Summary: Upper extremity elbow trauma is commonly encountered in clinical practice. Various treatment options exist for radial head fractures depending on how destabilizing the injury is to the elbow’s mechanical function. The purpose of this case report is to demonstrate a surgical treatment option for comminuted radial head fractures requiring replacement using a new radial head replacement system.

Key Words: radial head replacement, radial head fracture, elbow, terrible triad injury

INTRODUCTION

Radial head fractures are one of the most common elbow fractures. The radiocapitellar articulation is responsible for approximately 60% of load transfer across the elbow joint and plays a major role in elbow stability.1 Treatment options for radial head fractures vary based on fracture displacement and severity. Nonoperative treatment may be considered for Mason type I minimally displaced radial head fractures with concentric reduction of the radiocapitellar joint and for some Mason type II fractures with no mechanical block to motion. For displaced fractures requiring surgical intervention, treatment options are based on the number of fracture fragments and severity of comminution. Open reduction and internal fixation is recommended for reconstructible 1- to 2-part fractures without significant comminution. Fractures consisting of 3 or more fragments such as Mason type III or IV radial head fractures have inferior outcomes when treated with open reduction and internal fixation and often require replacement because open reduction and internal fixation is not a feasible option to restore the stability required for early range of motion.2,3 Treatment with radial head replacement restores valgus and longitudinal stability with forearm rotation while preserving elbow range of motion.4 Fragment or radial head excision is typically reserved for low-demand patients with persistent pain after radial head fracture because it can exacerbate elbow and/or wrist instability and, therefore, is typically contraindicated in the traumatic setting.

Various implants exist for radial head replacements, including unipolar versus bipolar heads, cemented versus cementless stems, and monoblock versus modular designs. Systems with anatomic-cemented or press-fit and smooth, loose-fit stems are available.4,5 The purpose of this case report is to describe the technique for unstable radial head fractures using a new radial head replacement system.

PATIENT INFORMATION

A 55-year-old man presented with a posterolateral elbow fracture dislocation after falling from a roof, approximately 10 feet above the ground (Fig. 1). The patient presented to the emergency department, where he underwent closed reduction resulting in a concentric reduction with no block to passive range of motion. A computed tomography scan performed after reduction revealed a small coronoid fracture and a minimally displaced radial head fracture with concentric reduction of the radiocapitellar joint and for some Mason type II fractures with no mechanical block to motion. For displaced fractures requiring surgical intervention, treatment options are based on the number of fracture fragments and severity of comminution. Open reduction and internal fixation is recommended for reconstructible 1- to 2-part fractures without significant comminution. Fractures consisting of 3 or more fragments such as Mason type III or IV radial head fractures have inferior outcomes when treated with open reduction and internal fixation and often require replacement because open reduction and internal fixation is not a feasible option to restore the stability required for early range of motion. Fragment or radial head excision is typically reserved for low-demand patients with persistent pain after radial head fracture because it can exacerbate elbow and/or wrist instability and, therefore, is typically contraindicated in the traumatic setting.

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radial head, with limited supination/pronation and flexion/extension secondary to pain. The patient had approximately a 5-degree arc of pronation/supination and was lacking approximately 45 degrees of elbow extension. He was able to flex the elbow to 120 degrees with unacceptable pain. Plain radiographs taken during clinic visit demonstrated a loss of the previously obtained reduction (posterolateral dislocation) of the radiocapitellar joint (Fig. 4).

Treatment options were discussed with the patient, and because of the chronicity of the elbow dislocation, both open reduction and internal fixation of the radial head fracture and radial head replacement with lateral ulnar collateral ligament (LUCL) repair/reconstruction were presented. Given the persistent instability of this injury with significant lack of range of motion, the patient was agreeable with surgical treatment. Informed consent was obtained before surgery, with the patient expressing understanding of the surgical plan.

SURGICAL TECHNIQUE

The patient was taken to the operating room and placed supine on a regular table with a hand table on the operative side. Before draping, anteroposterior (AP) radiographs of the contralateral elbow and wrist were taken and saved for reference to aid with radial head sizing. A tourniquet was applied to the extremity, and an Esmarch bandage was used to exsanguinate the extremity. The Kocher approach to the radiocapitellar joint was used, and the plane between extensor carpi ulnaris and anconeus was identified. The joint capsule was identified, which, in this case, was relatively superficial due to the chronic nature of the patient’s radial head dislocation. The equator of the radiocapitellar joint was located, and the capsule was incised in the mid radiocapitellar plane to avoid further damage to the LUCL. The forearm was pronated to protect the posterior interosseous nerve, which crosses the proximal radius from anterior to posterior within the supinator muscle approximately 4 cm distal to the radial head. The radial head was found to be significantly deformed because of a malunion of the radial head fracture in addition to a groove on the proximal portion of the radial head, created by its articulation with the capitellum while in a
dislocated position. The decision was made to proceed with radial head replacement, and the radial head was resected approximately 11 mm from the articular surface using a microsagittal saw. There was a significant amount of soft tissue interposed within the radiocapitellar joint and overlying the sigmoid notch of the proximal ulna, which was excised.

Next, we turned our attention to placing the implant. The Radial Head Replacement System (DePuy Synthes, West Chester, PA) consists of a one-piece straight smooth-stemmed implant to be used with a sterile single-use instrument kit. The medullary canal of the proximal radius was sequentially sounded by hand up to a 6.5-mm stem for the prosthesis. The sounder was advanced until the end of the circular ribs was in level with the radial neck osteotomy. Of note, the depth, diameter, and trajectory of the stem can be seen using fluoroscopic imaging with the sounder in place. A planer was placed down the shaft of the final sounder, clicking into place, to create a smooth contact surface on the radial neck and was planed by hand. This planer can also be used to make small adjustments in the level of resection if a small amount of additional radial resection is required. A ruler was used to measure the diameter of the radial head. It is important to note that the radial head is elliptical in shape, and maximum outer diameter and minimum outer diameter of the radial head can vary based on a patient’s anatomy. The minimal outer diameter of the resected radial head was measured between 23 and 24 mm, and a 22-mm radiolucent trial was selected. Radiolucent trials were then used under fluoroscopic guidance to obtain optimal radial head length, and a symmetric ulnohumeral joint space was obtained and compared with the preoperative contralateral elbow AP radiograph. AP view of the wrist demonstrated ulnar variance, which was symmetric to the nonoperative side. Full range of motion and excellent stability were noted with concentric reduction of the radiocapitellar joint. Rotational motion was unrestricted within the medullary canal. The final implant of a 22-mm radial head diameter with a 6.5-mm stem and neutral or +0 head thickness was placed. Once again, full range of motion and excellent stability were noted and confirmed on AP and lateral fluoroscopic images of the elbow.

Next, the traumatic injury to the LUCL was addressed. After predrilling, a G2 QuickAnchor (DePuy Mitek, Raynham, MA) was placed at the center of rotation of the capitellum and the LUCL, which had been avulsed from its ulnar insertion, whipstitched, and repaired back to the lateral epicondyle. Stability of the elbow was confirmed a final time. The capsule was repaired with number 2 ethibond. The fascia and subcutaneous tissue were closed with 2-0 vicryl, and the skin was closed with 3-0 monocryl and dermabond. The patient was placed in a well-padded splint at 90 degrees of elbow flexion and slight forearm pronation.

Postoperatively, the patient continued the use of the splint and sling for 2 weeks, after which, the splint was removed and aggressive range of motion was begun. One-month radiographs (Fig. 5) demonstrate a well-fit radial head prosthesis. At the 3-month follow-up, the patient had elbow motion of 20–130 degrees, with 85 degrees of pronation and supination (Fig. 6). The patient reported no pain and has returned to work and his usual activities of daily living. He continues to work with occupational therapy.

DISCUSSION

Appropriate implant sizing is a crucial technical step of radial head replacement to avoid overstuffing of the radial head and overlengthening the radius, both important for long-term functional outcome.6,7 After resection of the head and any fracture fragments, both the head height and diameter must be accurately measured to determine appropriate implant sizing. It is important to be familiar with the sizing options of your chosen radial head replacement system to avoid placing an implant that is incorrectly sized.

Regarding sizing, implant diameter and thickness are the 2 key components when determining sizing intraoperatively. Implant diameter is determined by measuring the diameter of the excised radial head and can be accurately estimated by piecing together the fractured fragments. It is important to note that the radial head is elliptical in shape, and the minimum and maximum outer diameter of the radial head can vary based on the patient’s anatomy. Using the minimum outer diameter of the radial head as a reference for sizing will avoid overstuffing the proximal radioulnar joint. Regarding radial height, minimal implant thickness will dictate the minimal length of radial head, which must be resected to avoid overlengthening. We prefer resecting 1–2 mm more than the minimal radial head length to avoid overlengthening, while taking care not to overresect the proximal radius. If the radius seems overlengthened with the smallest thickness trial, we recommend using a planer or microsagittal saw to sequentially resect additional proximal radius to ensure that appropriate length is obtained. In the setting of comminuted radial head/neck fractures where it is not possible to use the proximal aspect of the radial head as a landmark for depth of resection, the most proximal aspect of the sigmoid notch of the ulna is a reliable reference.8 Similarly, when trialing implants, the most proximal aspect of the radial head trial should be
flush with the most proximal aspect of the lesser sigmoid notch of the ulna. If significant amount of lesser sigmoid notch is visible during trialing, the component length is likely undersized.

Fluoroscopic evaluation of ulnohumeral joint symmetry is also critical when assessing implant height. Widening of the radial aspect of the ulnohumeral joint is indicative of overlengthening of the radius (Fig. 7). Preoperative contralateral AP elbow films can be extremely helpful when judging ulnohumeral joint symmetry, and ulnar variance based on contralateral AP wrist radiographs can be used as a confirmatory technique to ensure that appropriate radial length has been restored. This is especially useful in the setting of an Essex-Lopresti injury, which is commonly associated with radial head fractures in the trauma setting.\(^9\) A specific advantage of the Radial Head Replacement System is the radiolucent trials, which can improve implant sizing with the assistance of intraoperative fluoroscopic evaluation. Our preferred technique includes optimal fluoroscopic monitor positioning and dimming of the operative room lights during trialing to improve the visualization of the ulnohumeral joint space on the C-arm monitor because subtle differences may be difficult to assess with suboptimal image quality. Once a symmetric ulnohumeral joint space is obtained, we confirm appropriate ulnar variance on an AP radiograph of the wrist and visually inspect the articulation of the trial radial head prosthesis with the lesser sigmoid notch. Visual assessment of the radial aspect of the ulnohumeral joint is also performed to ensure that there is no visible gapping. Finally, elbow range of motion and stability are assessed before final implant placement.

Characteristics of the implant are also important when considering radial head replacement.\(^10,11\) The radial head system described is a smooth-stemmed implant, which self-centers inside the canal, allowing for unrestricted motion, given patient-specific anatomic inconsistencies.\(^12\) Data suggest that a loose, smooth-stemmed implant is more similar in function to a bipolar implant, allowing optimized radiocapitellar contact.\(^13\) Bone formation around the proximal radial neck has been observed more commonly in smooth-stemmed implants, although the clinical implications of these findings require further exploration.\(^10\) In comparison, a cemented-implant or press-fit implant with rigid fixation requires specific positioning, with consideration of the native anatomy to allow for appropriate tracking. In addition to increased intraoperative complexity, symptomatic aseptic loosening is more common in these rigid implants, leading to revision surgery.\(^5,10\)

Data support the use of radial head replacement as an effective treatment option for irreducible radial head fractures.\(^11,14–18\) These have been shown to restore stability and motion and improve pain.\(^5\) Important complications reported include postoperative elbow stiffness, pain, ulnar nerve palsy, posterior interosseous nerve palsy, and heterotopic ossification.\(^17\) A final key step to keep in mind in restoring function and range of motion of the elbow is early mobilization.\(^14\)

**CONCLUSION**

Radial head fractures not amenable to surgical fixation can be reliably treated with radial head replacement. Appropriate implant sizing is crucial for elbow stability and postoperative functional outcome. The Radial Head Replacement System is a surgical option that allows for simplified intraoperative implant sizing when treating radial head fractures requiring replacement in the acute trauma setting.

**REFERENCES**


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