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Cup arthroplasty of the rheumatoid shoulder

Hemiarthroplasty of the humeral head, using a stainless steel cup, was performed in 26 shoulders of patients with rheumatoid arthritis who had severe pain and loss of function. All the shoulders were Larsen's radiographic Grade 4 or 5. After 2 (1–5) years, all the shoulders were painless and had satisfactory function. Partial radiolucent zones exceeding 1 mm were seen in three shoulders.

Eggert Jónsson
Niels Egund[1]
Ian Kelly
Urban Rydholm
Lars Lidgren

Departments of Orthopedics and [1]Diagnostic Radiology, Lund University Hospital, S-221 85 Lund, Sweden

A variety of hemiarthroplasties has been used at the glenohumeral joint (Neer 1974, Marmor 1977). However, only Steffee & Moore (1984) have described the use of a humeral head cup. Their results are comparable with those reported for other types of shoulder arthroplasty (Neer et al. 1982, Cofield 1983).

Patients suffering from rheumatoid disease frequently have osteoporotic, deficient glenoid bone, weak deltoid muscles, and thin rotator cuff tendons, which may be torn. These structures are important for the function of a non-constrained arthroplasty at the shoulder (Walker 1982), and the results of surgery in these patients should therefore be analyzed separately.

We report the use of a humeral head cup arthroplasty in rheumatoid arthritis.

Patients and methods

Twenty-six shoulders were operated on with a hemispheric stainless steel cup from 1981 until 1985 (Figure 1). There were 6 men and 19 women aged 60 (33–74) years. These patients had suffered from rheumatoid arthritis for 12 (5–34) years and had had shoulder symptoms for 5 (1–21) years. In 5 cases the disease had begun in the shoulder.

The shoulder joints were examined radiographically with routine projection with the humerus in abduction, internal and external rotation. The degree of attrition of the humeral head and of the glenoid cavity was assessed from these radiographs (Figure 2, Table 1). The shoulders were all Grade IV or V according to Larsen et al. (1977).

Operation. The shoulder was approached through an anterior saber-cut incision, preserving the cephalic vein by retracting it medially with a narrow strip of the deltoid muscle. The subdeltoid bursa was excised. The subscapularis tendon was divided between stay sutures approximately 1.5 cm from the bicipital sulcus. If the tendon of the long head of the biceps was intact, but could not be saved, it was tenodesed in the bicipital sulcus and divided proximally. Intraarticular constrictions were cut with scissors. The humeral head was then dislocated. The anterior part of the rotator cuff was incised to facilitate the dislocation when required. The glenoid bone was curetted, cysts evacuated, and osteophytes were removed. The humeral head was then prepared using a hemispheric reamer until a good surface was obtained at approximately 45 degrees to the shaft of the humerus, adjusting the degree of retroversion to align the joint. A thorough synovectomy was performed and any cysts present were curetted clean. After preparing the humeral head with pressure irrigation, a cup of the appropriate size was cemented into place using gentamicin containing Palacos® bone cement.

The hemispheric stainless steel cup was initially 3 mm and later 1.7 mm thick. It has both circumferential and radial grooves on the inside to enhance its fixation and to permit the extrusion of excess cement (Figure 1). The rim is tapered in cross section. The cup is available in two sizes: 38 mm and 42 mm in diameter (The Scandinavian Shoulder (Scan Shoulder), MITAB, Sjöbo, Sweden).

Operative findings. The majority of the patients had intraarticular adhesions. The rotator cuff was intact in 19, thin in 4, and ruptured in 3. The biceps tendon was intact in 16 and ruptured in 10. The hum-

Table 1. Radiographic analysis

Larsen's grade	No.	Bone attrition (mm)					
		Humeral head			Glenoid		
		<5	5–10	>10	<5	5–10	>10
IV	2	2	0	0	2	0	0
V	24	6	10	8	9	12	3

Figure 1. View of the cup from the inside illustrating the tapering rim and the cement-retaining grooves.

eral head bone was good in 14, had cysts in 9, and was very deficient in 3 patients. The shape of the glenoid cavity was well preserved in most cases, although many had cysts and osteophytes.

Postoperative radiography. This included anteroposterior and lateral views of the proximal portion of the humerus, each projection being defined in relation to the elbow joint. In addition, fluoroscopy was used to obtain a true lateral view of the cup and, when this position of the arm had been achieved, the degree of retroversion or anteversion was determined by measuring the angle between the direction of the forearm in 90 degrees of flexion and that of the central x-ray beam. From the radiograph obtained in this position, the angle between the cup rim and the longitudinal axis of the humerus was measured (Figure 2).

Superior subluxation of the head of the humerus was estimated using two measurements as a guide: (a) the displacement of the inferior margin of the neck of the humerus, which normally forms an arch with the inferior aspect of the neck of the scapula (Dijkstra et al. 1985); (b) the point on a line drawn parallel to the superior and inferior margins of the glenoid cavity where it formed a tangent to the medial aspect of the humeral head or the cup. In 10 normal shoulders, the position of this point was found to be a few millimeters inferior to the midpoint of the glenoid cavity as measured on the radiograph.

Rehabilitation. Postoperatively, the arm was placed on a polyurethane resting splint in slight flexion and abduction with approximately 60 degrees of internal rotation. The elbow was mobilized immediately and the shoulder was mobilized on the 5th day passively and actively, apart form external rotation, which was avoided for 6 weeks to protect the repaired subscapularis tendon. The hospital stay usually lasted 3 weeks, after which rehabilitation continued on an out-patient basis. At 6 weeks the splint was discontinued and no further restrictions were imposed. Clinical and radiographic assessments were performed at 3, 6, and 12 months and annually thereafter.

Follow-up. Twenty-six shoulders (25 patients) were reviewed by an orthopedic surgeon who was not involved in the primary surgery at 18 (6–54) months and again at 28 (16–64) months. Two patients had died of unrelated causes at 60 (No. 1) and 32 (No. 8) months, respectively, both having had painless shoulders.

Results

The detailed results are shown in Table 2. Pain relief was good in all the shoulders and represented a major improvement over the preoperative state (Table 3). Function was similarly improved, although only 1 patient could use the hand above head height, an activity rarely attempted by patients with polyarthritis.

The total ranges of flexion and abduction were limited, and the greatest gains in motion were seen in flexion and internal rotation (Table 4). The mobility of the elbow joint was unchanged in 20 cases and decreased in 6; there was a decrease of flexion of 10 to 20 degrees in 3 cases and a decrease of extension of 15 to 30 degrees in 5 cases.

Radiographic analysis. From the radiographic measurements (Figure 2), the mean of the ratio of a/b preoperatively was 1.27 (0.80–1.68), and postoperatively it was 1.50 (0.84–2.23), which was greater than the values obtained for 11 normal shoulders: 1.35 (1.10–1.50). The mean valgus angle of the cup was 39 (21- 62) degrees.

Superior subluxation was found both preoperatively and postoperatively. It was present preoperatively in 17 shoulders, unchanged after surgery in 5, greater in 4, less in 3, and absent in 5 shoulders. Of the nine shoulders with no preoperative superior subluxation, three developed subluxation between 6 and 12 months postoperatively; the subluxation was 5 mm in 2 shoulders and 10 mm in 1 shoulder. The pres-

Table 2. Preoperative, peroperative and follow-up data on 26 cup arthroplasties of rheumatoid shoulders.

	A	B	C	D	E	F	G	H	I	J	K		L		M		N		O		P		Q		R	S	T
1	F	68	21	1	R	V	T	60	3	1	4	1	40	20	45	80	30	45	60	60	0	50	150	150	20	20	+ +	+ +	− −
2	M	45	7	2	L	V	N	64	3	1	3	1	70	45	85	70	40	50	10	50	0	10	120	120	30	45	− +	− +	− −
3	F	60	13	5	L	V	N	55	3	1	4	1	70	60	75	80	20	50	10	80	15	30	145	150	25	40	− +	− +	− −
4	M	58	16	2	L	V	R	55	3	1	4	1	30	45	35	80	0	45	0	80	0	20	130	140	20	30	− +	− +	− −
5	F	33	21	21	R	V	T	45	4	1	4	1	0	80	0	40	0	40	0	40	0	50	150	150	15	35	− +	− +	− −
6	F	44	15	15	L	V	T	44	4	1	4	1	15	100	70	120	10	30	0	80	0	20	150	150	0	0	− +	− +	− +
7	M	63	13	1	R	V	N	43	1	1	4	1	65	55	30	70	20	55	0	45	0	30	120	130	20	20	− +	− +	− −
8	F	63	34	10	R	V	N	32	3	1	4	1	50	30	30	70	20	20	15	70	15	30	140	140	20	20	− +	− +	− −
9	F	64	6	6	R	V	N	41	4	1	4	1	15	50	10	50	10	40	10	30	10	20	135	135	0	0	− +	− +	− −
10	F	68	5	4	R	V	N	40	4	1	4	1	20	50	20	50	10	50	20	55	30	40	135	135	0	0	− +	− +	− −
11	F	63	10	9	L	V	N	31	3	1	4	1	20	45	60	90	0	40	0	50	0	20	150	150	0	0	− +	− +	− −
12	F	36	10	7	L	V	N	31	4	1	4	1	10	80	10	80	0	55	0	40	0	35	150	130	0	20	− +	− +	− −
13	F	35	6	3	L	V	N	29	4	1	4	1	20	60	0	70	0	50	0	30	0	50	150	150	0	0	− +	− +	− −
14*	F	43	19	10	R	V	R	28	3	1	4	1	25	45	40	45	25	55	10	50	15	25	150	135	0	30	− +	− +	− −
15	M	71	10	5	L	V	R	28	4	1	4	1	10	70	30	70	0	60	0	40	0	40	150	150	0	0	− +	− +	− −
16	F	71	24	10	L	IV	N	24	4	1	4	1	0	90	0	90	0	40	0	70	0	80	150	150	0	0	− +	− +	− −
17	F	40	15	4	L	V	N	24	2	1	4	1	0	70	0	75	0	40	0	35	0	10	70	80	70	60	− −	− +	− −
18	M	49	11	5	R	V	N	23	2	1	4	1	20	70	20	80	30	30	20	45	0	30	140	140	0	0	− +	− +	− −
19	F	63	11	5	L	V	T	19	4	1	4	1	0	45	0	80	0	30	0	80	0	30	150	140	0	20	− +	− +	− −
20	F	33	9	9	R	V	N	19	2	1	4	1	20	45	20	70	0	45	20	80	10	10	120	150	20	20	− +	− +	− −
21	F	65	16	5	L	V	N	18	4	1	4	1	20	45	40	45	0	35	10	90	10	40	150	150	0	25	− +	− +	− −
22	F	58	10	1	L	V	N	18	4	1	4	1	10	45	30	70	0	45	30	90	0	30	150	150	0	0	− +	− +	− −
23*	F	44	20	10	L	V	N	16	4	1	4	1	25	50	35	70	30	45	10	55	15	30	135	135	30	30	− +	− +	− −
24	F	43	9	4	L	IV	N	16	4	1	4	1	10	70	10	90	10	40	0	30	0	20	150	150	10	10	− +	− +	− −
25	F	61	9	7	R	V	N	13	4	1	4	1	0	45	60	70	0	40	10	90	0	45	160	160	0	0	− +	− +	− −
26	F	73	20	3	L	V	N	13	3	1	4	1	15	55	15	50	15	60	0	60	0	30	150	150	0	0	− +	− +	− −

A: Sex
B: Age, years
C: Duration of RA in years
D: Duration of shoulder pain
E: Side
F: Larsen class
G: Supraspinatus tendon
N = normal; T = thin; R = ruptured
H: Follow-up period, months
I: Pain at rest, before/after
J: Pain on exertion
1 = no pain; 2 = slight;
3 = moderate; 4 = severe.
Shoulder motion (degrees)
K: Abduction, before/after
L: Flexion
M: Extension
N: Internal rotation
O: External rotation
Elbow motion (degrees)
P: Flexion, before/after
Q: Extension deficit
Ability to reach
R: Mouth S: Perineum
T: Above head

ence of the subluxation was not associated with less motion.

The retroversion of the cup with respect to the humerus varied between −15 (anteversion) and +45 degrees, with an average of +5.8 degrees.

Radiography revealed radiolucent zones at the margin of the cup, between the cement and the bone in 2 cases, and between the cup and the bone in 1 case. These zones measured 1.5 mm, 2.5 mm, and 1.5 mm, respectively. The last-mentioned was a patient that initially complained of postoperative pain.

Complications. Four patients complained of pain at the first follow-up: Shoulders Nos. 6, 17, and 19 had deficient humeral head bone stock: two with humeral heads that were described as "finger ends" after reaming, and one with large cysts in the head. Shoulder No. 6 had radiographic features suggestive of loosening, but shoulders Nos. 17, and 19 had no such

Table 3. Cup arthroplasty of rheumatoid shoulders. Pre- and postoperative pain.

	At rest		At motion	
	Pre	Post	Pre	Post
None	1	26	0	26
Slight	3	0	0	0
Moderate	8	0	1	0
Severe	14	0	25	0

Table 4. Cup arthroplasty of rheumatoid shoulders. Pre- and postoperative motion in degrees. Mean (range)

	Pre	Post
Abduction	24 (0–70)	57 (20–100)
Flexion	30 (0–75)	66 (40–120)
Extension	10 (0–40)	44 (20–60)
Internal rotation	9 (0–60)	59 (30–90)
External rotation	5 (0–30)	32 (10–80)

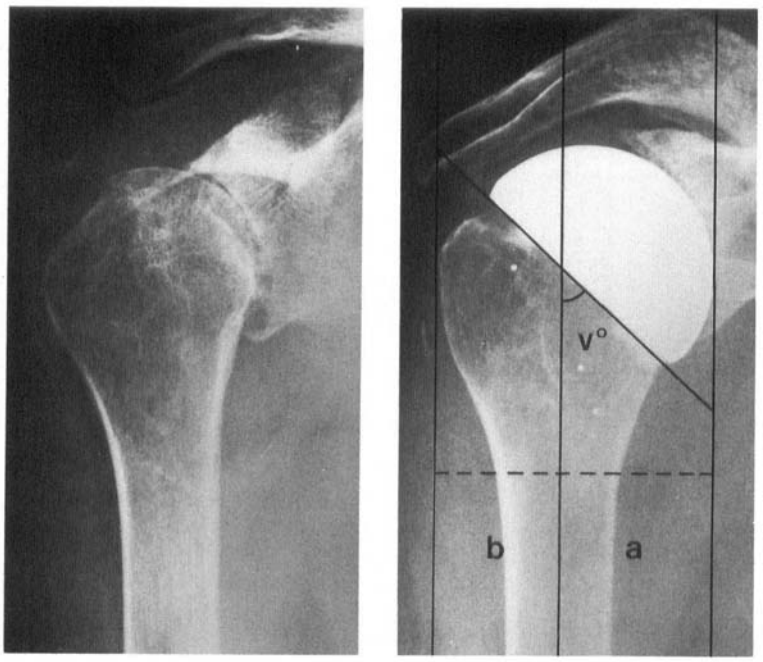

Figure 2. Rheumatoid arthritis before and after arthroplasty. The tantalum balls are used for roentgenstereophotogrammetry. a = the offset of the cup from the midline of the humerus. b = the offset of the greater tuberosity. v = the angle between the base of the cup and the shaft of the humerus.

signs; these two shoulders, however, had extremely poor motion. All three patients suffered from a temporary increase in the activity of their disease and recovery from pain had been spontaneous at the second follow-up.

Shoulder No. 15 was painful due to subacromial impingement and was reoperated on with an anterior acromioplasty with good result.

Thus, all 4 patients with complications had painless shoulders at the second follow-up 10 months later.

Discussion

We have found that the preliminary results from the use of a cup arthroplasty of the humeral head in rheumatoid patients are comparable with those obtained using stemmed humeral head replacements (Marmor 1977, Clayton et al. 1982), and total shoulder arthroplasty (Pahle & Kvarnes 1985). The small gains in the ranges of movement compared with arthrosis (Neer et al. 1982) are typical findings in the rheumatoid patient. However, comparisons between series are difficult because of the lack of uniformity in the presentation of the results (Table 5).

Cup arthroplasty has the advantage that it does not violate the humeral medullary cavity; it is simple to perform; and it is widely applicable because the humeral neck is almost invariably spared, even in the most severely damaged shoulders (Dijkstra et al. 1985). In the event of failure, there is sufficient bone stock for an arthrodesis.

There are several theoretical objections to the use of a hemiarthroplasty in patients with rheumatoid arthritis. These are glenoid wear, cup loosening, and humeral neck fracture.

The problems encountered with loosening of glenoid components in total shoulder arthroplasty (Lettin 1981, Cofield 1983), and the often osteoporotic and deficient bone in rheumatoid patients led to the use of a hemiarthroplasty. However, the articulation of metal and bone can also cause problems owing to glenoid wear. Fifteen of our patients had more than 5 mm of glenoid bone loss preoperatively, but only 1 patient complained of pain postoperatively, and at reoperation this was found to be due to impingement.

Our measurements showed that the size of the humeral head was restored or enlarged except in some cases with bone attrition greater than 5 mm.

Bone attrition on either side of the shoulder joint will cause medialization of the humerus, thus reducing the lever arm for elevation and

Table 5. Shoulder motion in degrees after arthroplasty for rheumatoid arthritis[a]

	N	Abduction	Flexion	Extension	I.R.[b]	E.R.[c]
Murray et al. (1985) normal joints in older women	10	178	170	61	56	94
Gristina & Webb (1981) total arthroplasty	19	69 (29)	50 (15)	39 (4)	90 (40)	32 (12)
Clayton et al. (1982) hemi arthroplasty	7	– –	– (19)	–	– (9)	– (15)
total arthroplasty	6	– –	– (34)	–	– (3)	– (12)
Neer et al. (1982) total arthroplasty	50	– –	– (57)	–	– –	– (60)
Cofield (1984) total arthroplasty	29	103 (46)	– –	–	– –[d]	35
Pahle & Kvarnes (1985) total arthroplasty	41	– (24)	– (16)	– (13)	– (6)	– (15)
Present series cup hemi arthroplasty	26	57 (33)	66 (36)	44 (34)	59 (50)	32 (27)

[a] Figures in brackets represent gains in motion.
[b] I.R. = Internal rotation.
[c] E.R. = External rotation.
[d] Internal rotation expressed only in terms of anatomic level reached by hand.

increasing vertical pull. This can be partially compensated for by the increase in the off-set of the humeral head. In the case of extreme humeral head attrition, we now use a stemmed prosthesis with the same head configuration.

Finite element analysis of designs of humeral components (Orr & Carter 1985) suggests that a cup would produce large shear stresses between the cup and the bone or cement, and rim stress concentrations; the former would predispose to loosening and the latter to humeral neck fractures. We have not encountered this problem in our patients.

The presence of superior subluxation on the radiographs is often interpreted as a sign of total rotator cuff rupture. In our series only three cuffs were ruptured. It therefore seems possible that superior subluxation is a sign of a diseased rather than a ruptured cuff.

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