Shoulder surgery for rotator cuff tears

Ultrasonographic 3-year follow-up of 97 cases

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We reexamined 97 of 116 shoulders operated on for rotator cuff lesions after an average follow-up time of 37 months. Seventy percent had a good or excellent clinical result, and 14 percent were graded as poor. Upon ultrasonographic examination of the 97 shoulders, 37 had a normal rotator cuff, 31 had thinning and/or hyperdensity, and 29 had a complete rupture of the cuff. Patients with concomitant anterior acromioplasties did better than those without. There was a poor correlation between clinical and ultrasonographic results. We recommend that rotator cuff tears should be closed only if this can be achieved without undue tension. If extensive tissue mobilization or coverage with alloplastic material or with regional muscle flaps is required, the lesion should be debrided and left open, and only an anterior acromioplasty should be performed.

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Most follow-up reports on operative treatment for rotator cuff tears have been based on clinical observations (Samilson 1975, McLaughlin 1962, Packer et al. 1983, Refior and Stürz 1984, Ellmann et al. 1986). They obtained good and excellent results in the majority of patients. The anatomic integrity of the rotator cuff, however, cannot be judged by clinical examination alone.

There are a few reports on arthrography after rotator cuff repair (Preston and Jackson 1977, Calvert et al 1986). Arthrography has a diagnostic accuracy of approximately 95 percent (Preston and Jackson 1977, Melzer et al. 1986), but the size and the location of a tear, as well as incomplete rotator cuff lesions, are not as well estimated (Ellmann et al. 1986). In addition, postoperative fibrosis may prevent filling of the subacromial bursa with contrast medium, and thus lead to false negative results (Crass et al 1986). False positive results have been described as well (Calvert et al. 1986), which have been due to leakage through the operated on rotator cuff.

The diagnostic accuracy of ultrasonography has been shown to be comparable to that of arthrography (Bretzke et al. 1985, Crass et al. 1986, Middleton et al. 1986, Mack et al 1988). Ultrasonography also gives additional information on the size and thickness of the lesion.

Patients and methods

Between November 1980 and December 1987, 111 patients with rotator cuff tears were treated surgically at the Department of Orthopedics, Hannover Medical School. Five patients had bilateral lesions. The mean age was 51 (29–79) years. The dominant shoulder was affected in 91 cases. A complete tear was found in 93 shoulders, incomplete lesions in 23. In 59 percent, the rupture was spontaneous; 27 percent reported an indirect trauma, such as a fall on the outstretched arm; and only 14 percent sustained a direct shoulder injury. Forty patients were engaged in athletic activities, usually swimming and various ball games.

Surgery was considered indicated in cases of persistent pain on movement accompanied by significant loss of function, mostly of shoulder abduction. Almost all the patients had been treated nonoperatively for several weeks up to 6 months. The "saber-incision" approach was used, with removal of the deltoid attachments, as necessary for exposure, and with resection of the subacromial bursa.

Sixty-one tears were located within the supraspinatus tendon, while 34 also affected the infraspinatus and five the subscapularis tendon. In 16 shoulders a subtotal defect of the rotator cuff was found. The maximum diameter of the lesion measured less than 2 cm in 43 shoulders, from 2 to 4 cm in 57 shoulders, and more than 4 cm in 17 shoulders. The

Table 1. Observations in 116 shoulders operated on for rotator cuff disease

A	B	C	D	E	F	G	H	I	K	A	B	C	D	E	F	G	H	I	K
1	2	78	2	1	2	2	2	–	–	59	1	57	1	1	1	3a	2	50	3
2	1	63	2	1	2	3	2	–	–	60	1	43	1	3	1	3	2	100	1
3	1	74	1	1	1	2	2	70	2	61	1	71	1	1	1	3	2	30	1
4	2	60	2	1	1	2	1	65	3	62	1	34	1	1	1	3a	2	95	3
5	1	36	1	1	1	2	2	100	1	63	2	57	1	1	1	2a	2	90	2
6	2	61	1	1	1	3a	2	80	3	64	2	57	2	1	1	2a	2	40	3
7	2	48	2	3	1	1	1	100	1	65	2	45	1	2	1	3a	2	100	1
8	2	58	1	1	1	2	2	65	1	66	1	63	1	2	1	3	2	90	1
9	2	39	1	1	2	3a	2	–	–	67	1	59	1	1	1	3a	2	40	3
10	2	63	2	2	1	3	2	–	–	68	1	60	1	1	1	3	2	70	2
11	1	63	1	1	1	2	3	50	1	69	1	48	2	2	1	2	2	80	2
12	2	49	1	1	1	3a	2	–	–	70	1	38	1	2	1	3	2	100	1
13	2	63	1	2	1	2a	2	80	1	71	1	40	1	3	1	3	2	100	1
14	2	57	2	2	2	3	2	–	–	72	2	42	1	1	1	3	2	95	1
15	1	37	2	3	2	3	2	–	–	73	1	59	1	1	2	3a	2	100	2
16	1	36	1	3	1	3	2	100	2	74	1	54	1	2	1	3	2	70	1
17	2	51	1	1	2	3a	2	–	–	75	1	48	1	3	1	3	2	85	1
18	2	40	2	3	2	3	2	–	–	76	1	36	1	2	1	2a	2	90	3
19	1	40	1	3	1	3	2	65	2	77	1	57	1	2	1	3	2	100	2
20	1	46	1	1	1	3a	2	95	2	78	1	35	1	2	1	3	1	100	2
21	2	44	1	1	1	1a	2	100	3	79	2	54	1	2	1	3	2	60	3
22	2	55	2	1	1	3a	2	30	2	80	1	70	1	2	1	3a	2	–	–
23	2	41	1	2	1	3a	2	100	1	81	1	55	2	2	1	2	2	75	3
24	1	67	1	1	2	1	2	45	1	82	1	57	1	2	1	1a	1	–	–
25	2	51	1	1	1	3a	2	90	1	83	1	60	2	1	2	3a	2	40	1
26	1	69	1	3	1	3	2	30	1	84	2	44	2	1	1	3a	2	90	1
27	2	66	1	1	1	2a	2	80	3	85	1	45	1	3	1	3a	2	40	3
28	1	51	1	1	1	3a	2	40	3	86	1	56	1	1	1	3	2	100	3
29	1	34	1	1	1	3a	2	100	2	87	1	44	2	1	1	2	2	100	2
30	1	43	1	1	1	1a	2	95	2	88	1	53	1	2	1	3a	2	95	1
31	1	52	1	1	2	3	2	–	–	89	1	39	2	1	2	3a	2	100	2
32	2	66	1	2	1	3a	2	90	1	90	1	49	1	2	1	3	2	80	1
33	1	48	1	1	2	3	2	–	–	91	2	70	2	1	1	3a	2	–	–
34	1	53	1	3	1	1	2	40	3	92	1	62	1	1	1	3a	2	40	3
35	1	41	1	1	2	3a	2	–	–	93	1	56	1	2	1	2a	2	90	2
36	1	36	1	1	2	3	2	100	1	94	1	32	1	3	1	3	2	90	2
37	1	42	1	1	2	3a	2	–	–	95	1	58	2	1	1	2a	2	100	3
38	2	40	1	3	1	3a	2	100	1	96	2	51	1	1	1	3	2	85	3
39	2	67	1	1	1	1	2	75	3	97	1	78	1	1	1	3	2	50	3
40	2	44	2	1	1	1	2	90	2	98	1	46	1	2	1	3	2	40	1
41	1	34	1	1	1	3a	2	100	2	99	1	46	2	2	1	3	2	100	1
42	1	56	2	2	1	3a	2	95	2	100	1	52	1	3	1	3	2	85	2
43	1	57	1	1	1	2a	2	–	–	101	1	34	1	2	1	3	2	90	2
44	1	51	1	2	1	2	2	30	3	102	1	55	2	1	1	3a	2	100	1
45	1	46	1	3	1	3	2	–	–	103	1	44	1	1	1	3a	2	70	2
46	2	52	2	1	1	3a	2	95	2	104	1	52	1	1	1	3	2	100	1
47	1	42	1	1	2	1a	1	90	2	105	2	57	1	1	1	3a	2	90	2
48	2	37	1	1	2	3a	2	95	1	106	2	57	2	1	1	3a	2	100	2
49	1	54	1	1	1	3a	2	95	3	107	1	35	1	2	2	1a	2	90	3
50	1	39	1	3	2	1a	1	100	1	108	1	36	1	1	1	1a	2	100	2
51	1	35	1	3	2	1a	1	100	2	109	1	54	1	1	1	3a	1	50	3
52	1	57	1	1	1	2a	2	90	1	110	1	54	1	1	1	3a	1	75	3
53	1	52	1	2	1	2	2	100	1	111	1	48	1	1	2	2a	2	100	2
54	1	55	1	1	1	3a	2	85	1	112	1	52	1	1	1	3a	2	–	–
55	1	79	1	1	1	2a	2	60	3	113	1	52	1	2	1	3	2	30	3
56	2	60	1	2	1	3a	2	85	3	114	2	29	1	2	2	3	2	100	1
57	1	52	1	1	1	2	2	85	2	115	1	44	1	1	1	3	2	85	1
58	2	54	1	1	1	3a	2	100	1	116	1	44	2	1	1	3	2	85	3

A Case
B Sex: 1 male, 2 female
C Age at surgery
D Side: 1 dominant, 2 nondominant
E Trauma: 1 inadequate, 2 injury to arm, 3 direct injury to shoulder
F Tear type: 1 complete, 2 incomplete
F Tear type: 1 complete, 2 incomplete
G Surgery: 1 debridement only, 2 closure under tension, 3 closure without tension, a additional acromioplasty or resection of coracoacromial ligament
H 1 no cast, 2 cast for 4–6 weeks
I Score
K Ultrasonography: 1 normal ultrasonographic appearance, 2 loss of thickness/hyperdensity, 3 defect

Table 2. 100-point scoring system used in various shoulder conditions

Pain	
none	40
with/after heavy physical activity	35
with/after light physical activity	30
constant pain with motion	20
pain at night	10
constant pain	0
Function	
unlimited	40
limited with heavy physical activity	30
limited with light physical activity	20
constant limitation	10
complete loss of shoulder function	0
Stability	
full stability	20
subjective instability without dislocation	10
recurrent shoulder dislocation	0

Table 3. Results in 97 reexamined patients

Score	< 50	50–59	60–69	70–79	80–89	90–100
Patients	14	4	5	7	13	54

cuff tear was closed side to side, if possible, with interrupted sutures. In cases of tendon avulsions from the greater tubercle, the tendon was reattached to its original position with sutures through drill holes. Incomplete lesions were excised, if sufficiently deep. Because of retraction of the edges, four incomplete lesions and seven complete tears could not be closed without undue tension, and were merely debrided.

Additional anterior acromioplasties with resection of the coracoacromial ligament (Neer 1983) were performed in 48 shoulders, whereas resection of the coracoacromial ligament alone was done in 13 shoulders. The long biceps tendon was either resected or reattached in 12 shoulders, and synovectomies were performed in three shoulders. Postoperatively, most of the patients were immobilized for 2 to 6 weeks. A spica cast was used with the shoulder in 60° abduction, neutral rotation, and 45° anteversion. During the last 2 years, functional treatment with only a short period of immobilization and early physiotherapy was preferred.

Ninety-seven shoulders were reexamined clinically and by ultrasonography after 37 (12–101) months. The clinical result was graded according to a 100-point scale (Table 2) and classified as follows: excellent 90–100 points, good 80–89 points, fair 70–79 points, and poor below 70 points.

For the ultrasonographic examination, we used transverse and longitudinal transducer positions, as well as dynamic testing during motion. A real-time scanner (Philips R 1200), first with a 5 MHz and later with a 7.5 MHz linear transducer (Philips CS 9000), was used. The unaffected, contralateral shoulder was examined for comparison. The ultrasonographic result was classified into three groups (Figure 1): 1) normal, 2) loss of thickness and/or hyperdensity, and 3) a defect or absence of the rotator cuff.

Results

A normal clinical examination or slight pain or minimal limitation of motion without any notable functional impairment at the operated on shoulder was found in more than one half of the patients (Table 3). Seventy percent of all the patients had a good or excellent result, and 14 percent were graded poor. Almost one fifth of the contralateral shoulders revealed some abnormality.

In 37 shoulders, ultrasonography revealed a normal rotator cuff, in 31 shoulders loss of thickness and/or hyperdensity of the rotator cuff, and in 29 shoulders a complete rupture. One third of the contralateral rotator cuffs were ultrasonographically abnormal.

Clinical results were generally less favorable in older patients than in younger ones, with a correlation coefficient between age and clinical score of 0.52.

The clinical outcome was better with incomplete than with complete rotator cuff lesions, with a mean score of 88 points in the first group versus 80 points in the second group. Accordingly, a ultrasonographic examination revealed more advanced changes of the rotator cuff in complete tears than in incomplete lesions. These two groups, however, also showed differences as to their age and their treatment. For this reason, they were not immediately comparable.

Patients with concomitant anterior acromioplasties or a mere division of the coracoacromial ligament did better than the others: The score averaged 85, as compared with 76. Also, the ultrasonographic result was better in patients operated on with anterior acromioplasty, but the patients were not randomly selected for acromioplasty.

Clinical scores averaged 84 points in the group with normal ultrasonographic findings, 88 points in

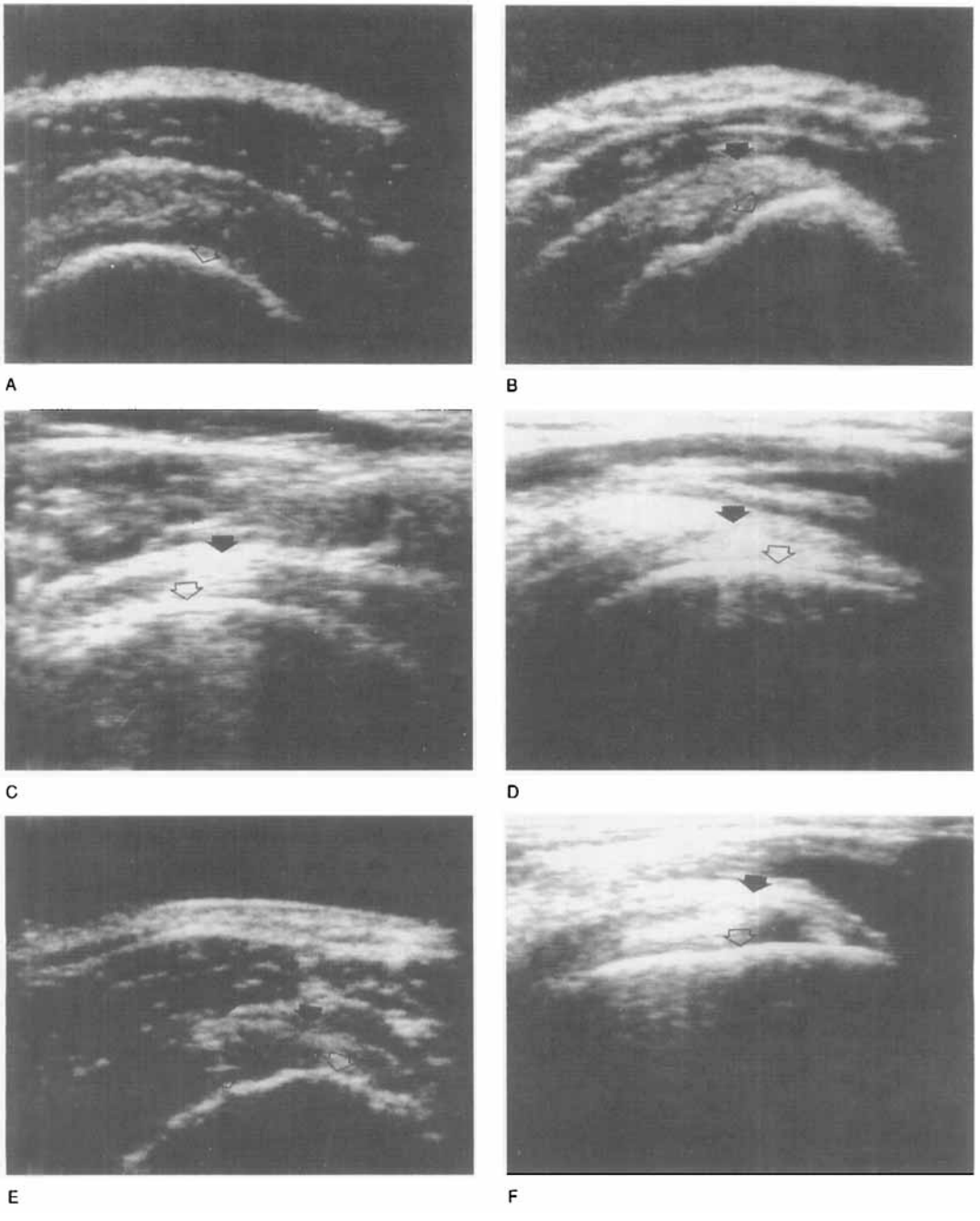

Figure 1. Classification of the ultrasonographic results. Solid arrows, subacromial bursa. Empty arrows, humeral head surface.

A. Normal ultrasonographic appearance in the transverse transducer position,

B. in the longitudinal transducer position.

C. Thinning of rotator cuff and nonhomogeneous, increased echo density in the transverse transducer position,

D. in the longitudinal transducer position.

E. Irregular echo pattern with loss of continuity of rotator cuff in the transverse transducer position,

F. in the longitudinal transducer position.

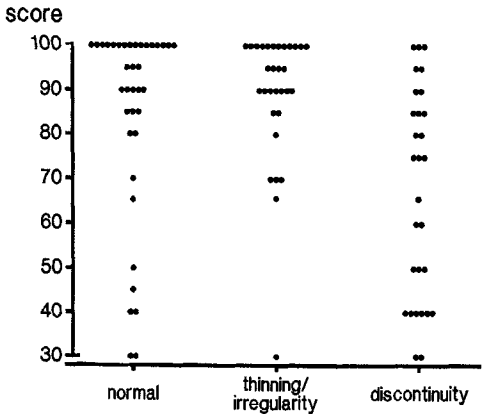

Figure 2: Clinical outcome, graded by 100 point score, related to ultrasonographic findings at follow-up examination. Mean score for normal ultrasonographic appearance was 84, thinning/nonhomogenicity 88, and discontinuity 67.

the group with thinning or nonhomogeneous echo patterns, and 67 points in the group with recurrent defects of the rotator cuff (Figure 2). Although these differences were significant ($P < 0.05$, t-test), there was a wide variation in scores within each of the three ultrasonographic groups. A patient with an intact rotator cuff on ultrasonographic follow-up may thus have had a bad clinical result and vice versa.

Discussion

Most authors (Samilson 1975, McLaughlin 1962, Packer et al. 1983, Refior and Stürz 1984, Ellmann et al. 1986) have reported satisfactory clinical results following surgical closure of rotator cuff tears in more than two thirds of their patients.

Ultrasonography is a relatively new diagnostic tool in conditions affecting the rotator cuff. When compared with shoulder arthrography, it appears to be almost equal in accuracy (Bretzke et al. 1985, Middleton et al. 1985, Crass et al. 1986, Mack et al. 1988). In our study, the ultrasonographic appearance of each shoulder could be assigned to three groups of distinct, characteristic echo patterns (Figure 1). This distribution can be assumed to be reliable, and ultrasonography offers the important advantage of being noninvasive and easily applicable.

Crass et al. (1986) also followed patients with operated on rotator cuff tears ultrasonographically. Using a 10 MHz transducer, they found irregular echo patterns in all but 1 of their 40 patients, thinning of the rotator cuff in none, and irregular echo patterns with loss of continuity in one quarter. These results are comparable to ours. The fact, however, that the thickness of the rotator cuff was normal in all the cases is surprising. Thinning as a sign of degenerative disease of the rotator cuff should be expected in a number of cases. In our study, the high percentage of patients with a normal ultrasonography may be explained by the better healing potential if incomplete lesions are included. Also, slight irregularities due to scar formation within the rotator cuff may not have been detected with the 7.5 MHz transducer that was used.

Mack et al. (1988) examined 60 patients with chronic, postoperative shoulder pain. Fifty of these had undergone rotator cuff repair. Some alterations of cuff echogenicity or decreased thickness were present in all 50 patients. Forty-three had recurrent full-thickness tears ultrasonographically. Twenty-seven were taken to revision surgery, and in 26 the ultrasonographic diagnosis proved correct.

Anterior acromioplasty has been found to have a positive effect on the clinical result of rotator cuff repair also by others (Neer 1983, Packer 1983, Ellman et al. 1986). This emphasizes the role of subacromial impingement as one source of pain in rotator cuff disease.

In our study, there was a clear correlation between age and clinical outcome. Progressive degenerative changes of the rotator cuff with increasing age shift the pathomechanics of rotator cuff rupture from a traumatic tear in the young to mostly degenerative tears with minimal trauma in the elderly. Suturing through degenerated cuff tissue in elderly persons appears to carry an unfavorable prognosis.

Of special interest is the relationship between clinical outcome and ultrasonographic appearance on follow-up examination. Autopsy studies (Cooton and Rideout 1964, Rothman et al. 1975, Neer et al. 1983, Refior et al. 1987) have shown that patients may be completely asymptomatic even in the presence of complete rotator cuff tears. Also, rotator cuff tears treated nonoperatively may still become asymptomatic (Brown 1949, McLaughlin 1962, Samilson and Binder 1975). Although our study showed a significant difference between scores of patients with ultrasonographically intact rotator cuffs and patients with rotator cuff defects, a wide variation of clinical scores was found in each group. Other factors, such as age, may also have influenced both the clinical result and the rotator cuff integrity.

A successful repair of the rotator cuff did not guarantee good clinical results.

The question therefore arises: What part does closure of the rotator cuff take in the relief of symptoms and in the restoration of arm function? The impingement syndrome, improved by anterior acromioplasty, may be contribute to pain relief. Other things, such as increased blood flow in the area of the incision or intensified physical aftercare may be equally important.

When considering reconstruction of the rotator cuff, the surgeon must therefore carefully weigh the benefits that may reasonably be expected from the operation and the extent of the necessary procedure. He must keep in mind that anatomic integrity of the rotator cuff does not necessarily guarantee a satisfied patient. In small tears, where closure can be achieved by inserting a few sutures into the rotator cuff, this seems to be a perfectly reasonable thing to do. A "watertight" closure, however, is not required. In larger defects—where coverage would require extensive tissue mobilization or even coverage with alloplastic material or with regional muscle flaps—the lesion should be debrided and left open.

We conclude that in patients over 40 to 50 years of age surgery is only indicated if symptoms remain unresponsive to intensive physiotherapy for 3 months; younger patients suffer predominantly traumatic tears and could be operated on earlier, unless there is evidence of preexisting rotator cuff disease. An anterior acromioplasty with division of the coracoacromial ligament and excision of the subacromial bursa should be performed in all cases. Minor tears should be closed with absorbable sutures, but it is better to leave large defects open after careful debridement of the margins.

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