Periprosthetic Fracture of the Ulna—A Case Report

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Abstract

After resection of the radial head, the load transmission through the forearm is changed dramatically. Most of the axial load is transmitted to the ulna. This can happen through the interosseous membrane, if intact, thus preventing proximal migration of the radius. However, radial head resection entails some slacking of the interosseous membrane, thereby reducing its ability to transmit load. In traumatic lesions of the interosseous membrane there is no limit to the proximal migration of the radius until the ulnar head abuts on the carpus. In both cases the load transmitted by the ulna increases dramatically and can promote fractures thereof. A 52-year-old, right-handed male patient presented with a periprosthetic fracture of the right ulna 6 weeks after implantation of an ulna head prosthesis. He had previously undergone radial head excision for malunion of the radial head and secondary humeroradial osteoarthritis. This operation had reduced pain and improved the range of motion at the elbow but entailed degenerative arthritis and related symptoms at the distal radioulnar joint (DRUJ). From the spectrum of possible treatment options, ulnar head resurfacing/hemiprosthesis was elected and performed without intraoperative or postoperative irregularities. However, 6 weeks postoperatively, as he was lifting a heavy object, a periprosthetic fracture of the ulna occurred, which ultimately was treated successfully by open reduction and plate fixation. Plate fixation of periprosthetic fractures is an established treatment concept after excluding implant loosening. Periprosthetic fracture of the ulna seems to be a rare complication but can be treated similarly.

Keywords

- periprosthetic ulnar fracture
- radial head resection
- ulnar head prosthesis

Treatment of patients presenting with ongoing pain and disability after resection arthroplasty of the distal ulnar head remains challenging, and several procedures have been described to restore stability of the distal radioulnar joint (DRUJ).^{1–3} After resection of the radial head, the interosseous membrane transmits 90% of the axial load through the forearm; thus, it has to resist proximal migration of the radius.⁴

However, continuity and mechanical competence of the interosseous membrane can be absent after traumatic disruption of the interosseous membrane in Essex-Lopresti injuries.^{5,6} Slacking of the interosseous membrane, thereby negating its ability to transmit load, has also been reported as a consequence of radial head resection.⁷ Instability of the

forearm, with proximal translation of the radius and consecutive relative lengthening of the distal ulna, substantially increases distal ulnar loading and leads to osteoarthritis, persistent pain, and decreased grip strength.^{7–9}

The purpose of this report is to describe a rare complication of prosthetic replacement of the distal ulna in a situation with compromised structures withstanding proximal translation of the radius and therefor increasing ulnar loading.

Case Report

A 52-year-old man presented with a recent onset of ulnar-sided wrist pain 2 months after excision arthroplasty of the

radial head. Forty-seven years earlier, the patient had sustained a fracture of the right proximal radius that resulted in a malunion of the radial head and secondary humeroradial and mild humeroulnar osteoarthritis, causing debilitating restriction of range of motion (ROM) in flexion-extension (110° – 15°) as well as pronation-supination (20° – 15°) (**►Fig. 1**).

The initial postoperative follow-up after excision arthroplasty of the proximal head of the radius was unremarkable. However, 2 months after the procedure the patient presented with worsening ulnar-sided wrist pain. Physical examination of the right wrist revealed painfully decreased ROM, decreased grip strength, a painful DRUJ ballottement test, as well as pain on palpation of the DRUJ in pronation and supination. Plain radiographs of the right wrist revealed severe osteoarthritis of the DRUJ (**►Fig. 2**).

Prosthetic replacement of the distal ulna head was recommended and performed (First Choice Partial Ulnar Head Replacement, Ascension Orthopedics, Austin TX). The DRUJ was exposed via a standard dorsal approach through the fifth extensor compartment followed by an L-shaped arthrotomy. The medullary canal was opened using a starter awl and reamed with a standard 4.5-mm powered drill to prepare for implant insertion. The size-specific burr could not be used because it was too large to fit the medullary canal of the ulna. However, no fracture or perforation of the ulna shaft was noted either intra- nor postoperatively. At 6 weeks the patient complained about a sudden onset of severe ulnar-sided wrist pain accompanied by a cracking noise while lifting a heavy object wearing a forearm splint. Conventional radiographs revealed a non-displaced transverse periprosthetic fracture of the ulna at the tip of the prosthesis shaft. Forearm splinting was continued and functional therapy postponed. At 10 weeks, plain radiographs of the forearm showed increasing angulation and a secondary ulnar plus variance without signs of implant loosening (**►Fig. 3a,b**). The patient was scheduled for surgical intervention.

Fracture fixation was performed via a standard approach to the ulna shaft using a contoured 2.7-mm seven-hole LC-DCP (Limited Contact–Dynamic Compression; Synthes, West Chester PA) plate. The plate was placed at the volar aspect of the ulna. Adequate reduction was confirmed under fluoroscopic guidance. Preoperative evaluation of the bone stock favored the cortex ulnar to the prosthesis as the site for screw placement in the distal fragment. Three nonlocking screws had firm purchase in the distal fragment directly passing next to the prosthesis, which was left in situ. Compression at the fracture site was achieved by eccentric screw positioning in the proximal fragment (**►Fig. 4a,b**).

Postoperative management included immobilization in a long-arm splint and active mobilization of forearm rotation after 8 weeks following confirmation of fracture healing on plain radiographs. The clinical course remained uneventful. At a final 6-month follow-up the patient was pain free, and there was decreased ROM with wrist flexion-extension of 50° – 60° and pronation-supination of 40° – 50° .

Discussion

To our knowledge this is the first case of a periprosthetic fracture of the distal ulna reported in the literature. In the management of ongoing painful DRUJ instability, prosthetic replacement of the distal ulna is a viable treatment option.¹⁰ Periprosthetic fracture of the ulna is an extremely rare complication. In larger long-term follow-up series, van Schoonhoven et al as well as Yen Shipley et al did not observe a single case.^{10–12}

Various designs of ulnar head implants have been available for more than 20 years. In this case, as previously mentioned, we used the First Choice Partial Ulnar Head Replacement with the smallest available stem diameter, 4.5 mm. The size-specific burr could not be used, and the medullary canal was prepared with a standard 4.5-mm powered drill bit. Postoperative imaging revealed a tight fit of the prosthesis (**►Fig. 5**).

The problem of adjusting intramedullary implants to the diameter of the medullary canal and curved anatomy of the ulnar shaft has already been discussed by various authors. After measuring 142 adult human cadaveric ulnar bones, McFarlane et al found that none of the bones had a diameter of less than 4 mm.¹³ These results were confirmed by Windisch et al analyzing the medullary cavities of 65 cadaveric ulnar bones. The authors also reported a mean varus angulation of the ulnar medullary cavity of 8.95° (range: 4° – 13.5°) and conclude that different intramedullary implants accounting for the varying anatomical variants are needed.¹⁴ In our case, the patient's anatomy was insignificant regarding diameter of the ulnar medullary cavity. Thus, we suspect that curvature of the distal ulna conflicted with the straight shape of the instruments and implant. However, no widely accepted standard exists for measuring ulnar angulation.

The role of radial head resection as a contributing factor to this complication in our patient is strongly suggestive. After resection of the proximal head of the radius, the load transferred to the ulna is increased by sixfold, putting the ulna and the ulnocarpal joint at risk, especially after the insertion of a prosthetic implant.⁷ Moreover, in the absence of the proximal radial head, 90% of axial force applied to the wrist is transferred from the radial head–capitellar contact to the interosseous membrane.^{4,7} In a retrospective analysis of 57 patients, van Schoonhoven et al described one case of an ulnar head prosthesis implanted after an Essex-Lopresti injury and consecutive resection of the proximal head of the radius. In a first step the authors performed a prosthetic replacement of the proximal radial head to account for the resulting instability of the forearm after this injury.¹⁵ Both absence of the radial head and compromised integrity of the interosseous membrane result in a loss of stabilizing structures preventing relative lengthening of the ulna and therefore ulnocarpal abutment.⁴

Traumatic longitudinal instability of the forearm is a frequently missed diagnosis upon initial presentation. Chronic sequelae of this injury, including severe pain of the DRUJ, were first described in 1992 by Trousdale et al.¹⁶ Treatment methods for chronic Essex-Lopresti injuries are aimed at

Fig. 1 Humeroradial and humeroulnar osteoarthritis before radial head resection.

Fig. 2 Osteoarthritis of the DRUJ ulna plus variance of ~ 5 mm.

Fig. 3a,b Plain radiograph showing a periprosthetic fracture of the ulna.

Fig. 4a,b Plain radiograph showing fracture fixation after a periprosthetic fracture of the ulna.

reestablishing longitudinal stability and leveling of the DRUJ. Replacement of the radial head with a metallic implant restores forearm stiffness and prevents further distal migra-

tion of the radius.^{17,18} Shortening osteotomy of the ulna is a frequently performed procedure to address ulnocarpal abutment.¹⁹ Therefore, if a chronic Essex-Lopresti injury is

Fig. 5a,b Postoperative radiograph of the distal ulnar head prosthesis, bone cyst in lunate bone.

suspected, prosthetic replacement of the distal ulnar head alone does not address the underlying pathology of forearm instability. In our case, however, the absence of radiohumeral abutment on plain radiographs 16 months after resection of the radial head may suggest an intact interosseous membrane withstanding further proximal migration of the radius (► **Fig. 6**).

However, periprosthetic fractures of the distal ulna can be treated, in analogy to periprosthetic fractures of other locations, with a bridging plate after excluding implant loosening. Open reduction and internal plate fixation without implant removal is considered a well-established treatment concept for periprosthetic fracture of other long bones, namely in total shoulder and total hip arthroplasty.^{20,21} Considering periprosthetic fractures of the distal ulna, a screw/plate dimension of 2.7 mm diameter seems to be appropriate for fixation if sufficient bone stock is present.

Conflict of Interest
None

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Fig. 6 Plain radiograph 16 months after resection of the proximal radial head showing absence of humeroradial abutment.

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