Radiocapitellar prosthetic arthroplasty: a report of 6 cases and review of the literature

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Background: Radiocapitellar prosthetic arthroplasty has recently been introduced to treat isolated degenerative arthritis of the radiocapitellar joint. Although this procedure is conceptually attractive and sound in situations in which radial head resection is inadequate, clinical experience is still limited. Its role in the treatment of isolated radiocapitellar degenerative arthritis in the ligamentous-intact elbow and forearm is not yet defined. Our purpose was to report the short-term results of 6 patients who were treated by radiocapitellar prosthetic arthroplasty for isolated radiocapitellar degenerative arthritis in the ligamentous-intact elbow, as well as to provide a review of the literature.

Methods: Six patients were treated by radiocapitellar prosthetic arthroplasty for isolated degenerative arthritis of the radiocapitellar joint in the ligamentous-intact elbow. Their medical records were reviewed, and each patient was seen in the office. The mean follow-up period was 50 months (range, 30-64 months).

Results: The implant survival rate was 100%. Pain improved in all patients and all patients were satisfied. The mean flexion-extension arc increased from 98° (range, 75°-115°) to 110° (range, 105°-120°) (P = .17), and the mean pronation-supination arc increased from 133° (range, 75°-115°) to 143° (range, 120°-170°) (P = .34). The mean Disabilities of the Arm, Shoulder and Hand score was 24.3 (range, 6.7-52.5). According to the Mayo Elbow Performance Score, there were 3 excellent and 3 good results.

Conclusion: The short-term follow-up results of radiocapitellar prosthetic arthroplasty for isolated radiocapitellar degenerative arthritis in the ligamentous-intact elbow and forearm seem favorable.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Prosthesis; replacement; elbow; arthritis; terminology; lateral compartment

Radiocapitellar prosthetic arthroplasty involves radial head arthroplasty with a polyethylene-articulating surface, combined with metallic capitellar resurfacing arthroplasty.

This technique has recently been introduced as a treatment option for isolated radiocapitellar degenerative arthritis when radial head resection is inadequate because of the need to stabilize the lateral column, as well as in the ligamentous-intact elbow and forearm. The body of clinical and biomechanical data regarding this type of partial elbow arthroplasty is limited to date, and terminology has been inconsistent.

The short-term results of 6 patients who were treated by radiocapitellar prosthetic arthroplasty for isolated degenerative arthritis in the ligamentous-intact elbow and forearm seem favorable.

Approval for this study was obtained from our institution’s medical ethical committee.

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Materials and methods

Each patient was informed that data concerning his or her case would be submitted for publication. Six consecutive patients were treated at our institution by radiocapitellar prosthetic arthroplasty between November 2007 and October 2010 for isolated symptomatic degenerative arthritis of the radiocapitellar joint that was refractory to conservative treatment. Isolated degenerative arthritis of the radiocapitellar joint was considered when patients had pain at rest, an inability to perform activities of daily living because of pain at the elbow, and naturally, radiographic degenerative changes of the radiocapitellar joint. Narrowing of the ulnohumeral joint space was present to a greater or lesser degree in all patients, but the joint space of the ulnohumeral joint was intact. Patients with narrowing of the ulnohumeral joint space were not candidates for radiocapitellar prosthetic arthroplasty. All procedures were performed by 1 dedicated elbow surgeon (D.E.). In all patients, the ligamentous structures about the elbow were intact. The medical records were reviewed, and each patient was seen in the office for a clinical assessment and radiographic evaluation. Postoperative elbow function was assessed with the Mayo Elbow Performance Score and Oxford Elbow Score. In addition, the Disabilities of the Arm, Shoulder and Hand questionnaire and Short Form 36 questionnaire were administered. Radiographs of the elbow were reviewed for signs of implant loosening, degenerative changes of the ulnohumeral articulation, and signs of osteopenia of the capitellum and overstufing of the radiocapitellar joint. Degenerative changes were graded as none, slight, moderate, or severe as previously described by Broberg and Morrey. Overstuffing of the joint was determined based on widening of the lateral ulnohumeral joint space. The patients comprised 4 women and 2 men. There were 4 right and 2 left elbows, and 4 dominant elbows were involved. The mean age at surgery was 53 years (range, 32-69 years). The radiocapitellar degenerative arthritis was primary in 3 patients, post-traumatic in 2, and post-infectious in 1. One patient had avascular necrosis of the capitellum. In all patients, the Lateral Resurfacing Elbow (Biomet, Warsaw, IN, USA) was used and placed without bone cement. The mean follow-up period was 50 months (range, 30-64 months).

During surgery, the patient was supine, with the arm resting on an arm table. Prophylactic antibiotic coverage consisted of 2 g of cefazolin intravenously. A tourniquet was used. An extended lateral approach was performed, using the column procedure described by Mansat and Morrey. The lateral collateral ligament was detached from the humerus; it was reattached using transosseous stitches at the end of the procedure. In all cases, both the capitellar and radial head components were placed without bone cement, as recommended by the manufacturer. Resection of osteophytes about the ulnohumeral joint was performed as deemed necessary to obtain optimal range of motion. Postoperatively, a long arm cast was applied for 2 weeks, followed by mobilization of the elbow by a specialized physiotherapist. Forced supination was avoided for 6 weeks.

Preoperative and postoperative motion was compared by use of a 2-tailed Student t test for paired samples. P values are reported.

Results

Demographic data, overall clinical outcome data, and patient-derived outcome data of the patient sample are shown in Tables I, II, and III, respectively. Pain improved in all patients, and all patients were satisfied with the treatment. Mean flexion was essentially unchanged: 124° (range, 100°-150°) preoperatively and 128° (range, 120°-135°) postoperatively (P = .33). The mean extension deficit decreased from 26° (range, 10°-45°) to 18° (range, 5°-30°) (P = .27), and the mean flexion-extension arc increased from 98° (range, 75°-115°) to 110° (range, 105°-120°) (P = .17). Mean pronation decreased from 72° (range, 60°-80°) to 70° (range, 60°-80°) (P = .70), mean supination increased from 72° (range, 70°-115°) to 73° (range, 60°-90°) (P = .29), and the mean pronation-supination arc increased from 133° (range, 75°-115°) to 143° (range, 120°-170°) (P = .34). None of the patients had valgus instability, and 1 patient had grade 1 varus instability (ie,
lateral pain with stress). We attribute the grade 1 varus instability in this patient to the combination of pre-existing mild hyperlaxity of all joints and neutral elbow alignment (instead of the usual slight valgus alignment). According to the Mayo Elbow Performance Score, there were 3 excellent and 3 good results. There were no wound infections, neurovascular injuries, or systemic complications.

At the most recent follow-up, the implant survival rate was 100% with no radiographic signs of loosening in any case. Degenerative changes of the ulnohumeral articulation (mild in 3 and moderate in 1), deemed asymptomatic during the preoperative clinical examination, had remained unchanged in all. In 4 of 5 patients with an intact capitellum (the sixth case had had avascular necrosis of the capitellum), mild capitellar osteopenia had developed (Figs. 1 and 2).

Discussion

Despite the recent introduction of devices to replace the lateral elbow joint, terminology has been variable, including radiocapitellar hemiarthroplasty, lateral replacement elbow, total lateral resurfacing arthroplasty, hemiarthroplasty or unicompartmental arthroplasty, radiocapitellar replacement, and radiocapitellar prosthetic arthroplasty. We believe that the latter is the most appropriate terminology because (1) it is anatomically descriptive; (2) it avoids confusion with distal humeral replacement, which is also referred to as hemiarthroplasty; and (3) it avoids confusion with other types of radiocapitellar arthroplasty, such as resection arthroplasty or interposition arthroplasty. We suggest using the term “radiocapitellar prosthetic arthroplasty” in the future when describing this procedure.

At present, there are 2 radiocapitellar prosthetic arthroplasty systems on the market. The Lateral Resurfacing Elbow system (Biomet) is composed of 2 monoblock components (Fig. 3). The capitellar component is spherical, made of cobalt chrome and has an extended skirted rim and tapered, cruciform, hydroxyapatite-coated peg to ensure secure press-fit fixation. The radial head component has a tapered, hydroxyapatite-coated, cruciform cobalt chrome stem connected to a metal-backed polyethylene articulation. The system is available in 4 sizes (small, medium, large, and extra large). The prosthesis is to be placed without bone cement. The published clinical experience with this device is limited to 2 studies reporting on a total of 22 patients, discussed earlier. The Uni-Elbow Radio Capitellum system (Small Bone Innovations, Morrisville, PA, USA) is composed of a modular radial head prosthesis and a monoblock capitellar component (Fig. 4). The capitellar component is spherical, made of cobalt chrome, and plasma sprayed with commercially pure titanium. It is to be placed without bone cement. It is available in 2 sizes (small and large) and right- and left-hand
configurations. The system is truly modular, in that any size of capitellum will fit any size and type of radial head. The rHead Standard is a unipolar design. The cobalt chrome stem is curved to match the intramedullary anatomy of the proximal radius. It comes in 2 sizes (standard collar and extended collar) and can be inserted with or without bone cement. A Morse taper lock connects the stem to a metal-backed polyethylene articulation, which is available in 4 sizes (sizes 1, 2, 3, and 4). Additional designs include the rHead Recon, a bipolar design with an all-polyethylene articulating part, which is connected to the stem by a ball-and-socket mechanism; and the rHead Lateral, which is a side-loading design. The published clinical experience with this system is limited to a series of 3 cases and a case report.5,9

In addition to the large existing body of data concerning the native radial head and radial head arthroplasty, Sabo et al17-19 have studied the anatomy of the capitellum and the biomechanics and kinematics of the radiocapitellar prosthetic arthroplasty. With 3-dimensional surface modeling, they showed the capitellum to be more elliptical in shape, rather than spherical, with a greater radius of curvature in the medial-lateral direction. Using a cadaveric model, they showed that radiocapitellar prosthetic arthroplasty with both a spherical and anatomic (ie, ellipsoid) capitellar design is associated with similar and large reductions in contact area compared with the native radiocapitellar articulation, ranging from 30% to 70% depending on implant design, elbow flexion, and forearm rotation.18 This is in accordance with the finding by Liew et al10 that metallic radial head arthroplasty is associated with an average decrease in radiocapitellar contact area of 68% as compared with the native radiocapitellar joint. Again using a cadaveric model, it was shown that the capitellum has a subtle but real role in providing valgus and rotational stability to the ulnohumeral joint; placement of either a spherical or anatomic capitellar arthroplasty (ie, without a radial head prosthesis) corrected the increased varus-valgus laxity and ulnar rotation observed in the capitellum-deficient elbow.

To date, clinical data related to radiocapitellar prosthetic arthroplasty are limited to 4 publications including 26 cases, and most of the data are pooled data.3,5,9,16 Two commercially available implant systems were used, the Lateral

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DASH, Disabilities of the Arm, Shoulder and Hand questionnaire; OES, Oxford Elbow Score; SF-36, Short Form 36 questionnaire.
Resurfacing Elbow system (Fig. 3) and the Uni-Elbow Radio Capitellum system (Fig. 4), and in 1 case, a custom-made prosthesis was applied. No comparative studies between type of prostheses exist. Heijink et al. reported on 3 cases, in 2 of which degenerative arthritis of the capitellum had developed after metallic radial head arthroplasty for chronic longitudinal radioulnar dissociation. The Uni-Elbow Radio Capitellum system was used. In the third, degenerative arthritis of the capitellum was the result of bone-on-bone impingement after radial head resection for chronic longitudinal radioulnar dissociation, and a custom-made radiocapitellar implant was used (Techmedica, Camarillo, CA, USA). The length of follow-up was 25 months and 63 months for the first 2 cases and 173 months for the custom prosthesis. The implant survival rate was 100% and there were 2 excellent results, 2 good results, and 1 fair result according to the Mayo Elbow Performance Score.

Pooley reported on 5 patients, 4 of whom had either primary or post-traumatic degenerative arthritis and 1 of whom had rheumatoid arthritis. In all patients, the Lateral Resurfacing Elbow system was used. No individualized follow-up time was provided; the cases were part of a series of 10 cases, which also included 5 capitellar resurfacing arthroplasties, for which the mean follow-up ranged from 9 to 18 months. For the 5 radiocapitellar prosthetic arthroplasty cases, the implant survival rate was 100% and there were 2 excellent results, 2 good results, and 1 fair result according to the Mayo Elbow Performance Score. Mean flexion increased from 125° (range, 120°-135°) to 140° (range, 135°-145°), the mean extension deficit decreased from 37° (range, 25°-80°) to 18° (range, 5°-30°), and the mean arc of movement increased from 88° (range, 40°-115°) to 122° (range, 105°-140°). Stability was not mentioned. Kepler et al. reported the 12-month follow-up of a patient who was treated with the Uni-Elbow Radio Capitellum system for nonunion after open reduction–internal fixation of an intra-articular coronal-plane shear-type fracture of the capitellum and lateral trochlea. The Mayo Elbow Performance Score was not
provided. Flexion was $130^\circ$ and extension was $20^\circ$, with full rotation. There was no instability. Giannicola et al reported on 17 cases, of which 11 had primary degenerative arthritis and 6 had post-traumatic degenerative arthritis. Only pooled data were reported; the cases were part of a series of 20 cases, which also included 3 capitellar resurfacing arthroplasties. For the entire series, the mean follow-up period was 22.6 months (range, 6-47 months). The implant survival rate was 100%. The mean Mayo Elbow Performance Score was 85 (range, 50-100), representing 12 excellent, 2 good, 3 fair, and 3 poor results. Flexion averaged $125^\circ$ (range, $25^\circ$-$150^\circ$), the extension deficit averaged $25^\circ$ (range, $0^\circ$-$65^\circ$), and the arc of movement averaged $95^\circ$ (range, $0^\circ$-$150^\circ$). Pronation averaged $70^\circ$ (range, $15^\circ$-$85^\circ$), and supination averaged $75^\circ$ (range, $35^\circ$-$85^\circ$). Three patients had instability.

Radiocapitellar prosthetic arthroplasty can be an option for symptomatic isolated radiocapitellar degenerative arthritis when radial head excision is not adequate because of the need to stabilize the lateral column. This is the case with deficiency of the medial collateral ligament and with axial forearm instability, in which metallic radial head replacement is warranted. However, capitellar erosion may result from the reduction in radiocapitellar contact area and occurrence of capitellar osteopenia observed after metallic radial head replacement. The large axial forces, particularly with longitudinal radioulnar dissociation, may aggravate this. Conversion to radiocapitellar prosthetic arthroplasty may be considered, which preserves the unaffected ulnohumeral compartment and largely maintains elbow kinematics and stability. It has even been suggested to consider capitellar resurfacing at the time of metallic radial head replacement when capitellar bone stock is poor. In the complex situation of chronic longitudinal radioulnar dissociation, in which the axial instability had initially gone undiagnosed or untreated or was treated in a delayed fashion, radial head replacement has been shown to perform poorly in 1 study. Published experience with radiocapitellar prosthetic arthroplasty in the setting of longitudinal radioulnar dissociation, either acute or chronic, is limited, and at present, there is no published experience on radiocapitellar prosthetic arthroplasty in the setting of medial collateral ligament deficiency. Traditionally, radial head excision has been used for the treatment of symptomatic isolated radiocapitellar degenerative arthritis without medial collateral ligament insufficiency or axial forearm instability. However, radial head resection has been associated with potential proximal migration of the radius and secondary wrist disability, even if all ligamentous constraints are intact. Moreover, the long-term effect of radial head resection on the development or expedition of ulnohumeral degenerative arthritis is not clearly understood. Several authors reported favorable short-term outcomes of radiocapitellar prosthetic arthroplasty for isolated radiocapitellar arthritis. Our series also shows favorable results at a mean of 50 months’ follow-up.

The role of radiocapitellar prosthetic arthroplasty as a treatment for symptomatic radiocapitellar degenerative arthritis, either primary or secondary, as well as in either the ligamentous-intact or compromised elbow, remains open to debate. Finally, some clinical circumstances (eg, isolated capitellar erosion) would justify simply replacing a pathologic capitellum.

Several concerns arise with radiocapitellar prosthetic arthroplasty. The large reduction in radiocapitellar contact area observed with radiocapitellar prosthetic arthroplasty may potentially result in increased polyethylene wear. To what extent this is a threat to implant survival is difficult to predict. Overstuffing of the radiocapitellar joint, in addition to medially loading the ulnohumeral articulation, may aggravate this polyethylene wear and must be avoided. Understuffing of the joint results in increased radioulnar load transfer through the interosseous membrane and increased force transmission through the ulnohumeral articulation, which in turn may expedite the occurrence of ulnohumeral degenerative arthritis. In our series, mild and asymptomatic degenerative changes of the ulnohumeral articulation remained stationary. Whether the occurrence of mild osteopenia in all cases is related to understuffing remains unclear at this time.

**Conclusion**

Favorable short-term follow-up results of 6 consecutive cases of radiocapitellar degenerative arthritis in the ligamentous-intact elbow treated by radiocapitellar prosthetic arthroplasty are presented. Radiocapitellar prosthetic arthroplasty has been shown to largely preserve elbow kinematics and stability. The effect of reduced radiocapitellar contact area, as well as the resulting higher contact stress, on implant survival is unclear. Although published clinical experience is limited, it seems conceptually irrefutable that radiocapitellar prosthetic arthroplasty is indicated for symptomatic isolated radiocapitellar degenerative arthritis when radial head excision is not appropriate because of the need to stabilize the lateral column. The role of radiocapitellar prosthetic arthroplasty in the treatment of isolated radiocapitellar degenerative arthritis remains open to debate.

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