

Anterior Dislocation of the Radial Head Combined with Plastic Deformity of the Ulnar Shaft in an Adult: A Case Report

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A 25-year-old woman presented to the emergency room with a painful and swollen right forearm. She had just sustained an injury from an accident during which her arm was tightly wound by a rope as she was lowering a net from a fishing boat. Before being released, her arm was rigidly trapped in the rope for approximately ten minutes. Radiographs revealed anterior dislocation of the radial head that was accompanied by plastic deformation of the proximal ulna, manifested as a reversal of the proximal dorsal angulation of the ulna (PUDA); suggested a Monteggia equivalent fracture. With the patient under general anesthesia, we reduced the radial head by posterior compression at 90° of elbow flexion and at neutral rotation of the forearm. However, the reduction was easily lost and the elbow re-dislocated with even slight supination or extension of the arm. After the osteotomy of the ulnar deformity to restore the PUDA to normal, the reduction remained stable even with manipulation of the arm. We found that the patient could exercise a full range of motion without pain at the 3-month follow-up, and neither residual instability nor degenerative changes were observed at the final 3-year follow-up.

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Monteggia fractures are characterized by anterior dislocation of the radial head combined with fractures of the ulnar shaft. Since their first description by Monteggia, classification systems have been developed for these fractures and researchers have investigated their pathophysiology. Our understanding of Monteggia fractures has also led to the discovery of so-called Monteggia equivalent fractures, which have similar mechanisms of injury and presentations to Monteggia fractures.¹⁾ For example, Bado and Letts classified anterior dislocations of the radial head combined with plastic deformity of the ulna in pediatric patients as a major class of Monteggia equivalent fractures.²⁾ The importance of restoring proximal ulna dorsal angulation (PUDA) for the treatment of not only these fractures but also of other fractures involving the ulnar shaft is well known.³⁾ In pediatric patients, the standard treatment for acute and chronic dislocations of the radial head combined with either plastic deformity or malunion of the ulnar shaft is surgical treatment such as corrective ulnar

osteotomy.⁴⁾ Compared to pediatric patients, who because of their highly elastic and plastic bones often sustain fractures combined with plastic deformation of the ulna, adults show a very low incidence of such fractures. In fact, only ten or so cases have been reported in the literature so far. Because of the rarity of these fractures, the treatment of Monteggia equivalent fractures characterized by radial head dislocations combined with plastic deformity of the ulna is relatively unknown. Here, we report a case of anterior dislocation of the radial head combined with acute plastic deformation of the ulnar shaft in an adult patient. We describe the 3-year follow-up findings after ulnar osteotomy and review similar cases in the literature to discuss the characteristics and modes of treatment of Monteggia equivalent fractures.

Case Report

A 25-year-old housewife, who occasionally worked on a

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fishing boat, sustained injuries after an accident. As she was lowering the fishing net, the rope of the fishing net rigidly wound around her arm. Her arm remained twisted at the bow of the boat for approximately 10 minutes before help came and she was released. The patient was immediately transported to a nearby hospital and hospitalized.

At the time of hospitalization, the patient reported of severe pain on her right elbow. We found that the pain had severely restricted movement. We observed edema on the patient's elbow and forearm. There was overall tenderness, but distal sensory, motor, and circulation were normal. The patient did not have a previous history of trauma pertaining to either the elbow or forearm. She had not experienced any pain or discomfort of the elbow or forearm before the accident.

Radiographs revealed anterior dislocation of the radial head and avulsion fractures at the medial epicondyle and at the humeral tip. We observed 6° of volar angulation of the ulna, crossing from the metaphysis to the ulnar shaft, in contrast to 6° of PUDA observed in the unaffected arm. We did not observe indicators of chronic radial head dislocation, such as radial head deformity or degeneration (Fig. 1). Incidents of plastic deformation of the ulna in adults are very rare. To exclude neglected dislocations and to assess soft tissue injury around the joint, we conducted magnetic resonance imaging (MRI). We found that the proximal radioulnar joint and the radial head showed neither dysplastic or degenerative changes. Torn annular ligament parts were found floating in hematoma, and fractures, probably

induced by the avulsion at the flexor tendon insertion, were observed at the medial epicondyle and the humeral tip (Fig. 2). In spite of the radiographic suggestions against chronic but for acute plastic deformation of the ulna, we concluded that it may be too rash to perform surgical treatment. So we performed manipulation via compression of the radial head from the anterior aspect, which had already been attempted at the emergency unit but had failed, to restore the radial head and to test the plausibility of conservative treatment. As before, we were able to restore the dislocation relatively easily when the forearm was in a neutral position, but even a slight extension of the elbow or supination of the forearm led to re-dislocation with a popping sound. Subsequently, we decided that the patient required surgical treatment.

Monteggia fractures in adults generally require surgical treatment. Acute Monteggia fractures are treated through open reduction of the ulnar shaft, as the first line of treatment, to achieve anatomical reconstruction. Open reduction alone generally leads to satisfactory reduction of the radial head. But when radial head reduction, in spite of surgical treatment, is unsatisfactory or when there is soft tissue involvement, such as the annular ligament or the nerves, open reduction of the radial head through the lateral approach or annular ligament reconstruction is recommended.¹⁾ In addition, the effectiveness of corrective osteotomy for restoring PUDA have already been established for the treatment of ulnar deformity or of nonunion-induced radial head dislocations.⁵⁾ Thus, taking together preexisting guidelines and the literature

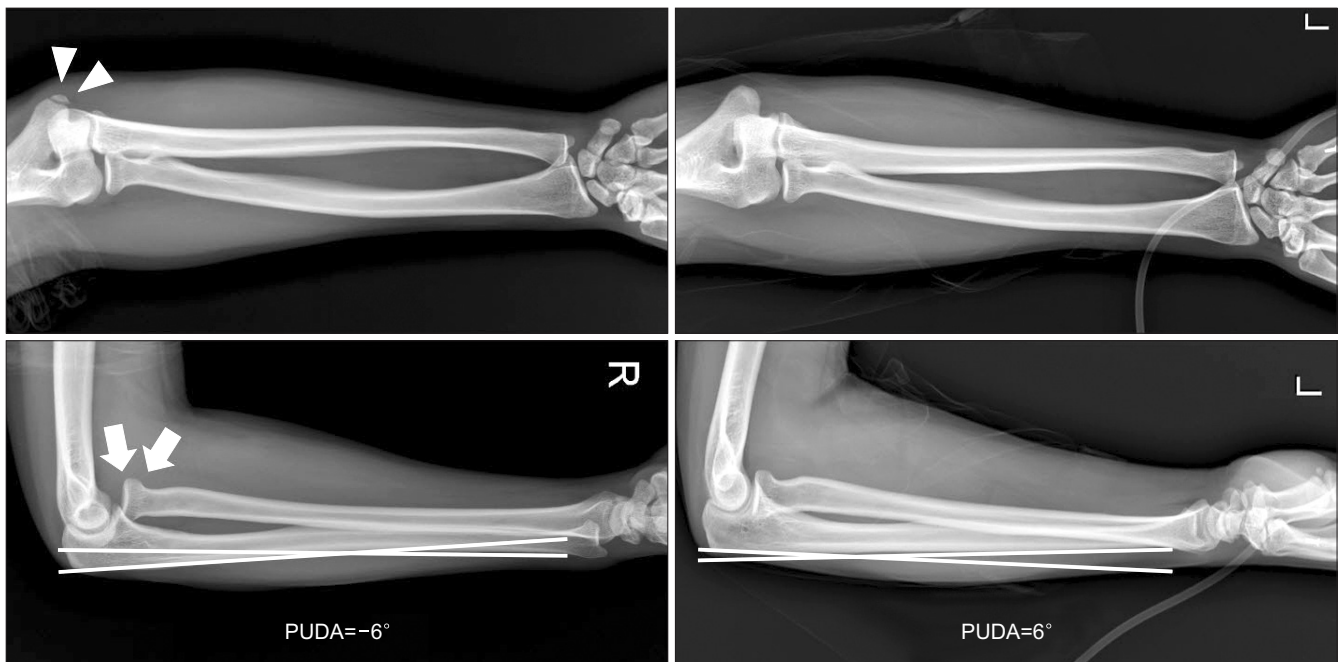


Fig. 1. On the plain radiographs, in the right forearm, anterior dislocation of the radial head (arrows) accompanied by anteriorly curved deformation of the ulnar shaft with reversed proximal ulna dorsal angulation (PUDA) measured at -6° and avulsion fracture of medial epicondyle (arrowheads) are observed. The PUDA on the left ulna is measured at 6° within normal range.



Fig. 2. On the magnetic resonance imaging, severe edema of the soft tissue around the elbow and intraarticular hematoma are observed. The contours of the lesser sigmoid notch of the ulna and the rim of the radial head are congruent without any evidence of dysplasia, but the anteriorly dislocated radial head overrides the coronoid process and the torn annular ligament is open and free-floating (arrows).

on the treatment of fractures in pediatric patients, we decided to measure the magnitude of PUDA of the unaffected arm and use it as an anatomical marker of recovery after ulnar osteotomy. We aimed to achieve complete radial head reduction through ulnar osteotomy, but in the case that the reduction is unstable we planned to use the lateral approach for the reduction and perform adjunct annular ligament reconstruction.

We made another attempt to reduce the radial head dislocation through posterior compression. As our attempt before, although the dislocation was easily restored, even a slight supination of the forearm or extension of the elbow led to redislocation with a popping sound.

We made a 15-cm incision at the posterior aspect of the forearm to expose the ulnar shaft. We then located and marked the apex dorsal angulation with a C-arm. Using a saw, we osteotomized the region encompassing the posterior cortical bone to the apex of the deformity. To prevent unnecessary rotational deformity and changes in length, we intentionally preserved a portion of the anterior cortical bone. Aiming for a slight overcorrective of PUDA, we fixed the plate (3.5 mm locking compression plate, 7 holes; DePuy Synthes, West Chester, PA, USA) at a 10° tilt around the central screw hole, so that the tip of the tilt was on top of the site of osteotomy. And we inserted one cortical screw each into the proximal and distal screw hole nearest

to the site of osteotomy. We tightened the screws in alternation so that the proximal and distal ulnar fragments came in contact with the plate and ensured that the remaining anterior cortical bone was osteotomized (Fig. 3). Post-corrective ulnar osteotomy, we found that slight compression of the radial head led to reduction of the radial head. We inserted locking screws into the remaining holes to complete the fixation. Using C-arm imaging, we checked that manipulation in any motion (rotation of the forearm, extension or flexion of the elbow, or any motion under forearm rotation) did not redislocate the radial head. This meant that adjunct treatment such as annular ligament reconstruction or resection of medial or lateral soft tissue was not required. Postoperative radiographs revealed that the degree of PUDA of the unaffected and affected sides were 6° and 7°, respectively.

During the first postoperative week, the patient was administered cast immobilization at 90° of elbow flexion. The patient then carried out joint motions under hinged brace administration for 5 weeks. On the 3rd postoperative month, the patient's elbow and forearm range of motions (ROMs) were fully restored with respect to the unaffected side. We observed the following ROMs: 0° of extension, 145° of flexion, 80° of pronation, and 70° of supination. Radiographs also revealed bone union of the ulna (Fig. 3, 4). At the final 3-year follow-up, we surgically removed hardware from the patient who at the time was asymp-



Fig. 3. The proximal ulna dorsal angulation (PUDA) was recovered by incomplete osteotomy on the back of the ulna at the deformation followed by tightening the cortical screws to stick the bones to the pre-bent metal plate (right). The radial head was relocated into place and stable articulation was maintained only with the corrective osteotomy with recovered PUDA to 7°. Stable reduction of the radial head and complete bony union were confirmed at the last follow-up at 3 years after surgery.



Fig. 4. At the final follow-up at 3 years postoperatively, complete range of motion of the elbow was recovered and no discomfort or symptoms were reported.

tomatic and did not show any signs of degenerative changes.

Discussion

In an adult bone, fractures may or not be combined with plastic deformity depending on the force of trauma and the maturity of bone. There have been few reports of Monteggia fractures involving radial head dislocations combined with plastic deformity of the ulna.^{6,7)} The major etiology of Monteggia fractures involving a dislocation combined with forearm plastic deformity in adults have been shown to be a low-energy and

progressive injury mechanism described as an 'entrapment on moving rollers in a machine.'^{6,7)} We observed a similar injury mechanism whereby the rope of the fishing net wrapped around the patient's hand and gradually twisted her arm. Therefore, patients with a similar history of trauma should be suspected of forearm lesions combined with plastic deformation of the ulna, so that even though they are rare they are not overlooked at the initial diagnosis.

The presence of an angulated ulnar shaft, which was found reverse in the anterior direction, led us to suspect an acute lesion, for which methods of treatment in adults are largely

unknown. This meant that deciding on the best treatment was difficult. We excluded the possibility of musculoskeletal dysplasia because radiographs showed that the patient had a normal PUDA on the unaffected side. We also excluded neglected chronic lesions from childhood because medical history of the patient revealed that she had never suffered from childhood trauma of the elbow or forearm and that before the trauma she had never felt any discomfort of the elbow or forearm. A chronic radial head dislocation combined with volar angular deformity of the ulna that had been neglected for many years would have led to dysplasia or degeneration of the radial head and the humeral capitellum. Yet compared to the unaffected arm, the affected arm did not show any of these signs. Moreover, assuming that the proximal radioulnar reduction was made to pre-injury levels, we found that the angulation of the lesser sigmoid notch of the ulna and the angulation of the lateral facet of the radial head were aligned on MRI; this alignment enabled us to predict the pre-injury alignment of the proximal radioulnar joint. Further, our observations of an acute annular ligament tear also suggest that the plastic deformation of the ulna was caused by an acute trauma. Our findings that ulnar osteotomy leads to a stable radial head reduction and a fully restored joint function at both short- and long-term postoperative follow-ups confirm our diagnosis of a Monteggia equivalent fracture involving an anterior radial head dislocation and plastic deformation of the ulna secondary to an acute trauma. A chronic lesion neglected for several years would not have been treatable by ulnar osteotomy alone. Achieving a complete ROM recovery and a stable radial head reduction after ulnar osteotomy alone is essentially impossible in patients with chronic lesions that have been neglected for years. Neglected Monteggia fractures in adults have been shown to require open reduction of the radial head and annular ligament reconstruction or resection/arthroplasty of radial head deformities.¹⁾

Despite making a diagnosis of an acute forearm lesion combined with plastic deformation, we were uncertain as to the best choice of treatment for this lesion in adults. The standard choice of treatment for pediatric patients is reduction of the forearm and conservative treatment consisting of cast immobilization at 90° of flexion and in complete supination for a number of weeks. However, osteotomy may be recommended for patients aged four years or older with a fixed deformity of 20° or greater.⁸⁾ The rarity of these fractures in adults has meant that standard treatment guidelines have not been established. But because neglecting radial head dislocations causes valgus deformity of the elbow and restricted ROM, including restricted flexion caused by interposition of material and restricted rotation caused by radial head deformity, leads to secondary degenerative changes later on, early reduction is important.⁷⁾ Recent biomechanical studies have shown that the extent of angular deformation of PUDA combined with annular ligament tears positively correlates with the extent of radial head dislocations.⁹⁾

Thus, the anatomical reduction and internal fixation of the ulna and closed reduction of the radial head should be prioritized in patients with acute Monteggia fractures, while open reduction of the radial head through the lateral approach should be performed only when there is interposition of soft tissue, such as the annular ligament, or an unstable radial head reduction.¹⁰⁾ In general, PUDA begins from the olecranon tip and forms its apex on average 47 mm distally from the tip. The anatomical dorsal angulation of the proximal ulna is on average 5.7° (range, 0°–14°), meaning that around 96% of the population have bilateral symmetry in angulation.³⁾

On MRI, we observed rupture and displacement of the annular ligament and noted that the majority of soft tissue surrounding the elbow joint, such as the musculotendinous complex, remained intact (Fig. 2). However, we also observed a mediolateral ligament injury and avulsion fractures of the medial epicondyle and the humeral tip (Fig. 2). As described in studies on Monteggia fractures, a decrease in PUDA has been reported to induce radial head dislocations in adults and pediatric patients, suggesting that increasing PUDA should be one of the main purposes of fixation. Past studies have also demonstrated that osteotomy should be used to treat deformities. In this study, we employed as our primary treatment corrective osteotomy for the misalignment of the ulna to restore PUDA. If necessary, we also planned to conduct secondary annular ligament reconstruction and soft tissue resection, for example, if the radial head reduction is unstable despite surgical treatment. Here we found that joint stability can be achieved by restoring PUDA via osteotomy. We did not need to perform reconstruction of ligament(s) surrounding the elbow or soft tissue resection, such as a capsular release. At the final follow-up, we observed that the patient's elbow and forearm function had fully been restored.

One of the recommended surgical treatments for pediatric patients with acute or chronic dislocations of the radial head combined with plastic deformation of the ulna, and for those with Type 1 Monteggia fractures, is ulnar osteotomy.⁵⁾ However, when radial head reduction is unsatisfactory in spite of ulnar osteotomy, physicians have performed adjunct annular ligament reconstruction. Following this recommendation, we used ulnar osteotomy in our adult patient to osteotomize the area of deformity and to restore PUDA. We found that restoring the bony structure led to stabilization of the elbow joint without the need for annular ligament reconstruction, to the stable reduction of the radial head, and to full restoration of elbow function that lasted through to the final follow-up. Although our findings are from a single case, they suggest that the major pathogenesis of radial head instability in Type 1 Monteggia fractures, classified in terms of the Bado classification, in adults is probably ulnar deformity. Therefore, our findings demonstrate the utility and effectiveness of corrective ulnar osteotomy for a stable radial head reduction without the need for adjunct treatment such as annu-

lar ligament reconstruction.

To sum up, here we report a case of anterior dislocation of the radial head combined with acute plastic deformation of the ulna in an adult patient. We found that correction of the PUDA through ulnar osteotomy without additional soft tissue resection was able to restore elbow function completely in the long-term. The findings of this study highlight the need for physicians to increase their awareness of radial head dislocations combined with plastic deformation of the ulna in adults. Our findings suggest that corrective ulnar osteotomy can restore PUDA in adult patients as in pediatric patients.

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