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Shoulder arthrodesis for paralysis and arthrosis

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Twenty-three patients with a mean age of 35 years (11 males and 12 females) were reexamined 6 years after shoulder fusion. Indication for the operation was shoulder paralysis in 14 cases and arthrosis in 9. In 4 patients the operation had to be repeated because of nonunion. Eighteen patients had improved function, particularly in bringing the hand to the midline of the body, to the face, and to the side pocket. However, bringing the hand to the back and the anal region often deteriorated. One third of the patients, mainly those with arthrosis, had considerable shoulder pain at the follow-up.

Even though many investigators have reported acceptable results after shoulder arthrodesis with respect to motion and control of pain (May 1962, Makin 1977, Cofield & Briggs 1979, Rybka et al. 1979, Rowe 1983, Cofield 1986), less satisfactory long-term results have also been reported (Barton 1972). In recent years, prosthetic replacements have been widely used for painful shoulder conditions (Lettin et al. 1982, Neer et al. 1982, Cofield 1984).

I have reviewed the results of shoulder fusion in terms of healing, motion, and relief of pain.

Patients and methods

From 1970 through 1983, 29 shoulder arthrodeses for paralysis (19 cases) or arthrosis (10 cases) were performed at my hospital. Twenty-three patients (Table 1) were reexamined after 7 (2–13) years; 2 patients were dead and 4 were lost to follow-up. The mean age of the patients with paralysis was 26 (15–51) years and with arthrosis 48 (31–60) years. The average time between the onset of symptoms and the operation was 9 (1–26 years). Both sides were equally often operated on. In 4 patients the paralysis was limited to the shoulder region and in 10 it involved the entire extremity, but was more severe proximally. The etiology was poliomyelitis in 5, obstetric complication in 2, and other traumatic plexus injury in 7 patients.

The indication for fusion was poor function in the paralytic group and disabling pain in the arthrotic group. Two shoulders had been operated on before the first attempt at arthrodesis. The operative technique included removal of intraarticular debris, residual articular cartilage, and sclerotic bone, combined with fixation with one to three screws (Figure 1). The under surface of the acromion was dissected from soft tissues and the humeral head was approximated to the acromion. In some cases the acromion was osteotomized to facilitate the approximation. Autogenous bone grafts were not used.

The position aimed at was according to Barr et al. (1942). At operation, no device was used to estimate the position of the scapula and desired angles. Postoperatively, a spica cast was applied. The patients were followed clinically and radiographically at least until the fusion was judged to be solid.

At reexamination the patients were questioned about residual pain. The functional capacity was estimated by the ability to carry out seven simple tasks: reach the mouth, bring the hand to the crown of the head and behind the neck, place the hand on the ipsilateral buttock, on the midline of the body, anteriorly and posteriorly, and into the side-pocket of the trousers. The position of fusion was measured both clinically and radiographically. Clinically, the angle was measured with reference to the trunk, with the scapula in the

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Table 1. Data for 23 patients with shoulder arthrodesis

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A	B	C	D		E		F		G		H		I	
1	M 39	23	60	110	55	70	10	10	35	50	5	35	0	– 5
2	M 23	4	5	40	0	25	20	20	60	55	0	40	30	0
3	M 19	19	40	80	25	50	0	0	90	85	45	30	30	0
4	F 20	20	–	–	25	40	20	20	80	75	–30	90	5	30
5	F 19	14	40	75	60	65	0	0	80	70	5	45	0	10
6	F 51	3	20	70	45	65	0	0	25	45	–40	65	5	0
7	F 26	17	0	40	20	30	15	20	40	45	–65	90	5	0
8	M 22	1	40	80	55	65	60	10	85	75	–40	80	0	20
9	M 22	2	5	50	–	–	0	0	60	40	15	70	–	–
10	M 28	2	0	60	30	40	45	40	70	45	–25	80	20	15
11	F 27	16	5	75	40	55	0	0	10	50	0	40	25	0
12	F 15	15	–	–	–	–	0	0	70	60	0	20	–	–
13*	M 30	5	0	30	–	–	0	0	60	40	–	–	–	–
14	M 26	9	0	40	5	20	15	25	40	45	–15	80	25	0
Arthrotic Cases														
15	F 44	1	25	75	60	20	40	80	65	50	–50	80	0	20
16	M 47	5	50	90	60	70	60	30	40	40	–30	50	–10	–30
17	M 60	5	25	70	–	–	60	45	60	45	–15	80	5	0
18	F 35	1	–	65	–	–	90	60	85	90	5	70	–	–
19	F 60	5	30	80	40	50	90	70	55	45	–15	80	15	20
20	F 31	1	35	85	40	50	80	60	60	40	90	40	5	–
21	F 54	5	15	65	55	60	105	50	90	50	15	25	5	30
22	M 51	26	0	45	20	20	60	50	40	40	0	5	5	–
23	F 52	2	25	70	70	75	45	35	85	60	10	20	0	10

A	K	L	M	N	O	P	Q	R	S	T
1	3 3	3 3	3 3	3 3	3 3	3 3	3 3	2 2	2	2
2	3 1	3 3	3 3	2 3	2 2	2 2	2 1	1 1	2	2
3	3 3	3 3	3 2	3 3	3 3	3 3	3 3	1 1	1	12
4	3 1	3 3	3 3	1 2	1 1	2 1	2 1	1 1	2	12
5	3 1	3 1	3 1	2 3	2 3	3 3	3 3	1 1	2	12
6	3 3	3 3	3 3	3 3	3 3	3 1	3 1	2 2	3	13
7	2 2	3 3	3 3	2 2	2 2	2 2	2 2	4 2	3	5
8	3 1	3 2	3 3	2 3	2 3	3 2	3 1	3 2	2	9
9	3 2	3 3	3 3	3 3	3 2	3 1	3 1	2 2	3	4
10	3 1	3 3	3 3	3 3	2 2	2 1	2 1	3 3	3	6
11	3 1	3 2	3 3	3 3	3 3	3 1	3 1	1 1	2	10
12	3 1	3 1	3 1	2 2	2 1	2 3	2 2	1 1	2	3
13	3 3	3 3	3 3	3 3	3 3	3 3	3 3	3 2	1	7
14	3 3	3 3	3 3	2 3	2 3	2 3	2 3	3 4	3	3
15	1 2	2 3	3 3	2 3	1 3	1 2	1 1	4 4	3	9
16	3 1	3 3	3 3	3 3	3 3	3 2	3 1	4 4	3	4
17	1 2	2 3	2 3	2 3	2 3	1 2	1 1	4 4	4	3
18	1 1	1 1	2 1	2 1	1 1	1 1	2 1	4 1	2	2
19	3 2	2 2	3 3	2 3	2 1	2 1	2 1	4 2	2	6
20	1 1	1 1	3 3	3 3	1 1	1 1	1 1	4 4	3	5
21	1 1	1 1	1 2	3 3	2 3	2 3	1 2	4 1	1	5
22	1 2	2 3	2 3	2 3	2 3	2 3	2 3	4 4	4	13
23	1 2	2 2	2 3	2 3	2 3	1 3	1 2	4 3	3	2

A case number
B sex age
C years between onset of symptoms and arthrodesis
Position of arthrodesis:
D radiographic abduction of the humerus related to the medial (first column) and lateral border (second column) of the scapula
E clinical flexion (first column) and abduction (second column)
Range of active motion:
Preoperatively; F flexion (first column) and abduction (second column)
At follow-up; G flexion (first column) and abduction (second column)
H external (first column) and internal rotation (second column)
I extension (first column) and adduction (second column)
Possible hand excursion:
K mouth, L neck, M crown, N posterior midline, O buttock, P trousers sidepocket, Q anterior midline; 1 easy, 2 difficult, 3 impossible. First column preoperatively, second column postoperatively.

R Pain; 1 no, 2 mild, 3 moderate, 4 severe. First column preoperatively, second column postoperatively.
S Patient's assessment; 1 excellent, 2 good, 3 fair, 4 poor
T Years follow-up

* Severe plexus lesion. Amputation through the humerus was performed 2 years after the arthrodesis.

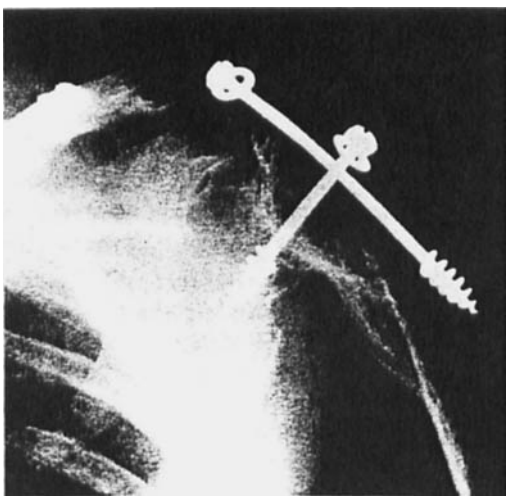

Figure 1. Case 13. A 38-year-old man 6 years after a brachial plexus injury and 3 years after shoulder arthrodesis.

neutral position. The angle of flexion was also measured in this position. Attempts were made to measure the angle of rotation. However, this proved impossible with the scapula in the neutral position.

Results

Radiographically confirmed solid union was achieved primarily in 18 cases within 3 to 7 months and after a reoperation in 4 cases (Cases 2, 9, 12, 20). One elderly patient (Case 17) refused a new cumbersome operation because the screws made the joint stable and painless enough. The reoperations were performed after 5 to 26 months. The cause of failure was technical in every case: debridement of the joint had been insufficient, or the position or fixation of the arthrodesis had been inappropriate.

Fifteen shoulders caused no or minimal pain, two caused moderate, and 6 caused severe pain. Preoperatively, 14 shoulders were painful (Table 1).

In paralytic cases the range of active flexion and abduction was preoperatively on an average 13° and 10° and at the follow-up 58° and 56°, respectively. In arthrotic cases the figures were 70° and 54° preoperatively and 64° and 51° at the follow-up, respectively. The range of regained extension, adduction, and rotation was small. At the follow-up the range of active flexion averaged 61°, of abduction 54°, of external rotation minus 6°, of extension 9°, of adduction 7°, and of internal rotation 55°. Only 6 patients had adduction of the arm more than 10°, and 2 patients could not entirely adduct the arm to the side. Only 3 patients had external rotation more than 20°, and 6 could not reach the midline.

Table 2. Angle of arthrodesis and range of active motion (mean values, degrees)

	Angle between the humerus and the lateral border of the scapula	
	>75 (mean 83) n 9	<75 (mean 54) n 12
Flexion	58	60
Abduction	56	50
Adduction	4	7

Only 1 patient could perform all seven functions tested , six were possible for 1 patient, and five were possible for 4 patients (Table 2). Eighteen patients considered the function of the extremity improved and 1 impaired (Case 17). Twenty patients would choose the same operation, if the operation had not been performed, and 12 evaluated the end result as excellent or good. In the paralytic group, there was no correlation between the patient's opinion of the result and pain. Four patients considered the result good without substantial objective improvement of the functional ability (Cases 1, 2, 3, 21). However, in the arthrotic group, displeased patients clearly had pain and poor function.

Radiographically, the angle between the humerus and the lateral border of the scapula averaged 66° (30–100°) and between the humerus and the vertebral border 21° (0–60°). Clinically, the position of fusion averaged 48° of abduction and 39° of flexion. In most cases there was internal or neutral rotation. An angle between the humerus and the lateral border of the scapula more than 75° did not increase the range of active flexion and abduction (Table 1). In 1 patient (Case 16), it was 90°, and he had a 30° limitation of adduction and an active abduction of the arm of only 40°. The widest angle was 110° (Case 1), the lack of adduction was 5°, and the range of active abduction only 50°.

In the arthrotic group, pain on exertion improved in 3 cases (Cases 18, 19, 21). Pain at rest diminished in 4 cases. In the paralytic group, shoulder pain at rest was present in 3 patients

preoperatively (Cases 1, 7, 10); in 1 the pain diminished (Case 7). There was no difference in the position of the arthrodesis or the range of motion between the six most painful shoulders and the rest of the patients.

Discussion

A full range of scapulothoracic motion and sufficient strength in the trapezius and serratus anterior muscles to elevate and rotate the scapula are important for shoulder fusion (May 1962). In the 14 paralytic cases of the present series, there was normal or almost normal strength in 13 trapezius and 12 serratus anterior muscles. However, in some cases the strength of the scapulothoracic muscles might have been too small.

Various positions for shoulder fusion have been recommended. Becker (1973), Fukuda et al. (1978), Kessel (1982), and Rowe (1983) recommended abduction of 20–30° compared with the mean abduction of 48° among my patients. According to Rowe (1974), lifting and elevation of the hand to the face and head are accomplished more efficiently when there is no abduction of the arm. Also, higher figures have been recommended: Barr et al. (1942) 45–50°, Horvath (1927) 90°.

There was no clear connection between the angle of clinical abduction and the range of active motion at the follow-up examination. Cofield & Briggs (1979) also stated that neither the angle of abduction nor flexion influences function very much, and that rotation is the most important determinant of functional success after shoulder fusion. However, a position in extensive abduction was harmful.

The position of clinical flexion averaged 39° among my patients. Most authors recommend 15–30° (Barr et al. 1942, Kessel 1982, Rowe 1983) and warn against excessive flexion, which will produce winging of the scapula (Becker 1973, DePalma 1973), and which was in fact seen in some of my patients.

Some authors recommend external rotation of 15–40° (Barr et al. 1942, May 1962, DePalma 1973). Rowe (1983) recommended internal rotation of 45–50°. He preferred to measure the angle of rotation with the arm positioned on the side of the body. During the operation, it is very difficult to estimate the angle of rotation. With the arm positioned at the side, most of my patients had internal rotation.

The estimation and maintenance of the position selected is difficult (Davis & Cottrell 1962, Beltran et al. 1975). Charnley & Houston (1964) and Rowe (1974) emphasized that the angle of abduction should be determined on the basis of the clinical position of the arm relative to the side of the body. In my series, this method was used at operation. However, the exact desired angle of abduction and flexion was seldom achieved.

The important requisities after arthrodesis of the shoulder are according to Rowe (1974) that the hand should reach the face, head, and midline of the body anteriorly and posteriorly; that the arm should be in the position of maximum strength for lifting, pushing, and pulling; that the shoulder should be comfortable when the arm is at the side of the body, and that the scapula should not be prominent in this position. In my arthrotic group, almost all the functions of the extremity deteriorated; only reaching the mouth and the midline of the body anteriorly did not change. By contrast, in the paralytic group, the function of the extremity improved markedly; only bringing the hand to the buttocks did not change.

Shoulder fusion can be difficult to achieve and many intraarticular and extraarticular surgical procedures have been described (Brett 1933, Charnley 1951, Carrol 1957, Davis & Cottrell 1962, Debrunner & Cech 1975). Complete healing of a shoulder arthrodesis can be achieved in more than 90 per cent of the cases (May 1962, Charnley & Houston 1964, Cofield & Briggs 1979, Rybka et al. 1979, Schröder & Frandsen 1983). An advantage of internal fixation by screws is that this procedure ensures maintenance of the position. Removal of the screws, if needed, is a minor operation, and it can usually be performed under local anesthesia. May (1962) emphasized the use of autogenous bone grafts. However, my five nonunions were judged to be caused by technical failures, not by the absence of a bone graft.

My results in patients with arthrosis were not thoroughly acceptable. Rowe (1983) recommended arthrodesis of a painful arthrotic shoulder joint instead of a prosthetic replacement if the patient's occupation requires heavy manual labor. None of my patients could do heavy work. In

patients with paralytic shoulders, however, the arthrodesis provided marked functional improvement, and for these patients the operation can be recommended.

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