Early Effectiveness of Arthroscopic Repair for Full-Thickness Tears of the Rotator Cuff

An Outcome Analysis*

BY GARY M. GARTSMAN, M.D.†, MARK R. BRINKER, M.D.†, AND MYRNA KHAN, M.S.‡, HOUSTON, TEXAS

Investigation performed at The Center for Musculoskeletal Research and Outcomes Studies, Fondren Orthopedic Group, Texas Orthopedic Hospital, Houston

ABSTRACT: Fifty consecutive patients completed standardized questionnaires regarding general health status as well as function of the shoulder before and an average of thirteen months after arthroscopic repair of a full-thickness tear of the rotator cuff. Comparison of the preoperative and postoperative responses to the questions demonstrated highly significant improvements in the patient's assessment both of general health and of function of the shoulder. The Short Form-36 (SF-36) General Health Survey revealed significant improvements in the most recent follow-up scores compared with the preoperative scores with regard to physical functioning ($p = 0.0001$), role-physical ($p = 0.0001$), bodily pain ($p = 0.0001$), vitality ($p = 0.0001$), social functioning ($p = 0.0001$), role-emotional ($p = 0.006$), mental health ($p = 0.0213$), and physical component summary ($p = 0.0001$). The University of California at Los Angeles (UCLA) Shoulder Score, the Constant Shoulder Score, and the American Shoulder and Elbow Surgeons (ASES) Shoulder Index showed significant improvements in all postoperative total and component scores ($p = 0.0001$). Most importantly, all three shoulder-rating systems demonstrated significant improvements in the postoperative scores for pain and function ($p = 0.0001$).

While a general health status instrument such as the SF-36 can document the impact of an orthopaedic condition on a patient as well as the results of treatment, a more complete representation of the patient's condition requires the use of region-specific self-assessment questionnaires and evaluation by a physician.

Historically, clinical research of disorders of the shoulder has focused on traditional parameters, such as pain relief, changes in range of motion, strength, and stability of the joint, that are primarily of interest to the orthopaedic surgeon. Current research has focused on various aspects of specific function, such as reaching overhead, lifting, sleeping on the affected side, performing work-related activities, and participating in sports. More recent publications[1,11-14,16,17] have concentrated on the impact of orthopaedic treatment on a patient's perception of his or her general health. Such studies may be categorized as outcomes research. Outcomes questionnaires allow patients to characterize their quality of life through the use of standardized and validated self-assessment instruments[2,22-25]. Matsen et al.[16,17] used such instruments to demonstrate the early effectiveness of total shoulder arthroplasty in patients who had primary osteoarthrosis of the glenohumeral joint.

The purpose of the present study was to determine the early effectiveness of arthroscopic repair of full-thickness tears of the rotator cuff. Our goals were to determine changes in patients' perceptions of their general health as measured by the Short Form-36 (SF-36) General Health Survey[25]; to correlate the scores on the SF-36 with changes reflected by traditional shoulder-rating systems, such as the University of California at Los Angeles (UCLA) Shoulder Score[5], the Constant Shoulder Score[3,4], and the American Shoulder and Elbow Surgeons (ASES) Shoulder Index[20]; and to examine the effect of several clinical variables on the scores according to the SF-36 and shoulder-rating systems.

Materials and Methods

Arthroscopic repair of a full-thickness tear of the rotator cuff was performed on fifty consecutive patients from January 1994 to December 1994. The criterion for inclusion was a full-thickness, reparable tear of one or more tendons of the rotator cuff, as verified at the operation. A tear was considered reparable if its torn ends could be placed at or within five millimeters of their anatomical insertion when traction was applied with either a grasping instrument or a suture. If the tendon could not be positioned appropriately, extra-articular adhesions were removed.

The criteria for exclusion were a previous operation on the shoulder, a partial-thickness tear of the rotator cuff, and an irreparable tear. Patients who were receiving Workers' Compensation and those in whom an acute tear had been repaired less than three months after the

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†The Center for Musculoskeletal Research and Outcomes Studies, Fondren Orthopedic Group, Texas Orthopedic Hospital, 7401 South Main Street, Houston, Texas 77030.

‡Baylor Computing Resources Center, IREL 300, One Baylor Plaza, Houston, Texas 77030.

injury were also excluded. As we wished to maintain as much uniformity as possible in the study group, we limited the investigation to chronic tears. Patients who have an acute tear have often sustained substantial trauma with additional osseous or soft-tissue damage. Similarly, patients who are receiving Workers' Compensation have non-anatomical issues that may affect the outcome. Misamore et al. documented inferior results in this population.

The primary indication for the operation was persistent pain in the shoulder that had not responded to at least six months of non-operative treatment, such as avoidance of painful activities and a home physical therapy program designed to maintain or improve the range of motion of the shoulder and to increase the strength of the uninvolved muscles of the shoulder[7]. We prescribed non-steroidal anti-inflammatory medication unless it was contraindicated for medical reasons, and we administered a subacromial injection of cortisone if pain had not decreased after two to three months.

The study group consisted of twenty-six men and twenty-four women. The average age at the time of the operation was sixty-two years (range, thirty-seven to seventy-eight years). The average duration of symptoms before the operation was 20.4 months (range, six months to twelve years). Thirty-five patients received an average of 1.9 (range, one to six) subacromial injections of cortisone before the operation. Thirty-seven patients had radiographic imaging preoperatively: fourteen had arthrography and twenty-three had magnetic resonance imaging. The average duration of follow-up after the index procedure was 12.7 months (range, eleven to twenty-one months).

Patient Rights

In order to maintain confidentiality throughout the investigation, each patient was assigned an identification number. The name of the patient and his or her identification number were kept separate so that the statistician who analyzed the data had no knowledge of the patient's identity.

Before the investigation began, statistical analysis was performed to quantify the number of patients needed for statistically valid conclusions to be drawn. Each patient provided written informed consent stating that he or she comprehended the purpose of the study as well as the potential risks and benefits of the operation. The patient was informed of the right to forms of operative and non-operative care other than that being studied and the right not to participate in the study even if he or she selected the type of care that was being investigated. Understanding of these two rights was documented in writing.

Assessment of the Shoulder

Immediately before the preoperative physical examination, each patient completed self-assessment forms documenting the level of pain in, satisfaction with, and function of the shoulder. We collected sufficient data to derive scores with the UCLA Shoulder Score, the Constant Shoulder Score, and the ASES Shoulder Index. Each patient also completed the SF-36.

The UCLA Shoulder Score is a 35-point scale consisting of 10 points for pain, 10 points for function, and 5 points each for motion, strength, and patient satisfaction. The Constant Shoulder Score has a total of 100 points: 15 points for pain, 20 points for function, 40 points for active range of motion, and 25 points for strength. The ASES Shoulder Index is determined with use of a visual analog scale for pain and ten self-assessed activities of daily living. The visual analog scale goes from 0 points (no pain) to 10 points (unbearable pain). The pain score is subtracted from 10 and the resulting number is multiplied by 5 for a maximum of 50 points. The ten activities of daily living are scored from 0 to 3 points. The sum of these scores is multiplied by 5/3 for a maximum of 50 points. Thus,

TABLE I
SCORES ACCORDING TO THE SHORT FORM-36 GENERAL HEALTH SURVEY[25]

Parameter	Score* *(Points)* Preop.	At Most Recent Follow-up	P Value†
Physical functioning	56.4 ± 27.5	75.8 ± 26.2	0.0001
Role-physical	29.3 ± 39.1	75.0 ± 42.3	0.0001
Bodily pain	27.6 ± 20.1	67.9 ± 24.4	0.0001
General health	70.5 ± 26.8	71.9 ± 22.7	NS
Vitality	51.7 ± 22.9	64.4 ± 19.6	0.0001
Social functioning	59.8 ± 33.2	83.5 ± 27.2	0.0001
Role-emotional	66.0 ± 42.3	82.7 ± 33.2	0.006
Mental health	70.8 ± 23.3	77.4 ± 21.2	0.0213
Physical component summary	34.1 ± 9.8	46.5 ± 10.6	0.0001
Mental component summary	49.7 ± 13.3	52.6 ± 10.5	NS

*The values are given as the average and the standard deviation.
†As determined with the Wilcoxon signed-rank test. NS = not significant ($p > 0.05$).

TABLE II
UNIVERSITY OF CALIFORNIA AT LOS ANGELES SHOULDER SCORES[5]

Parameter	Score* *(Points)* Preop.	At Most Recent Follow-up	P Value†
Total	12.8 ± 4.1	31.7 ± 2.8	0.0001
Pain	2.5 ± 1.7	9.1 ± 0.9	0.0001
Function	3.8 ± 2.2	8.8 ± 1.3	0.0001
Active forward flexion	4.0 ± 1.0	4.9 ± 0.3	0.0001
Strength	2.2 ± 1.1	4.1 ± 1.0	0.0001
Patient satisfaction	0.3 ± 0.4	4.7 ± 0.5	0.0001

*The values are given as the average and the standard deviation.
†As determined with the Wilcoxon signed-rank test.

the maximum possible total score is 100 points.

We measured the active and passive range of motion as well as strength at the initial examination. Repeat evaluations were performed six weeks; three, six, nine, and twelve months; and then yearly postoperatively. Passive movements, including elevation, external rotation with the shoulder adducted, and internal rotation behind the back, were measured with a hand-held goniometer and were recorded to the closest 5 degrees. Active movements, including elevation, abduction, external rotation in abduction, and internal rotation behind the back, were also recorded, to allow scoring with the shoulder-rating systems. Strength on elevation was measured in pounds with a dynamometer. No attempt was made to increase the precision of the measurements through blinding of the examiner, determination of test-retest validity or interobserver and intraobserver reliability, instruction of the patient before the measurement, or use of a warm-up period or exercise before the evaluation. Anteroposterior glenoid, axillary, and supraspinatus outlet radiographs were made. Magnetic resonance imaging or arthrography was performed if necessary.

At the time of the operation, twenty-five shoulders had a tear of the supraspinatus; twenty had a tear of the supraspinatus and infraspinatus; two had a tear of the supraspinatus, infraspinatus, and teres minor; two had a tear of the supraspinatus, infraspinatus, and subscapularis; and one had a tear of the supraspinatus and subscapularis. The average length of the tear was 28.2 millimeters (range, ten to fifty-five millimeters); the average width (from the edge of the tendon to the anatomical site of insertion) was 12.5 millimeters (range, five to thirty millimeters); and the average area was 406 square millimeters (range, fifty to 1500 square millimeters).

Operative Technique

The details of the operative technique have been described[10]. We found a skilled assistant to be invaluable. The operation was performed with the patient in the sitting position and under general anesthesia. To diminish postoperative pain, regional (interscalene block) anesthesia was used before general anesthesia was induced.

The glenohumeral joint was inspected arthroscopically, and lesions were treated as necessary. The arthroscope was removed from the joint and was inserted into the subacromial space. Any bursal tissue that obscured visualization was removed, and the tear in the tendon was visualized. The length of the tear as well as the amount of medial retraction (if any) was recorded. Adhesions were removed from retracted tendons until full excursion was possible. The mobility of the rotator cuff tendons was limited by contracture of a number of anatomical structures, including the superior aspect of the glenohumeral joint capsule and the coracohumeral ligament. Adhesions from the rotator cuff to the inferior surface of the acromion and from the rotator cuff to the inferior aspect of the deltoid fascia also limited the ability to free the retracted tendons. A motorized soft-tissue resector or electrocautery, or both, was used to remove scar tissue between the tendon and the acromion or the deltoid fascia. If additional release was necessary, the articular capsule was incised along the glenoid margin.

TABLE III
CONSTANT SHOULDER SCORES[3,4]

Parameter	Score* *(Points)* Preop.	At Most Recent Follow-up	P Value†
Total	49.8 ± 13.6	82.7 ± 8.0	0.0001
Pain	3.6 ± 2.5	13.1 ± 2.7	0.0001
Function	12.8 ± 2.0	18.5 ± 1.2	0.0001
Range of motion	25.8 ± 9.1	37.7 ± 4.3	0.0001
Strength	7.6 ± 4.5	13.3 ± 5.5	0.0001

*The values are given as the average and the standard deviation.
†As determined with the Wilcoxon-signed rank test.

The tendon was grasped with a surgical instrument, and reparability was determined[9]. An arthroscopic subacromial decompression was performed[7]. Osteophytes on the inferior aspect of the acromioclavicular joint were removed if necessary as determined on preoperative radiographs or by inspection at the time of the procedure. The acromioclavicular joint was resected only if pain has been localized to, and there had been tenderness of, that joint on the preoperative physical examination[8].

A cancellous bed was prepared at the site of the proposed attachment of the tendon between the articular cartilage of the head of the humerus and the greater

TABLE IV
SCORES ACCORDING TO THE AMERICAN SHOULDER AND ELBOW SURGEONS SHOULDER INDEX[20]

Parameter	Score* *(Points)* Preop.	At Most Recent Follow-up	P Value†
Overall	31.3 ± 15.5	90.0 ± 10.3	0.0001
Pain	12.2 ± 8.5	44.2 ± 6.4	0.0001
Activities of daily living‡			
Total	19.1 ± 9.8	45.8 ± 5.6	0.0001
Section 1	1.56 ± 0.79	2.92 ± 0.34	0.0001
Section 2	0.92 ± 0.97	2.70 ± 0.61	0.0001
Section 3	0.86 ± 0.81	2.72 ± 0.45	0.0001
Section 4	2.42 ± 0.84	3.00 ± 0.0	0.0001
Section 5	1.66 ± 0.96	2.92 ± 0.27	0.0001
Section 6	1.02 ± 1.04	2.64 ± 0.63	0.0001
Section 7	0.54 ± 0.81	2.20 ± 1.07	0.0001
Section 8	0.60 ± 0.83	2.44 ± 0.93	0.0001
Section 9	1.30 ± 0.95	2.84 ± 0.37	0.0001
Section 10	0.56 ± 0.86	2.78 ± 0.58	0.0001

*The values are given as the average and the standard deviation.
†As determined with the Wilcoxon signed-rank test.
‡The total score for the activities of daily living was determined by multiplying the total of the section scores by 5/3.

TABLE
CORRELATION COEFFICIENTS

	SF-36									
	Physical Functioning	Role-Physical	Bodily Pain	General Health	Vitality	Social Functioning	Role-Emotional	Mental Health	Physical Component Summary	Mental Component Summary
SF-36										
Physical functioning	1.000†									
Role-physical	0.347†	1.000†								
Bodily pain	0.374†	0.387†	1.000†							
General health	0.407†	0.207	0.225	1.000†						
Vitality	0.258	0.342†	0.296†	0.258	1.000†					
Social functioning	0.235	0.331†	0.514†	0.024	0.398†	1.000†				
Role-emotional	0.046	0.376†	0.347†	–0.038	0.188	0.376†	1.000†			
Mental health	0.200	0.388†	0.522†	0.075	0.464†	0.599†	0.432†	1.000†		
Physical component summary	0.743†	0.641†	0.481†	0.639†	0.302†	0.144	–0.036	0.116	1.000†	
Mental component summary	–0.020	0.204	0.418†	–0.096	0.529†	0.696†	0.709†	0.770†	–0.190	1.000†
UCLA										
Total	0.114	0.064	0.195	0.214	0.049	0.151	0.072	0.087	0.138	0.054
Pain	0.007	0.080	0.191	0.162	0.129	0.075	0.029	–0.116	0.137	0.046
Function	0.213	0.048	0.104	0.328†	–0.011	0.107	0.032	0.135	0.197	0.027
Active forward flexion	0.138	0.225	0.323†	0.024	0.226	0.279†	0.060	0.212	0.181	0.152
Strength	–0.049	–0.063	–0.091	–0.013	–0.216	–0.117	0.071	–0.105	–0.122	–0.082
Patient satisfaction	–0.003	0.007	0.147	0.096	0.113	0.154	–0.067	0.080	0.071	0.023
Constant										
Total	0.156	0.292†	0.404†	0.009	0.204	0.286†	0.285†	0.179	0.198	0.212
Pain	0.001	0.129	0.272	0.268	0.120	–0.019	0.184	–0.048	0.137	0.046
Function	0.118	0.163	0.158	0.091	0.066	0.203	0.181	0.043	0.136	0.104
Range of motion	0.276	0.270	0.430†	–0.0002	0.291†	0.338†	0.172	0.293†	0.241	0.244
Strength	0.004	0.162	0.034	0.020	–0.118	–0.023	0.247	–0.042	0.036	0.015
ASES										
Overall	0.113	0.154	0.282†	0.140	0.159	0.158	0.144	0.031	0.194	0.062
Pain	0.062	0.136	0.302	0.092	0.102	0.128	0.146	0.020	0.168	0.061
Activities of daily living	0.122	0.137	0.207	0.190	0.154	0.137	0.065	0.050	0.173	0.051

*SF-36 = Short Form-36 General Health Survey, UCLA = University of California at Los Angeles Shoulder Score, Constant = Constant Shoulder Score, and ASES = American Shoulder and Elbow Society Shoulder Index.
†Correlation is significant ($p < 0.05$), according to Spearman rank correlations.

tuberosity. A power burr was used to remove a thin layer of cortical bone. No trough was used. An anchor of number-2 braided, non-absorbable suture was placed lateral to the cancellous bone surface. An instrument was used to pass the suture through the tendon approximately five millimeters from the site of the tear. The number of suture anchors (average, 2.3; range, one to four) varied with the length of the tear. Traction was placed on a suture in the margin of the tendon to reduce the tendon to its repair site and to allow tying of the suture without excessive tension with the upper extremity at the side. If this could not be accomplished, the tendon was repaired by attaching it medial to its anatomical location and thus closer to the articular cartilage of the humeral head[15]. No tendon was repaired so that abduction of the arm in a brace was necessary. After all of the repair sutures had been tied, the traction suture was removed. The puncture wounds were closed with adhesive tape. The average duration of the operation was 56.6 minutes (range, thirty-five to ninety minutes).

Postoperatively, a sling was applied to maintain the arm in slight abduction (15 degrees). An ice-pack wrap was also applied. The patients were routinely discharged to home the morning after the operation. Passive range-of-motion exercises in elevation and external rotation were started the afternoon of the operation and were performed at home for six weeks. Active range-of-motion exercises were started six weeks postoperatively, and strengthening of the deltoid, infraspinatus, supraspinatus, scapular rotators, and biceps with the use of rubber tubing was begun twelve weeks postoperatively. The range-of-motion and strengthening exercises were continued for one year.

Analysis of the Data

The score for the SF-36 was determined as described by Ware and Sherbourne[23]. The eight scales are scored from 0 (least healthy) to 100 points (most healthy). The

V

FOR THE CHANGES IN SCORE*

UCLA						Constant					ASES		
Total	Pain	Function	Active Forward Flexion	Strength	Patient Satisfaction	Total	Pain	Function	Range of Motion	Strength	Overall	Pain	Activities of Daily Living
1.000†													
0.726†	1.000†												
0.791†	0.297†	1.000†											
0.340†	0.190	0.159	1.000†										
0.617†	0.289†	0.411†	0.002	1.000†									
0.366†	0.236	0.257	0.085	–0.017†	1.000†								
0.704†	0.594†	0.791†	0.635†	0.617†	0.042	1.000†							
0.521†	0.824†	0.172	0.144	0.105	0.095	0.562†	1.000†						
0.331†	0.432†	0.130	0.120	0.410†	0.138	0.434†	0.346†	1.000†					
0.418†	0.300†	0.212	0.829†	0.082	–0.077	0.793†	0.231	0.183	1.000†				
0.461†	0.152	0.443†	–0.057	0.587†	0.067	0.352†	0.134	–0.063	–0.060	1.000†			
0.816†	0.344†	0.244	0.091	0.204	0.650†	0.624†	0.737†	0.701†	0.360†	0.073	1.000†		
0.660†	0.926†	0.926†	0.143	0.208	0.169	0.576†	0.855†	0.419†	0.254	0.233	0.860†	1.000†	
0.471†	0.288†	0.282†	0.039	0.135	0.450†	0.482†	0.410†	0.826†	0.351†	–0.141	0.824†	0.464†	1.000†

two summary measures — physical component summary and mental component summary — have been standardized for norm-based scoring with an average (and standard deviation) of 50 ± 10 points. The preoperative scores and the scores at the most recent follow-up evaluation were compared with use of the Wilcoxon signed-rank test to determine which parameters regarding general health status were significantly different after repair of the rotator cuff. The Wilcoxon signed-rank test is the non-parametric analogue of the paired t test.

The preoperative and most recent follow-up scores for the shoulder-rating systems were compared with use of the paired rank test to determine which parameters regarding the shoulder were significantly different after the operation. In addition, Spearman rank correlation coefficients were calculated for the changes in each of the twenty-four parameters to determine the degree to which the parameters were interrelated. This process involved three steps: calculation of the Spearman rank correlation coefficients, calculation of the t statistic, and determination of the associated probability value (p value) from the t table. A p value of 0.05 or less was considered significant. A strong correlation was defined as one that was significant with use of Spearman rank correlation.

The data were analyzed with standard statistical software (SAS, Cary, North Carolina).

The clinically relevant factors studied included the age and gender of the patient and the length, width, and area of the tear of the rotator cuff. These factors were selected because it was the consensus of a research committee at our institution that they were the most likely to affect the results of the SF-36. We acknowledge that other variables could have been studied and, in this regard, this study should be considered preliminary.

Results

An average of thirteen months after arthroscopic repair of the full-thickness tear of the rotator cuff, the score for most of the parameters (scales and summaries) on the SF-36 had improved significantly between the preoperative and most recent follow-up evaluations (Table I). There were significant improvements in phys-

TABLE
EFFECT OF THE

Variable	SF-36									
	Physical Functioning	Role-Physical	Bodily Pain	General Health	Vitality	Social Functioning	Role-Emotional	Mental Health	Physical Component Summary	Mental Component Summary
Preop. scores										
Age	–0.147	–0.0278	–0.278	0.024	–0.178	–0.309	–0.324	–0.217	–0.011	–0.326‡
Gender	0.0006§	NS	0.0122§	NS	NS	NS	NS	NS	0.0014§	NS
Length of tear	0.029	0.142	0.161	–0.006	0.074	0.004	–0.084	–0.104	0.189	–0.094
Width of tear	0.042	0.091	0.133	–0.057	0.102	0.00	–0.039	–0.096	0.141	–0.103
Area of tear	0.052	0.116	0.176	–0.021	0.086	0.009	–0.069	–0.099	0.182	–0.098
Postop. scores										
Age	–0.449‡	–0.194	–0.207	–0.362‡	–0.298‡	–0.121	–0.154	–0.259	–0.359‡	–0.112
Gender	0.0181§	NS	NS	0.0222§	NS	NS	NS	0.0095§	NS	NS
Length of tear	–0.078	–0.018	0.002	–0.130	–0.105	0.040	0.081	0.012	–0.125	0.069
Width of tear	–0.045	–0.034	0.041	–0.081	0.064	0.087	0.147	0.044	–0.102	0.095
Area of tear	–0.071	–0.022	0.025	–0.097	–0.011	0.095	0.145	0.048	–0.126	0.115
Difference between preop. and postop. scores										
Age	–0.245	–0.151	0.076	–0.367	–0.050	0.227	0.135	0.002	–0.352‡	0.236
Gender	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Length of tear	–0.060	–0.138	–0.006	–0.198	–0.216	0.074	0.116	0.098	–0.246	0.178
Width of tear	–0.074	–0.126	0.027	–0.057	–0.054	0.040	0.117	0.104	–0.186	0.182
Area of tear	–0.091	–0.126	0.010	–0.146	–0.134	0.072	0.144	0.116	–0.244	0.211

*The values for the continuous variables (age of patient and length, width, and area of tear) are given as correlation coefficients according to Spearman rank correlations, and the values for the categorical variable (gender) are given as p values according to the Wilcoxon rank-sum test. NS = not significant ($p \geq 0.05$).

†SF-36 = Short Form-36 General Health Survey, UCLA = University of California at Los Angeles Shoulder Score, Constant = Constant Shoulder Score, and ASES = American Shoulder and Elbow Society Shoulder Index.

‡Correlation is significant ($p < 0.05$).

§The scores for the men were significantly ($p < 0.05$) higher than those for the women.

#The scores for the women were significantly ($p < 0.05$) higher than those for the men.

ical functioning ($p = 0.0001$), role-physical ($p = 0.0001$), bodily pain ($p = 0.0001$), vitality ($p = 0.0001$), social functioning ($p = 0.0001$), role-emotional ($p = 0.006$), mental health ($p = 0.0213$), and physical component summary ($p = 0.0001$).

The total score and all component scores for the UCLA Shoulder Score (Table II), Constant Shoulder Score (Table III), and ASES Shoulder Index (Table IV) improved significantly postoperatively. Thus, all three shoulder instruments demonstrated significant improvement with regard to pain and function after arthroscopic repair of a full-thickness tear of the rotator cuff ($p = 0.0001$).

There was a strong correlation among many of the twenty-four parameters studied, indicating interrelationships between several of the variables (Table V). There were strong correlations among the improvements in the total scores of the three shoulder instruments ($p < 0.05$). However, these improvements did not correlate strongly with those indicated by the physical and mental component summary scores of the SF-36. There were strong correlations among the improvements in the pain scores of all three shoulder instruments ($p < 0.05$). However, no strong correlation was noted between the improvements in these scores and the improvement in the bodily pain score of the SF-36. Although strong correlations were observed between the improvement in the total score for activities of daily living of the ASES Shoulder Index and the improvements in the function scores of the UCLA and Constant systems ($p < 0.05$), no strong correlation was seen between the improvements in the function scores of the Constant and UCLA systems or between the improvement in the physical functioning score of the SF-36 and the improvements in the scores for function or activities of daily living of any of the three shoulder instruments.

Analysis of the effect of the age and gender of the patient and the width, length, and area of the tear revealed less of a postoperative improvement in the SF-36 physical component summary score in older patients ($r = –0.352$, $p < 0.05$) (Table VI). Compared with the men, the women had a significantly greater postoperative improvement in the total scores of the Constant and ASES systems ($p < 0.05$) (Table VI). The strength scores according to the UCLA and Constant systems at the most recent follow-up evaluation were significantly lower for the patients who had a longer tear ($r = –0.388$ and $–0.362$, respectively; $p < 0.05$) (Table VI). In addition, the patients who had tears of greater length, width, and area had less postoperative improvement in the strength score according to the Constant system ($p < 0.05$) (Table VI).

VI
VARIABLES ON SCORES*†

UCLA						Constant					ASES		
Total	Pain	Function	Active Forward Flexion	Strength	Patient Satisfaction	Total	Pain	Function	Range of Motion	Strength	Overall	Pain	Activities of Daily Living
–0.257	–0.153	0.002	–0.175	–0.456	–0.212	–0.326‡	–0.074	–0.172	–0.174	–0.447‡	–0.209	–0.129	–0.200
0.0123§	NS	NS	0.0264§	0.0044§	NS	0.0035§	NS	0.0145§	NS	0.0005§	0.0026§	NS	0.0026§
0.146	0.118	0.155	0.067	–0.190	0.134	–0.007	0.068	0.112	–0.003	–0.203	0.129	0.086	0.122
0.059	–0.081	0.124	–0.037	–0.090	0.309‡	–0.103	–0.148	0.002	–0.102	–0.099	–0.044	–0.119	0.016
0.126	0.017	0.180	0.016	–0.148	0.249	–0.059	–0.051	0.077	–0.057	–0.159	0.058	–0.016	0.093
–0.386‡	–0.016	–0.344‡	0.010	–0.492‡	–0.108	–0.303‡	0.113	–0.283‡	–0.084	–0.534‡	–0.125	0.159	–0.356‡
NS	NS	NS	NS	0.0083§	NS	NS	NS	NS	NS	0.0017§	NS	NS	NS
–0.346‡	–0.194	–0.143	–0.114	–0.388‡	–0.122	–0.366‡	–0.177	–0.127	–0.148	–0.362‡	–0.156	–0.197	–0.050
–0.159	–0.056	–0.073	–0.087	–0.279‡	0.001	–0.222	0.066	–0.163	–0.016	–0.305‡	–0.017	–0.068	0.066
–0.263	–0.078	–0.104	–0.118	–0.348‡	–0.055	–0.304‡	–0.066	–0.158	–0.102	–0.342‡	–0.086	–0.133	0.013
0.028	0.133	–0.185	0.179	0.00	0.083	0.124	0.095	0.031	0.200	–0.238	0.126	0.149	0.011
NS	NS	NS	0.0095#	NS	NS	0.0403#	NS	0.0297#	0.0191#	NS	0.0065#	NS	0.0073#
–0.263	–0.192	–0.195	–0.092	–0.092	–0.202	–0.175	–0.122	–0.191	–0.015	–0.285‡	–0.217	–0.157	–0.165
–0.110	0.091	–0.159	0.020	–0.185	–0.252	–0.002	0.155	–0.085	0.139	–0.318‡	–0.009	0.067	–0.009
–0.210	–0.052	–0.214	–0.043	–0.203	–0.243	–0.089	0.020	–0.162	0.070	–0.311‡	–0.128	–0.046	–0.108

Six patients had a decrease in the score for various components of the SF-36 at the most recent follow-up evaluation. Four patients had a decrease in four scores, one had a decrease in six scores, and one had a decrease in nine scores. All six patients said that their decreased health was a result of conditions unrelated to the shoulder. One patient had had worsening of asthma symptoms, one had a myocardial infarction, and one had recently had an operation for a herniated cervical disc. The remaining three patients had increased pain and decreased function because of osteoarthrosis, which affected the hip, knee, and lumbar spine in one patient each.

Discussion

Increasing restrictions on reimbursement for medical care influence not only the practice of health care but also the type of research that is conducted[26]. There has been increased interest in studies of the effectiveness of various medical treatments and operative procedures from the patient's point of view[6,13,19,21]. This type of investigation (outcomes research) appears to offer two advantages. First, through the use of general health status instruments, outcomes research offers an opportunity to characterize the impact of a particular condition on a patient's perception of his or her general health and then to measure the effect of treatment. Second, use of condition-specific or anatomical region-specific tools in conjunction with general health status instruments provides an understanding of which particular functions are most affected by a condition and which are most improved by treatment.

In the present study, it was demonstrated that self-assessment tools such as the SF-36 can accurately demonstrate both the effect of a tear of the rotator cuff on a patient's perception of his or her general health as well as the beneficial effect of operative repair. A region-specific questionnaire, such as the ASES, Constant, or UCLA shoulder system, provides additional information about which specific activities are most affected by the musculoskeletal lesion as well as the degree of improvement postoperatively.

It is also apparent that there is a potential for error if general health self-assessment instruments are relied on exclusively. As determined by the traditional shoulder-scoring systems, six of our patients had a successful result (a score of 33 points or more according to the UCLA system or a score of 90 points or more according to the Constant or ASES system); however, some of their scores decreased according to the SF-36. The patients were quite specific in describing the condition of the shoulder as excellent but their overall health and function as impaired. If one relied solely on the general health status instrument, the shoulder might erroneously be thought to be the source of the impairment.

It is unclear why there were poor correlations between the functional assessments provided by the shoulder instruments and the functional components of the SF-36, between the total scores of the shoulder instruments and the component summary scores of the SF-36, and between the pain ratings of the shoulder instruments and the bodily pain score of the SF-36. The discrepancies provide incentive for additional investigation.

These areas of weakness are not meant to diminish the importance of outcome studies. Rather, they serve as evidence that a complete understanding of a musculoskeletal condition not only requires analysis from the patient's point of view but also involves traditional orthopaedic research methods that document various parameters of the patient's history, the physical examination, the radiographic and operative findings, and the technique.

The questionnaires used in the present study were well accepted by the patients, who completed the forms independently and without difficulty or reluctance. Our impression was similar to that of Matsen et al.[17] in that many patients were enthusiastic about being asked for an assessment of their health status and shoulder function.

The present study involved return visits, discussion between the patient and the physician, physical examination, and research assistants who were trained in the use of statistical analysis and computer software. However, Matsen[16] found that these are not necessary to determine outcomes if the desired information is restricted to the patient's perspective. Although we agree with this assessment, we also believe that the methods used in the present investigation provide a more complete picture of the impact of a specific musculoskeletal condition on a patient as well as the changes brought about by operative intervention.

In summary, among a carefully defined group of patients who had a reparable full-thickness tear of the rotator cuff, the SF-36 demonstrated that operative repair improved the general health status within a relatively short time. Region-specific questionnaires more accurately identified and quantified specific functional defects in the shoulder preoperatively as well as improvement postoperatively. We recommend the use of both general and region-specific questionnaires to document the impact of musculoskeletal conditions and the effect of treatment.

References

1. **Beaton, D. E.,** and **Richards, R. R.:** Measuring function of the shoulder. A cross-sectional comparison of five questionnaires. *J. Bone and Joint Surg.,* 78-A: 882-890, June 1996.
2. **Bergner, M.; Bobbitt, R. A.; Kessel, S.; Pollard, W. E.; Gilson, B. S.;** and **Morris, J. R.:** The sickness impact profile: conceptual formulation and methodology for the development of a health status measure. *Internat. J. Health Serv.,* 6: 393-415, 1976.
3. **Constant, C. R.:** Age related recovery of shoulder function after injury. Thesis, University College, Cork, Ireland, 1986.
4. **Constant, C. R.,** and **Murley, A. H.:** A clinical method of functional assessment of the shoulder. *Clin. Orthop.,* 214: 160-164, 1987.
5. **Ellman, H.; Hanker, G.;** and **Bayer, M.:** Repair of the rotator cuff. End-result study of factors influencing reconstruction. *J. Bone and Joint Surg.,* 68-A: 1136-1144, Oct. 1986.
6. **Gartland, J. J.:** Orthopaedic clinical research. Deficiencies in experimental design and determinations of outcome. *J. Bone and Joint Surg.,* 70-A: 1357-1364, Oct. 1988.
7. **Gartsman, G. M.:** Arthroscopic acromioplasty for lesions of the rotator cuff. *J. Bone and Joint Surg.,* 72-A: 169-180, Feb. 1990.
8. **Gartsman, G. M.:** Arthroscopic resection of the acromioclavicular joint. *Am. J. Sports Med.,* 21: 71-77, 1993.
9. **Gartsman, G. M.:** Arthroscopic assessment of rotator cuff tear reparability. *Arthroscopy,* 12: 546-549, 1996.
10. **Gartsman, G. M.,** and **Hammerman, S. M.:** Full-thickness tears: arthroscopic repair. *Orthop. Clin. North America,* 28: 83-98, 1997.
11. **Kantz, M. E.; Harris, W. J.; Levitsky, K.; Ware, J. E., Jr.;** and **Davies, A. R.:** Methods for assessing condition-specific and generic functional status outcomes after total knee replacement. *Med. Care,* 30 (5 Supplement): MS240-MS252, 1992.
12. **Katz, J. N.; Harris, T. M.; Larson, M. G.; Krushell, R. J.; Brown, C. H.; Fossel, A. H.;** and **Liang, M. H.:** Predictors of functional outcomes after arthroscopic partial menisectomy. *J. Rheumatol.,* 19: 1938-1942, 1992.
13. **Kirwan, J. R.; Currey, H. L.; Freeman, M. A.; Snow, S.;** and **Young, P. J.:** Overall long-term impact of total hip and knee joint replacement surgery on patients with osteoarthritis and rheumatoid arthritis. *British J. Rheumatol.,* 33: 357-360, 1994.
14. **Liang, M. H.; Fossel, A. H.;** and **Larson, M. G.:** Comparisons of five health status instruments for orthopedic evaluation. *Med. Care,* 28: 632-642, 1990.
15. **McLaughlin, H. L.:** Repair of major cuff ruptures. *Surg. Clin. North America,* 43: 1535-1540, 1963.
16. **Matsen, F. A., III:** Early effectiveness of shoulder arthroplasty for patients who have primary glenohumeral degenerative joint disease. *J. Bone and Joint Surg.,* 78-A: 260-264, Feb. 1996.
17. **Matsen, F. A., III; Ziegler, D. W.;** and **DeBartolo, S. E.:** Patient self-assessment of health status and function in glenohumeral degenerative joint disease. *J. Shoulder and Elbow Surg.,* 4: 345-351, 1995.
18. **Misamore, G. W.; Ziegler, D. W.;** and **Rushton, J. L., II:** Repair of the rotator cuff. A comparison of results in two populations of patients. *J. Bone and Joint Surg.,* 77-A: 1335-1339, Sept. 1995.
19. **Pitson, D.; Bhaskaran, V.; Bond, H.; Yarnold, R.;** and **Drewett, R.:** Effectiveness of knee replacement surgery in arthritis. *Internat. J. Nurs. Stud.,* 31: 49-56, 1994.
20. **Richards, R. R.; An, K.-N.; Bigliani, L. U.; Friedman, R. J.; Gartsman, G. M.; Gristina, A. G.; Iannotti, J. P.; Mow, V. C.; Sidles, J. A.;** and **Zuckerman, J. D.:** A standardized method for the assessment of shoulder function. *J. Shoulder and Elbow Surg.,* 3: 347-352, 1994.
21. **Stewart, A. L.,** and **Ware, J. E., Jr.:** *Measuring Functioning and Well-Being: The Medical Outcomes Study Approach.* Durham, Duke University Press, 1992.
22. **Ware, J. E., Jr.:** Standards for validating health measures: definition and content. *J. Chronic Dis.,* 40: 473-480, 1987.
23. **Ware, J. E., Jr.,** and **Sherbourne, C. D.:** The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med. Care,* 30: 473-483, 1992.
24. **Ware, J. E., Jr.; Kosinski, M.;** and **Keller, S. D.:** *SF-36 Physical and Mental Health Summary Scales: A Users Manual,* pp. 3:2, 8:13, 8:30, 8:31. Boston, The Health Institute, New England Medical Center, 1994.
25. **Ware, J. E., Jr.; Snow, K. K.; Kosinski, M.;** and **Gandek, B.:** *SF-36 Health Survey. Manual and Interpretation Guide.* Boston, The Health Institute, New England Medical Center, 1993.

26. **Williams, A.:** Setting priorities in health care: an economist's view. *J. Bone and Joint Surg.*, 73-B(3): 365-367, 1991.