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Partial radial head arthroplasty: two case reports with minimum 8-year follow-up

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Open reduction–internal fixation of comminuted radial head fractures involving 4 or more pieces is associated with a high risk of failure. Such fractures are generally treated by excision or by radial head arthroplasty. However, replacement with a metal implant can change the biomechanics of the joint, especially if the normal shape and position are not re-created. These alterations can theoretically lead to excess joint wear and tear. As with any metal implant, there is also the risk of loosening or progressive arthritis.[8]

Some radial head fractures that are deemed unfixable involve only a portion of the articular surface, leaving half or more of the head and neck and thus length of the proximal radius intact. Theoretically, a partial prosthetic replacement could be accurately aligned to remaining landmarks as a method to restore elbow anatomy and stability.

The purpose of this report was to present the concept of a partial radial head replacement, including long-term results, in 2 patients.

Case report

Patient 1

A 20-year-old right-hand–dominant male roofer was referred to us 5 months after falling from a roof and sustaining a fracture-dislocation of the right elbow. He was initially treated nonoperatively for a comminuted radial head fracture but had difficulty with pronation and supination and underwent partial resection of the radial head at an outside facility. At the time of presentation, he complained of medial and lateral elbow pain with a sense of instability, snapping, and paresthesias in the ulnar nerve distribution.

Physical examination at presentation showed range of motion of 25°-125° in extension-flexion, 60° in pronation, and 80° in supination. There was ulnar nerve subluxation and diffuse painful crepitus at the lateral aspect of the joint with passive range of motion. Radiographs revealed a partial radial head defect and a small amount of heterotopic bone in the collateral ligaments. Stress radiographs revealed 2-3 mm of medial opening and 3-5 mm of lateral opening with varus-valgus stress and a grossly positive posterolateral rotatory drawer test. Further computed tomography imaging revealed a 40% radial head loss (Fig. 1) with an anteromedial subtype 2 coronoid fracture nonunion.[5]

Owing to the patient's young age and the fact that he had compromise of the coronoid, the radial head, and both collateral ligaments, it was necessary to restore the radial head capacity for load bearing and stability. Because more than half of the radial head was still intact and symmetry had been demonstrated in the right and left elbows, it was reasoned that the mechanics could be accurately restored by using contralateral 3-dimensional (3D) radial head measurements to design a prosthesis that aligned corresponding landmarks to re-create the missing bone.[1,6]

Computed tomography scans were performed of both elbows so that a patient-specific prosthesis corresponding to the missing articular segment could be custom-made based on the contralateral intact radial head. The prosthesis was made of cobalt-chrome with a titanium porous surface at the bone-implant interface for bone ingrowth. It also had screw holes for compression against the native bone and a spike on its distal surface so that it could be easily held in position by inserting the spike into the metaphyseal bone of the radial neck.

Dual incisions were used with the Kocher approach laterally and a standard medial approach to the elbow medially. The ulnar nerve was decompressed in situ. The coronoid nonunion was fixed with a retrograde lag screw, and both the lateral collateral ligament (LCL) and medial collateral ligament (MCL) were reconstructed with

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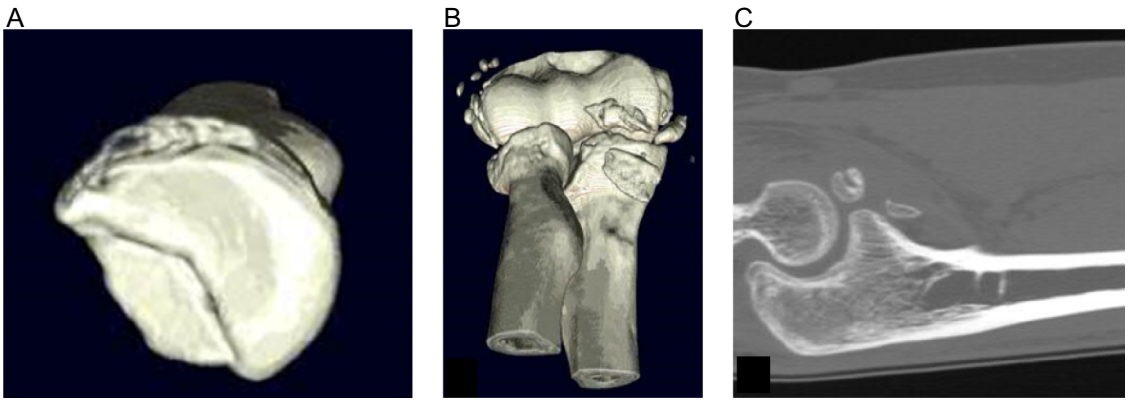

Figure 1 (**A**) A 3-dimensional computed tomography (CT) reconstruction showing the initial radial head defect involving 40% of the articular surface. (**B**) A 3-dimensional CT reconstruction showing an anteromedial subtype 2 coronoid fracture. (**C**) Sagittal CT cut demonstrating coronoid deficiency. (Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

plantaris tendon allograft. A step-cut was made in the radial head to yield a straight edge and flat surface against which to fix the prosthesis. The partial radial head was fixed to the prepared radius by tapping the distal spike into the step-cut in the neck and compressing with 3 screws (Fig. 2). The prosthesis had excellent congruity with the native joint surface at time of implantation.

At final follow-up, 13 years postoperatively, the patient rated his elbow as greatly improved compared with before the reconstruction with a Summary Outcome Determination (SOD) score[2-4] of 6/10. He reported a visual analog scale pain score of 2-3/10 because of persistent ulnar neuritis and a Mayo Elbow Performance Score of 85. His range of motion was 0°-145° in extension-flexion and 90°-90° in pronation-supination. Throughout the postoperative course, the patient had issues with his ulnar nerve, requiring a transposition and eventually a revision neurolysis. Elbow arthroscopy was also performed at the time of revision nerve surgeries for crepitus that he experienced during forearm rotation. Under direct visualization, it was noted that the synovitis was secondary to soft tissue irritation by the screw holes in the prosthesis. This clinically symptomatic crepitus was relieved postoperatively after limited arthroscopic débridement.

On radiographic examination, the joint space was well maintained with mild to moderate post-traumatic osteoarthritic change but no osteolysis or other complications associated with the implant (Fig. 2). Interestingly, diagnostic arthroscopy performed at the time of the second revision ulnar nerve transposition 11.5 years postoperatively revealed a pristine capitellum (Fig. 3).

Patient 2

A 46-year-old right-hand–dominant woman was referred 7 weeks after falling onto her outstretched, nondominant hand and sustaining a comminuted radial head fracture and MCL injury. She was initially treated conservatively but subsequently developed stiffness and pain in the elbow along with paresthesias in the hand.

Physical examination at presentation showed range of motion to be 60°-120° in extension-flexion with 35°-25° of pronation-supination. She had tenderness to palpation over the medial epicondyle and radial head. Radiographs showed a radial head malunion involving 50% of the anterior joint surface, resulting in a depressed articular fragment. Heterotopic ossification was noted along the radial neck and MCL (Fig. 4).

At the time of surgery, dissection by the Kocher approach revealed a proximal radius malunion whereby 50% of the radial head was malunited onto the neck. This malunited fragment was excised, and a step-cut was made to create a flat surface on which to fix the prosthesis. Four screws were used to secure the prosthesis. An open osteocapsular arthroplasty was performed to restore motion. A

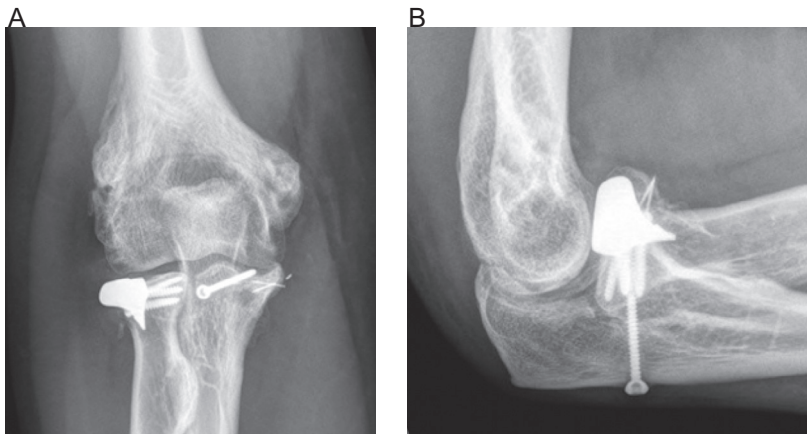

Figure 2 (**A**) Anteroposterior and (**B**) lateral radiographs of the right elbow 13 years postoperatively. Post-traumatic arthritic change is present in the elbow joint, but the implant itself demonstrates full boney ingrowth and no evidence of osteolysis or hardware failure. (Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

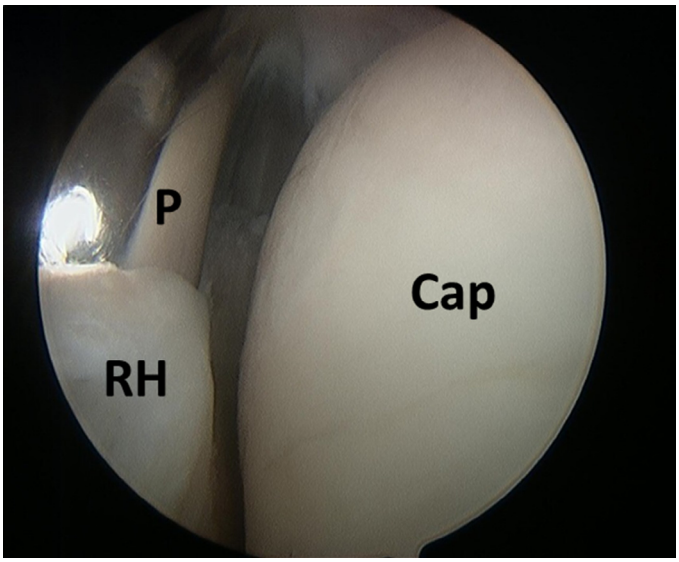

Figure 3 Arthroscopic view from the proximal anteromedial portal showing the radiocapitellar articulation 11.5 years postoperatively. Partial radial head prosthesis (*P*) fixed to the remaining native radial head (*RH*) with pristine capitellum (*Cap*) joint surface on the right. (Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

deficiency in the LCL was noted intraoperatively and was reconstructed using a plantaris tendon allograft. The joint was stable after LCL reconstruction, and thus the MCL was not treated.

At her 4-year clinical follow-up, she rated her elbow as "greatly improved" and a SOD score[2,3,6] of 8/10 compared to before her surgery. Elbow range of motion was 40°-130° in extension-flexion with 80°-70° of pronation-supination. The elbow was stable with negative posterolateral rotatory drawer and lateral pivot-shift test results. Throughout the postoperative course, the patient noted pain in the cold weather and with heavy lifting but was otherwise able to function in her activities of daily living with little difficulty. At final follow-up 8 years after surgery, her visual analog scale pain score at rest was 4/10, she scored 55 on the American Shoulder and Elbow Surgeons assessment and 65 on the Mayo Elbow Performance Score, and she rated her elbow as "improved" and a SOD score of 6/10 compared to before her surgery.[2,3,6]

At 4 years, the joint space was radiographically well maintained. The prosthesis demonstrated ingrowth with no change in implant positioning over time (Figs. 5 and 6). There were no signs of osteolysis or significant arthritic change.

Discussion

These long-term results suggest that partial radial head arthroplasty may be a feasible method for restoring joint congruity, thus

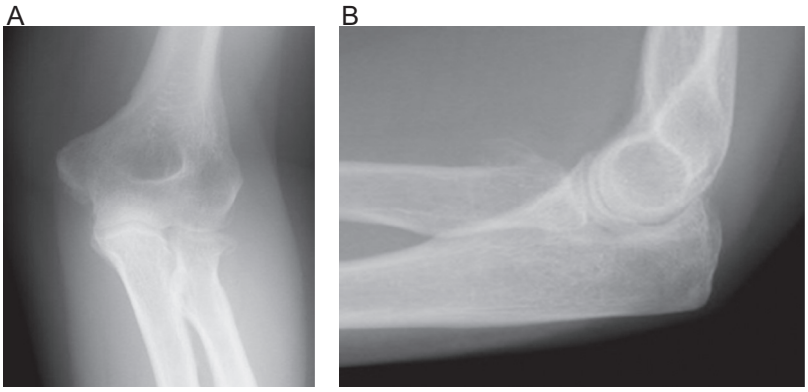

Figure 4 (**A**) Anteroposterior and (**B**) lateral preoperative radiographs of elbow. There is a malunion of the radial head resulting in a depressed intra-articular fragment involving 50% of the anterior joint surface and reactive heterotopic ossification along the radial neck and medial collateral ligament. (Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

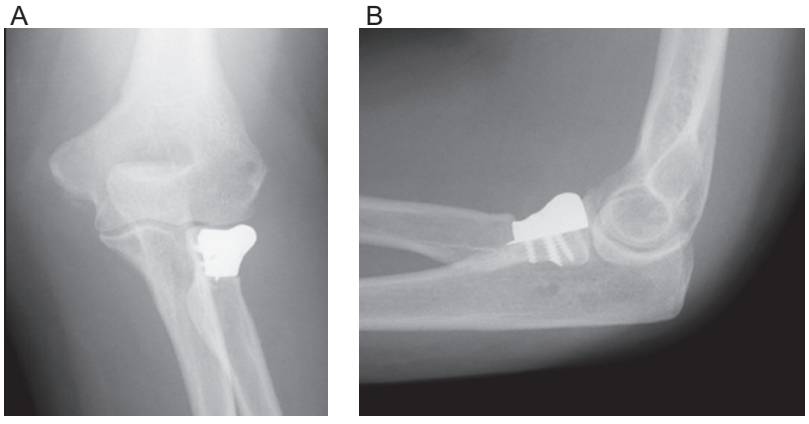

Figure 5 (**A**) Anteroposterior and (**B**) lateral radiographs of left elbow 1 month postoperatively. (Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

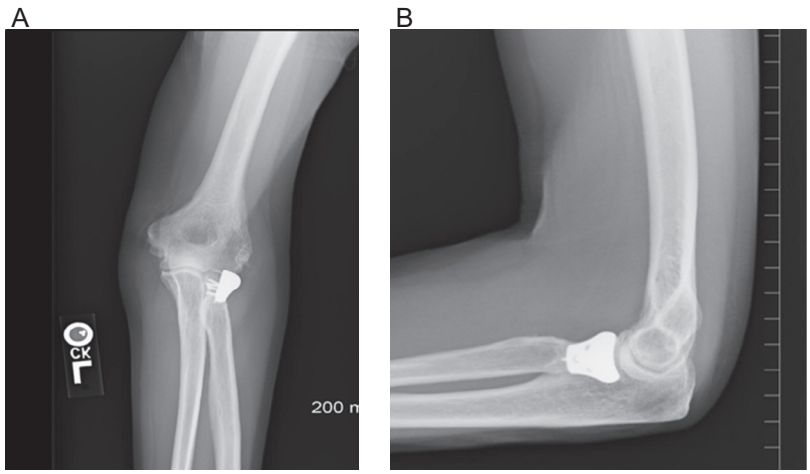

Figure 6 (**A**) Anteroposterior and (**B**) lateral radiographs of left elbow 8 years postoperatively. (Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

rendering it a viable option for young patients with partial radial head deficiency. Both patients presented here reported "greatly improved" outcomes postoperatively and return at least to activities of daily living with no functional deficit, although both reported pain with heavy lifting. On radiographic examination, both partial radial head implants remained well fixed with minimal evidence of capitellar wear or osteolysis after 8 to 13 years of follow-up.

Turner et al similarly published a case series using partial radial head allografts to repair radial head defects in the case of fracture-dislocation injuries.[7] That study showed good results in terms of union of the radial head graft with no failure related to the radial head allograft. This may be another option for radial head defects but is limited by accessibility to a bone bank that can provide radial head allografts.

Despite the clinical success of a custom partial radial head prosthetic replacement in these 2 cases, we did not continue to perform this technique for several reasons. First, it was time-consuming and costly to have these made. Patients who need such a device often cannot wait extended periods without consequences in terms of progressive joint damage. Second, the company that provided these prostheses stopped making custom implants of any sort. Both of these reasons, however, need not prevent future adaptation of the concept since 3D printing of patient-specific prostheses will almost certainly develop to a practical level.

With increased use of 3D printing, partial radial head arthroplasty may become more practical for customizable implants, perhaps using this implant as a "resurfacing" implant for the radial head. Future directions include technique development to facilitate arthroscopic insertion or other "minimally invasive" protocols. Additional studies on joint mechanics comparing partial replacement with a standard radiocapitellar arthroplasty are also needed to evaluate the changes in joint between these two implants.

Conclusion

Partial radial head arthroplasty may be a viable option for restoring joint congruity and therefore could be considered a possibility for young patients with a partial radial head deficiency. Both patients reported greatly improved outcomes postoperatively and were able to return to activities of daily living without functional deficit. On radiographic examination, the implants remained well fixed with minimal evidence or capitellar wear or osteolysis 8-13 years after surgery.

Disclaimer

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