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Radiocapitellar arthroplasty: a consecutive case series with 2 to 6 years' follow-up

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Background: The aim of this study was to analyze indications, outcomes, and complications in patients treated with radiocapitellar arthroplasty.
Methods: This prospective analysis of clinical and radiographic results included 16 elbows in 15 patients.
Results: This study included 4 men and 11 women (mean age, 51.9 years; age range, 32-65 years). The mean follow-up period was 3.4 years (range, 2-6 years). The indications were post-traumatic (n = 10) and primary radiohumeral osteoarthritis (n = 6). A mean of 2 surgical procedures (range, 0-4) had been performed before radiocapitellar arthroplasty. The mean Mayo Elbow Performance Score significantly improved from 46 points to 85 points ($P < .01$). The arc of motion improved from 106° to 117° ($P = .27$). Radiographic ulnohumeral degeneration progressed in 40% of cases but was not symptomatic in any. Subsequent surgery was required in 5 elbows (31%). Revision of the radial head component was necessary in 4 patients (25%). In 3 patients this was a result of loosening of the stem. The radial component was subsequently removed because of persistent pain in 1. Radiographic loosening not requiring revision was found in 2 patients.
Conclusion: The overall Mayo Elbow Performance Score was good to excellent after radiocapitellar arthroplasty. Both the revision and reoperation rates were high, and one should consider this before performing this procedure. Loosening of the radial head component was a problem. An improved fixation technique or an adaptation of the design is needed before this type of surgery can be recommended as a standard procedure.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Radiocapitellar arthroplasty; elbow prosthesis; elbow arthritis; post-traumatic; radial head; capitellum

The development of elbow osteoarthritis (OA) is known to occur asymmetrically, starting at the lateral side and progressing medially.[1,7,10] Lateral-sided changes often remain asymptomatic, and most patients do not seek medical advice until the ulnohumeral joint is affected.[3,14] However, debilitating symptoms do develop in a small percentage of patients owing

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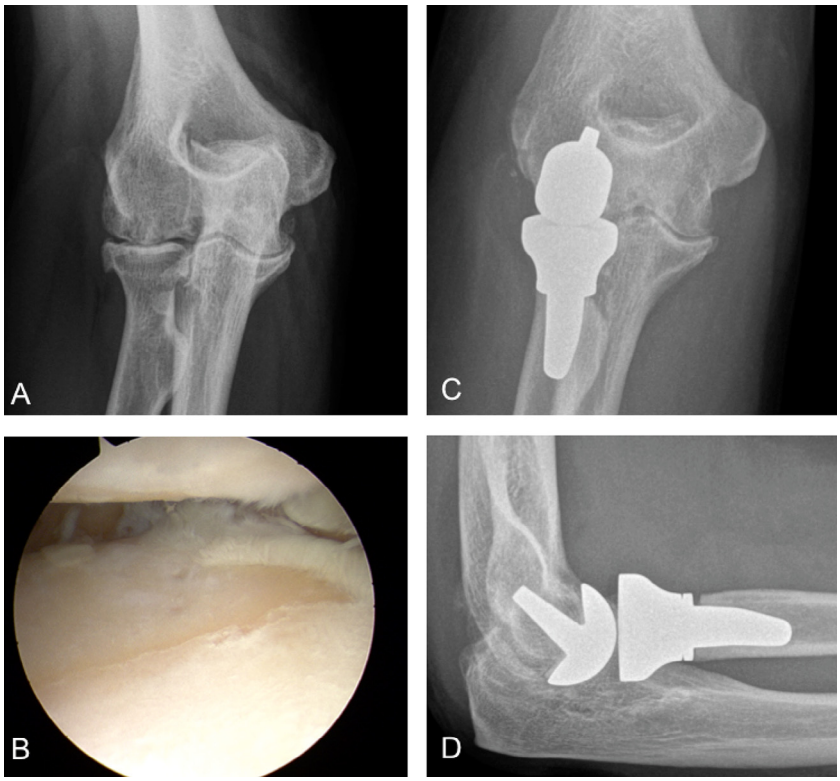

Figure 1 **(A)** Anteroposterior radiograph of the left elbow of patient 5 (elbow 13) showing primary osteoarthritis mainly in the lateral compartment. **(B)** Arthroscopic débridement was performed 10 months before the radiocapitellar arthroplasty and showed severe chondral defects of the radial head and the capitellum. **(C, D)** Anteroposterior and lateral radiographs 3 years after implantation of radiocapitellar arthroplasty. (Courtesy of the Monica Orthopaedic Research [MoRe] Foundation.)

to primary or post-traumatic degeneration, isolated to the lateral side of the elbow (Fig. 1).[5,18] Arthroscopic débridement and synovectomy often lead to excellent results in these patients. If these fail, there are several options such as resection of the radial head or interposition of the anconeus.[2,4,5,16] Both procedures have the theoretical disadvantages of increased valgus strain on the joint[21] and a decrease in longitudinal stability and load transfer. At least biomechanically, radiocapitellar arthroplasty (RCA) has been shown to restore elbow kinematics,[19] so RCA may be considered instead of resection with or without tissue interposition.

Other indications for RCA may include salvage procedures for capitellar erosion after radial head prosthesis placement, missed Essex-Lopresti injuries, or late sequelae with longitudinal instability of the forearm after radial head resection.[9,11] These indications are rare but include very challenging cases because patients undergoing RCA have often had several prior failed surgical procedures.[3,5,6]

Our treatment protocol for young and active patients with isolated primary or post-traumatic radiocapitellar arthritis is to perform an arthroscopic débridement if possible. However, if the radial head degeneration is too severe, basically needing a resection of the radial head, we perform RCA implantation without débridement first. The aim of this study was to report the outcome of a consecutive case series, treated by a single surgeon, with specific interest in indications, outcomes, and reasons for failure to potentially improve the outcome of this procedure in this difficult group of patients.

Materials and methods

For this prospective, single-institution study, we analyzed the results of all patients treated with RCA by the senior author between December 2010 and October 2015. Only patients with a minimum follow-up of 2 years were included in this study. Clinical and radiographic follow-up was performed preoperatively and after 2 and 6 weeks, 3 and 6 months, and 1 year, as well as yearly thereafter.

Clinical data

Preoperatively, patients were assessed in terms of elbow function using the Mayo Elbow Performance Score (MEPS). Demographic data, onset of symptoms, and previous surgical procedures on the affected elbow were noted. During follow-up, complications or subsequent operations were recorded in the notes. At final follow-up, patients' function was assessed again and the MEPS was calculated.

Radiographic analysis

Radiographic measurements and analysis were performed on both anteroposterior (AP) and lateral radiographs taken at 6 weeks

postoperatively and at final follow-up. The assessment included ulnohumeral degenerative changes such as joint space narrowing and osteophytes. To quantify these changes, we used the Kellgren-Lawrence classification (grades 0-4) on the AP radiographic view.[13] Furthermore, the ulnohumeral joint space was measured on the lateral and medial sides to estimate joint congruity after RCA.[5] The prosthetic components were assessed for signs of loosening. Loosening of the radial head component was graded on a scale from 1-7.[8,17]

Surgical technique and rehabilitation

All surgical procedures were performed with the patients in the supine position. Either general or locoregional anesthesia was used, depending on the patient's preference. A tourniquet was applied in all cases. We used the extensor tendon split approach (directly anterior to the lateral collateral ligament [LCL]), and the humeral LCL insertion was detached sharply in all patients for better exposure. The surgical steps are as follows: first, the radial head osteotomy is performed at the head-neck junction, and the shaft is reamed until a firm press fit is obtained. The height of the radial head is measured in relation to the sigmoid notch.[22] The size of the capitellar component is based on the lateral side of the capitellum. The orientation of the capitellar component is based on the rotational axis of the elbow, which is marked with a K-wire using the aiming device provided by the manufacturer. With the correct size of the capitellar cutting guide, the osteotomy is performed with an oscillating saw and finalized with a sharp osteotome. Special attention is given at this point not to extend the osteotomy into the trochlea. The resected radial head and capitellar surface are then used to reassess the size of the prosthetic components. The trial capitellar component is used to assess the osteotomy planes and orientation. At this point, small adjustments can still be made. For the next step, the humeral canal is prepared and the definitive capitellar component is implanted. According to the manufacturer's instructions, a small amount of cement is placed on the back of the component but not on the stem. This is done to prevent rocking of the implant, which could potentially cause loosening. The radial head component is placed without cement, but if it does not achieve a sufficient press fit, it may be cemented as well. Finally, the annular ligament is sutured and the LCL complex is reattached at its humeral insertion, using a bone anchor; alternatively, bone tunnels can be used.

No additional surgical procedures were performed at the time of RCA in any of the patients. Patients were allowed to mobilize their elbow without restriction on the first postoperative day. Usually, no physiotherapy was prescribed unless a range of motion (ROM) deficit was present after 6 weeks. After 3 months, unrestricted activity was allowed.

Statistics

Two tailed Mann-Whitney *U*, Wilcoxon signed rank, and paired *t* tests were used to compare the preoperative and postoperative outcomes. The level of significance was set at $P < .05$.

Results

In the included time span, a total of 16 RCA implantations were performed in 15 consecutive patients (4 men and 11 women; mean age, 51.9 years; age range, 32-65 years). The UNI-Elbow System (Stryker, Kalamazoo, MI, USA) was used in 15 elbows, whereas a custom capitellar replacement was used in 1 patient who had previously received a floating radial head prosthesis (Wright Medical, Memphis, TN, USA). One patient died 18 months after the RCA operation and was thus not included in the final results. The mean follow-up period was 3.4 years (range, 2-6 years). The indications included 10 post-traumatic and 6 primary OA cases (Table I). In 3 cases, a radial head prosthesis was already implanted and was converted to RCA by exchanging the metal head with a component with a polyethylene articulation. The stem was well fixed and could be left in place. Ten patients had undergone 1 or more surgical procedures before coming to our clinic. In all but 1 patient, RCA was not the primary procedure. This patient had a fracture-dislocation of the elbow with a type 3 radial head fracture 6 months before RCA. She was being treated for colon cancer at the time of the fall, and the radial head fracture was treated conservatively. During surgery 6 months later, we found that the radial head malunion had led to destruction of the capitellum and we decided to perform a primary RCA. Our patients underwent a mean of 2 surgical procedures (range, 0-4 surgical procedures) before the implantation of the RCA. Arthroscopic débridement was performed in 10 patients and was the most common preoperative procedure (Fig. 1). Three patients already had a prosthetic radial head replacement. The radial component was cemented in 4 patients because of a lack of an adequate press fit intraoperatively. A bipolar radial head component was used in 6 patients. There were 2 patients in whom the radial head prosthesis was converted to a radiocapitellar prosthesis and 4 patients in whom the orientation of the radial head relative to the capitellum was considered suboptimal on preoperative imaging. This was because of malunion of a radial head fracture in 2 patients and a radial head dislocation in the other 2 patients: 1 congenital and 1 traumatic.

Clinical results

The mean MEPS improved significantly from 46 points to 85 points ($P < .01$). This was mainly because of an improvement in pain scores at final follow-up compared with preoperative pain levels. No significant changes in ROM were found. The arc of motion improved from 106° preoperatively to 117° at final follow-up ($P = .27$) (Table I). Flexion improved from 133° to 134° ($P = .67$), and the extension deficit increased from 26° to 17° ($P = .22$). The preoperative MEPS was significantly ($P = .04$) lower in patients who received a bipolar radial head component (average, 35 points; range, 10-55 points) than in patients with a unipolar component (average, 53 points; range, 25-70 points). This difference was no longer significant at final follow-up (bipolar average MEPS, 80 points [range, 70-100 points]; unipolar average MEPS, 88 points [range, 70-100 points]; $P = .27$).

Table I Data in all patients treated with RCA

Patient No.	Sex	Age, yr	Prior surgical procedures	Indication	Before RCA		FU, yr	Final FU		Unplanned surgery (mo)
					MEPS, points	ROM, °		MEPS, points	ROM, °	
1*	F	41	1	Primary OA	55	120	—	—	—	
2	M	41	1	PTA (RH fx, conservative)	25	90	6	95	75	
3	M	61	2	PTA (fx-dislocation RH, conservative)	70	130	6	80	135	Revision of RH (24)
4	F	58	1	Primary OA	60	100	5	80	95	
5	M	53	2	Primary OA	50	80	5	100	115	
6	F	57	4	PTA (RH fx, ORIF)	55	135	5	70	140	Revision of RH (8)
7	F	43	1	PTA (RH fx, conservative)	50	85	3	65	95	Revision of RH because of impingement and arthrolysis (20)
8	F	44	3	Fx-dislocation, RHP; revision to RCA	45	140	4	70	145	Revision of RH and removal of RH (15)
9	F	49	3	PTA (RH fx, ORIF)	20	100	3	70	140	
10	F	56	1	PTA (RH fx, conservative)	55	120	2	100	135	
11	M	59	4	Fx-dislocation, ORIF, RHP; revision to RCA	50	120	3	80	125	
12	F	57	4	OA (Sauvé-Kapandji procedure 10 yr before)	55	130	2	100	140	
13 (same as patient 5)	M	55	1	Primary OA	55	110	3	100	120	
14	F	65	0	Fx-dislocation, delayed treatment because of colon cancer	55	80	2	95	70	
15	F	59	2	RH fx, RHP; revision to RCA	25	140	2	100	135	
16	F	32	2	Primary OA	10	20	2	70	90	Arthrolysis (12)
Mean		52	2		46	106	3,5	85	117	
Range		41-61	0-4		10-70	20-140	2-6	65-100	70-145	
Preoperative vs postoperative (*t* test)								$P < .001$	$P = .27$	

RCA, radiocapitellar arthroplasty; *FU*, follow-up; *MEPS*, Mayo Elbow Performance Score; *ROM*, range of motion; *F*, female; *OA*, osteoarthritis; *M*, male; *PTA*, post-traumatic arthritis; *RH*, radial head; *fx*, fracture; *ORIF*, open reduction–internal fixation; *RHP*, radial head prosthesis.

* Deceased.

Radiographic analysis

On analysis of radiographs 6 weeks after surgery, 7 elbows had no signs of ulnohumeral joint degeneration, 3 showed joint space narrowing (grade 1), and 5 showed osteophytic changes (grade 2). At final follow-up (2-6 years postoperatively), 9 elbows (60%) showed no progression of ulnohumeral degeneration, whereas OA progression increased from grade 0 to grade 1 in 3 elbows, from grade 1 to grade 2 in 1 elbow (patient 8), from grade 2 to grade 3 in 1 elbow (patient 12), and from grade 2 to grade 4 in 1 elbow (patient 14). At final follow-up, there was no significant difference in MEPS values between the patients with a Kellgren-Lawrence grade of 2 or more and patients with a grade of less than 2 ($P = .6$). The final arc of motion did not significantly differ between these 2 groups ($P = .7$).

On the 6-week postoperative AP radiographic view, the measured difference between the medial and lateral compartments of the ulnohumeral joint was less than 1 mm in 15 elbows and considered to be in the range of measurement error. However, in 1 elbow, the lateral side was 2.5 mm wider than the medial side and the RCA was considered to be overlengthened.

At final follow-up, none of the capitellar components showed any signs of loosening but 2 radial head components showed signs of loosening. We found grade 3 loosening in patient 12 and grade 4 loosening in patient 2 (Table I). Both patients were asymptomatic at final follow-up without the need for revision.

Revision surgery

Subsequent surgery was needed in 5 patients (31%) (Table I). One patient had an open arthrolysis due to stiffness 1 year after RCA. In 3 patients, the radial head component was revised because of loosening (1 bipolar and 2 unipolar). One of these patients (patient 8) still had pain after the first revision; thus, the radial head was removed subsequently. In another patient, only the radial head component was replaced owing to ulnar impingement; the stem was well fixed and left in place.

In these 5 patients, the mean MEPS improved from 46 points preoperatively to 71 points at final follow-up ($P = .05$). Pain improved significantly in these patients ($P < .01$). The clinical outcome (MEPS) of patients who needed revision surgery was significantly worse than that of patients who did not need subsequent surgery ($P = .01$).

Discussion

RCA is an uncommon procedure, as are its alternatives. RCA has the theoretical advantage of restoring elbow kinematics[19,21] and therefore decreasing the risk of progressive valgus deformity or proximal radial translation, as described after radial head resection[19,21] and anconeus interposition arthroplasty.[2,4] The outcome data after RCA are based on relatively small series. Published results are generally good to excellent in terms of pain relief.[3,5,9,10,12]

We found similar results in our patients, with a significant improvement in pain scores but not in ROM. These findings are in line with those of studies by Heijink et al[10] and Bigazzi et al.[3] Stiffness in arthritic elbows was the main indication in a multicenter study by Giannicola et al[5] in which either RCA or only a capitellar component was used in conjunction with an open débridement. They achieved a significant increase in ROM in their patients[5]; however, the final ROM reported was still less than our results and other series.[3,10]

Because of the lack of evidence in the literature, we mainly consider the use of RCA to be a salvage procedure, when other options have failed, or for young and active patients with severe joint destruction and functional restrictions. This may have introduced a small negative bias in the patients presented, with a preoperative MEPS of 46 points. Furthermore, most patients underwent 1 or more surgical procedures before RCA. Most of the prior open operations in our patient group were performed before the referral to our institution. Whenever possible and especially in primary OA patients, we prefer an arthroscopic débridement.[15,20] If this fails, RCA is an option, together with radial head resection, with or without interposition of soft tissue.[2,4,16] In a patient group comparable with ours, Baghdadi et al[2] showed that an anconeus interposition is a reasonable option to treat radiocapitellar pathology, even in young patients. The MEPS improved from 64 points to 82 points in their series, and the reoperation rate was 24%.[2,4] In our patient group, the MEPS improved from 46 points to 85 points, with a reoperation rate of 31%.

Although RCA is thought to restore elbow kinematics, it did not avoid the progression of ulnohumeral joint degeneration in 40% of our patients, although it was mostly asymptomatic. We found 1 patient with a significant opening of the lateral ulnohumeral joint, indicating a potential overstuffing of the RCA. The most rapid increase in degeneration of the ulnohumeral joint developed in this patient. Despite this, she was still very satisfied with her outcome after 2 years, mainly because of the complete pain relief. The relatively high rate of progression of ulnohumeral arthritis in our study is not in accordance with a similar study by Kachooei et al,[12] who found a lower rate of progression of ulnohumeral OA in their collective. One reason may be the use of a different measurement method for OA or the fact that they used a different implant.

The main reason for failure and decreased functional outcomes in our study was the radial component. Three patients needed revision because of early and progressive symptomatic loosening. Another 2 patients showed signs of asymptomatic loosening at final follow-up. Radial head component loosening was also reported to be the most common complication by Bigazzi et al.[3] The decision to cement the radial head was made intraoperatively in 4 patients in whom an insufficient press fit was achieved. However, as a direct result of this study's analysis, we would now have a lower

threshold to cement this particular radial head component. Giannicola et al[5] and Kachooei et al[12] did not report any loosening, but they used a different implant.

Limitations

Even though this is one of the largest series of consecutive patients treated by a single surgeon, the total number of patients is still small. One patient had died at follow-up, but we know that the RCA was unrevised at the time of her death. A further limitation is that not all patients had preoperative radiographs available for our analysis, given that most of the patients were referred to us and not all radiographs from other institutions were saved to our database. We therefore decided to use the 6-week postoperative radiographs to assess the progression of ulnohumeral arthritis.

Conclusion

This study reports on the clinical and radiographic outcomes of patients treated with RCA by 1 surgeon in an elbow referral center, with a minimum follow-up period of 2 years. The patient selection for RCA was very specific and individualized, mostly including complex and painful elbows in relatively young patients with failed previous surgery on their elbow. The overall MEPS was good to excellent, but the MEPS was less positive in patients who needed a revision. Both the revision and reoperation rates were high, and one should consider this before performing this procedure. Loosening of the radial head component was a particular problem in this series. An improved fixation technique or an adaptation of the design is needed before this type of surgery can be recommended as a standard procedure.

Disclaimer

Roger P. van Riet is a consultant with Acumed and Wright Medical. All the other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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