenodesis in 3, and repair of the coracoacromial ligament in 6 cases of massive rupture. The distal end of the clavicle was excised if inferiorly projecting osteophytes, which could contribute to impingement, were found at operation. Repair of the rotator cuff was accomplished by direct (side to side) suture in 19 (32%), and the ends of the torn cuff were sutured to a trough created in the humerus in 37 (64%). The repair was achieved by considerable mobilization in 21 patients. The site of reattachment was usually in the sulcus adjacent to the humeral articular surface; very rarely, when the tendons did not reach their original anatomic attachment without undue tension, the trough was made somewhat more medially. In only 2 patients, the repair of the massive cuff tear could not be accomplished because the quality of ruptured tendon was poor.

The size of the cuff tear was determined by the width of the avulsed tendon at its insertion. These were classified at surgery according to Post et al[19]: small tears are less than 1 cm, medium tears 1 to 3 cm, large tears 3 to 5 cm, and massive tears greater than 5 cm in diameter. There were 17 small tears, 20 moderate tears, 8 large tears, and 13 massive tears. In 41 (71%) cases, only the supraspinatus was torn, whereas in 7, all 3 (subscapularis, supraspinatus, and infraspinatus) cuff tendons were torn. In the remaining patients, a supraspinatus tear was associated with tear of either subscapularis or infraspinatus.

Tendon quality was rated as good, fair, or poor, based on the criteria of Iannotti et al.[13] A good-quality tendon had a thickness greater than or equal to 4 mm. In a fair-quality tendon, the cuff was thinned out, but when the suture was tied, there was no visual tendency for further tearing or pullout. Poor-quality tendons did not have these characteristics. Nine patients had an associated rupture of the biceps tendon. The surgical findings are summarized in Table II.

Postoperative treatment was similar for all patients. An

Table III Overall results (n = 58)

	UCLA	Constant and Murley
Excellent	25	42
Good	19	6
Fair	7	3
Poor	7	7
Pain relief		
No pain/occasional pain		43
Pain only during particular activities		9
Pain at rest/light activities		6
Patient satisfaction		
Normal/much improved		44
Moderate improvement		9
Slight or no benefit		5

Table IV Duration of preoperative symptoms versus results (UCLA)

Duration	Excellent	Good	Fair	Poor
<6 mo	3	4	3	1
6-12 mo	8	9	2	2
>12 mo	14	6	2	4

Chi-square = 5.92 (6 *df*); $P > .427$ (not significant).

Table V Age versus results (UCLA)

Age	Excellent	Good	Fair	Poor
<40	2	0	0	0
40-50	2	4	0	0
50-60	5	3	1	1
60-70	5	6	1	3
>70	11	7	4	1

abduction brace was used for 6 weeks in all cases in which the tendon was repaired to bone. Passive range of motion (ROM) exercises to full range were begun on the first postoperative day. Active exercises were started at 6 weeks. Resistive strengthening was begun when active motion was comfortable. The 21 patients who had side-to-side repair performed Codman's exercises (gravity assisted) in a sling as well as passive ROM to full range commencing on the first postoperative day.

All patients were followed up for a period of 1 year at 3, 6, and 12 weeks, 6 months, and 1 year by the operating surgeon, who recorded any specific complications, pain, and functional capabilities. Examination of each patient at final follow-up was performed by an independent surgeon, using the UCLA[7] (University of California at Los Angeles) End Result Scores and a modified Constant's Functional Score rating scale.[6] These rating scales evaluate pain, function, movement, and patient satisfaction. Manual muscle testing of abduction and forward flexion of the shoulder was performed, and muscle strength was classified according to the MRC grade. When strength was compared with that of the opposite, asymptomatic shoulder, 25 points were assigned if the strength was normal (grade V), 20 points if strength was grade IV, 10 points for grade III, and none for muscle strength of grade II or less. Results were analyzed by the use of shoulder functional scores as described by Constant and Murley[6]: excellent (80 to 100), good (65 to 80), fair (51 to 65), and poor (50). They were further analyzed with the UCLA system (Ellman et al[7]): excellent (34 to 35), good (28 to 33), fair (21 to 27), and poor (<20). There were 32 patients who were followed up over 3 years and 26 over 2 years.

The prognostic factors such as age, duration of symptoms, preoperative treatment, size of tear, and quality of the tendon were analyzed against results with the UCLA system only.

Statistical analysis was performed on the collected data with the use of MINITAB statistical software. Multivariate analysis was done with chi-square tables, with a significance level of $P < .05$. The variables evaluated included age, duration of symptoms, preoperative movement and muscle strength, tear size, and quality of tendon.

RESULTS

Functional results

The results were graded on the basis of pain, function, amount and strength of flexion, and patient satisfaction. Table III shows a comparison of the two different rating systems. Forty-eight (83%) were graded excellent or good according to the Modified Constant ratings system compared with 44 (76%) graded excellent or good by the UCLA criteria.

Correlation of duration of symptoms with functional results

In 26 patients, symptoms had been present for more than 1 year before surgery. There was no significant difference (chi-square = 5.92; $P > .43$) between the duration of symptoms in those patients who had a satisfactory result as opposed to an unsatisfactory outcome (Table IV).

Correlation of patient age with functional results

Tears in elderly patients (≥70 years of age) were repaired successfully: 18 cases of 23 had good to excellent result in this group (Table V). We found no significant correlation of poor outcome with old age.

Correlation of preoperative ROM with functional results

Patients whose preoperative abduction was less than 90° had a higher risk of having an unsatisfactory result (Table VI), and this was statistically significant (chi-square = 4.43; $P = .035$).

Table VI Preoperative range of movements (flexion/abduction) versus results (UCLA)

Flexion/abduction	Excellent	Good	Fair	Poor
<90°	2	5	3	3
>90°	23	14	4	4

Chi-square = 4.43 (1 *df*); *P* = .035 (significant).

Table VII Preoperative weakness versus results (UCLA)

MRC grade	Excellent	Good	Fair	Poor
Grade V/IV	22	9	3	2
Grade III or less	3	10	4	5

Chi-square = 13.3 (3 *df*); *P* = . 004 (significant).

Correlation of preoperative weakness with functional results

Twenty-two patients had preoperative weakness in the shoulder and were found to be less than grade IV on the MRC scale (Table VII). Thirteen of these 22 had a fair to poor outcome, indicating that patients with weak abduction preoperatively were more likely to have unsatisfactory results (chi-square = 13.3; *P* = .004).

Correlation of tear size with functional results

The size of the rotator cuff tear did not appear to have a significant effect on the outcome obtained in groups I, II, and III (Table VIII). However, 6 of 12 massive tears (group IV) had a fair or poor outcome, and this is statistically significant compared with groups I through III (chi-square = 8.05; *P* = .005).

Correlation of quality of rotator cuff with functional results

Shoulders in which the repaired cuff was of good quality at the time surgery had significantly (chi-square = 4.19; *P* = .04) better function than those with a poor-quality tendon (Table IX).

Complications

Superficial infection was seen in 2 patients. This resolved with 2-week treatment with oral antibiotics. One patient had a stiff shoulder that was manipulated at 3 months and one had minor reflex sympathetic dystrophy (complex regional pain syndrome), which responded to a single guanethedine block. Both patients had excellent results under Constant criteria. Two patients had transient ulnar nerve palsy, which resolved on observation (in one case the nerve involved was on the contralateral side).

Seven of the poorest results were analyzed separately. All were patients older than 60 years; in 4 cases, symptoms had been present for more than 12 months, in 6 cases there was a massive tear and poor quality of the cuff tendon, and 5 cases required significant mobilization of the tendon.

Table VIII Torn cuff size and results (UCLA)

	Type I*	Type II	Type III	Type IV
Excellent	10	10	4	1
Good	5	7	2	5
Fair	2	2	2	1
Poor	0	1	0	6

Chi-square = 8.05 (1 *df*); *P* = .005 (significant).
*Type I, ≤1 cm; type II, 1 to 3 cm; type III, 3 to 5 cm; type IV, >5 cm.

Table IX Quality of torn cuff tendon versus results

Quality	Excellent	Good	Fair	Poor
Good	20	12	5	1
Fair	5	7	0	4
Poor	0	0	2	2

Chi-square = 4.19 (1 *df*); *P* = .04 (significant).

DISCUSSION

Many reports in the literature have confirmed the satisfactory results of open surgical repair of full-thickness rotator cuff tears.[7,11,17,21] Although symptomatic rotator cuff tear is a common problem and can be disabling, there is a tendency to treat this problem nonoperatively in many county hospitals, where there is no specialized shoulder unit. There is also some reluctance to operate on elderly patients on the basis of the expectation that surgery may not be suitable and the outcome will be poor.

Many researchers used either arthrogram,[4] ultrasound,[8,9] or magnetic resonance imaging[23] to evaluate rotator cuff repair after surgery. It is our opinion that both the UCLA and Constant functional scoring systems are reliable and practical to use in the clinical situation. In this series, we achieved excellent to good results of surgical repair of cuff tear in 76% according to the UCLA scoring system and 83% with a modified Constant score. A subjective assessment showed that all but 5 patients considered themselves to be improved after surgery. Although 95% of the patients complained of severe pain before surgery, only 10% had pain at the follow-up evaluation.

A mean follow-up of 34 months allows only a short-term clinical evaluation of rotator cuff repairs. It was proposed in previous studies[1,23] that the results did not deteriorate over time. Hawkins et al[11] reported that the operative results in their patients had not changed 1 year after surgery. Thirty-two patients in the present

series were in fact followed for 2 to 4 years. Patients rated excellent to good at 1 year remained excellent to good throughout the follow-up period, indicating that most repeat ruptures occur during the first 12 months.

Although not uniformly reported, many clinical factors influence the result of a rotator cuff repair. Several points derived from this study deserve emphasis. There have been mixed reports. Cofield et al[5] concluded that patient age was a significant factor in predicting outcome; older patients had more significant disease and poorer outcomes. Our own figures showed that although larger tears and poorer results were more frequent, excellent to good results were achieved in 78% of patients older than 70 years. This suggests that age should not be the main factor in decision-making for surgery. Even a little improvement in pain and ROM in this age group can make a difference to the patient, and a gratifying outcome can usually be anticipated. Hattrup[10] reported somewhat similar results and obtained excellent or satisfactory results in approximately 90% of his patients older than 65 years.

Although much controversy surrounds the timing of surgery, few studies have actually definitively examined this duration of symptoms as it pertains to surgical outcome. Because most rotator cuff tears are chronic and not related to single-event trauma, it is difficult to define a critical reference point from which to measure the timing of surgery.

Some surgeons have advocated early repair of rotator cuff tears.[3,5,19] All patients in our study had a chronic tear, and no patient was operated on within the first 3 months. In more than half of our patients, repair was delayed more than 6 months after initial symptoms. There was no significant relation between the time to surgery and the final outcome in our data. This study demonstrated that satisfactory results can be obtained with delayed repair.

In an effort to determine the cost effectiveness of rotator cuff repair surgery, the treatment costs were analyzed for surgical treatment and physical therapy.[21] It was concluded that immediate referral of rotator cuff tears for specialized care results in decreased cost and earlier return to work. We do not agree that this is necessary in all cases of cuff rupture but believe earlier surgery is indicated in the younger age group with weakness of abduction and limitation of ROM because these patients were unlikely to do well with physiotherapy. Early repair is helpful in allowing early return to work.

The literature is divided over the predictive value of preoperative strength and motion, with some authors finding no prognostic value[7,19] and others finding useful information.[7,11] Some studies have shown that weakness in abduction and external rotation actually correlated with rotator cuff tear size.[5,11] We agree with the previous studies[7,11] that preoperative limitation of movement below 90° abduction and weakness below grade IV in abduction and external rotation increased the risk of a poor result.

Although the size of the tear did not affect the operative result in some reports,[9,14] recent reports[3,5,13] do suggest that it influences the functional outcome. It has been reported that larger cuff tears were associated with poor quality of the tendon tissue, the presence of a rupture of the long head of the biceps, and difficulty of tendon mobilization and repair.[3]

In contrast to previous observations,[3,19] our results do not support the concept that when massive rupture is excluded, the size of the tear is the major determinant of the strength of abduction and external rotation at the time of follow-up. However, unsatisfactory results were associated with both massive tears and poor quality of the cuff tendon, and these findings were statistically significant.

Rockwood et al[20] described 50 patients with a massive tear who underwent open acromioplasty and rotator cuff debridement. They reported 85% having relief of pain and most having increased strength after a specific rehabilitation program. They have not reported the long-term outcomes. Our results in massive tears were as efficacious for pain relief but functionally inferior. Despite this fact, it is our opinion that in all massive ruptures repair should be attempted, because although not proven, it appears that repair of the rotator tendon and coraco-acromial ligament may help in preventing progression to rotator cuff arthropathy.[12]

It has been reported[8,9] that the major determinant of the outcome of an operative repair of a tear is the integrity of the rotator cuff at the time of follow-up and the size of the postoperative defect. This was not assessed in the current study.

We agree with previous reports[1,7] that subjective assessment with manual muscle testing is both practical and reliable. However, the importance of isokinetic testing of shoulder strength in postoperative evaluation may be preferable when available. We were unable to perform comparative isokinetic studies in our patients.

The need for concomitant procedures with cuff repair did not jeopardize the result, and they should be performed when indicated. The use of an abduction brace to relax the tension on the repair also did not cause poorer results, although some patients could not tolerate bracing.

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