Missed posttraumatic radial head dislocation

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Summary
Radial head dislocations, either alone, or in association with fracture of forearm bones, are best managed acutely. If the injury is missed on initial radiographs, then treatment of the chronic injury involves open reduction of the radial head and reconstruction of the annular ligament. Alternatively, an ulnar elongation and corrective osteotomy may be done. In this article we describe the different methods that have been used to treat this injury and present illustrative cases with treatment guidelines.

Introduction
In 1814, Giovanni Battista Monteggia described fracture of the proximal ulna with dislocation of the radial head. In the most widely used classification system of these injuries published by Bado, four types are described. Type I is an anteriorly angulated fracture of the proximal ulna with an anterior dislocation of the radial head. Type II is a posteriorly angulated fracture of the proximal ulna and posterior dislocation of the radial head. Type III is a laterally angulated fracture of the proximal ulna and lateral dislocation of the radial head. Type IV is a fracture of proximal radius and ulna with an anterior dislocation of the radial head.

Three variants have also been described:

• isolated dislocation of the radial head;
• fracture of proximal ulna with fracture of the radial neck; and
• fracture of proximal ulna and radius with the radial fracture being more proximal than the ulnar fracture.

In an acute Monteggia injury, reduction of the radial head is generally possible by manipulation and correction of ulnar angulation. In some instances the annular ligament or capsule may be interposed and prevents reduction of the radial head. This necessitates an open reduction and repair of the annular ligament. If the injury is less than 3 weeks old, closed reduction is generally possible; if between 3 weeks and 3 months, open reduction is more commonly required with repair of the annular ligament. Injuries that are diagnosed with a delay of more than 3 months may be classified as chronic injuries¹ and these are best managed by reconstruction to maintain alignment of the radiocapitellar joint.
Stabilisation of the ulna by internal fixation may be needed in older children, or if the ulnar fracture is oblique or comminuted. There is a relatively high incidence of myositis and synostosis in this region and periosteal stripping should be minimal.

Missed injuries

Missed Monteggia injuries are fortunately rare, but by no means non-existent. Most reports of missed injuries in the literature are from referral centres and document series of 5–15 cases over periods of many years. The injury can be missed if adequate radiographs are not obtained in a child with an injury to forearm or elbow. All such injuries should have two orthogonal views centred on the elbow in addition to the appropriate imaging for the forearm injury.

Failure to recognise the loss of alignment of the radial head and the capitellum on initial radiographs is another cause of missed injuries. A line drawn through the centre of the shaft and head of the radius should intersect the capitellum in all X-ray views and in any position of the elbow.

If the radial head is not anatomically reduced after correction of ulnar alignment, this generally signifies an interposed annular ligament or biceps tendon. In these situations, open reduction of the radial head and internal fixation of the ulna should be undertaken. On follow-up after reduction of the radial head, a close watch should be kept for any recurrence of subluxation or dislocation which should be managed accordingly.

Natural history of persistent dislocation

One of the earliest reports on the natural history of an unreduced Monteggia injury was by Blount. His recommendation was against any treatment as late reduction was thought to result in a poorer functional outcome when compared to leaving an unreduced radial head. Many other contemporary reports supported this view.

Wiley reported poor results with reconstruction in late cases of traumatic dislocation of the radial head; all patients undergoing reconstruction in his series ended up with an excision of the radial head. In general, excision of the radial head in young children is avoided because of concerns about valgus deformity, ulnar neuropathy and wrist pain. However, the literature on this issue is equivocal. Watson Jones believed that excision of the radial head in the growing child led to proximal migration of the radius and secondary subluxation of the distal radio-ulnar joint. Additionally, lack of the proximal radius may lead to valgus deformity and instability of the elbow. In a series of 25 patients with a mean age of 14.2 years and average follow-up of 7.8 years, excision of the radial head was not associated with any of the aforementioned problems and resulted in good to excellent results in 19 out of 27 elbows. The salient feature was re-operation for removal of appositional bone growth in seven patients.

Another article showed improved arc of motion and reduced pain following radial head excision for congenital dislocation of the radial head at an average age of 13 years in eight elbows.

Over the years, there has been steadily mounting evidence that unreduced radial head dislocation is fraught with problems and poor function and hence reconstruction is now the preferred treatment. One of the earliest papers on reconstruction of the annular ligament was by Bell Tawse and in his series of six patients, there was a block to flexion and a progressive valgus deformity as a result of unreduced dislocation. Similarly, Best and Hirayama et al. recommended reconstruction in cases of late presentation because of deformity, reduced movements and pain.

Treatment options

Reduction of the radial head at a later stage may require open reduction and stabilisation of the radial head along with corrective osteotomy of the ulna. The two broad categories of procedures to achieve stability of the radial head include either open reduction of the radial head with reconstruction of the annular ligament, or corrective wedge osteotomy of the ulna to stabilise the radial head or a combination thereof.

Annular ligament reconstruction

The landmark paper regarding annular ligament reconstruction was written by Bell Tawse from Pontefract, England. He described reconstruction of the ligament using a strip of the central part of the triceps fascia, which is left attached to the ulna and is passed around the radial neck to stabilise the radiocapitellar joint. Ulnar osteotomy was not done in any patient. The patients included eight patients with posttraumatic radial head dislocation and one with congenital dislocation of the radial head. All patients regained a full or good range of movement except the one with congenital dislocation of the radial head who was left with a 40° fixed flexion deformity.
A modification to this technique was proposed by Lloyd Roberts and Bucknill\textsuperscript{6} in which the lateral portion of the triceps fascia was used, as it has a rolled edge and is thicker, instead of the central slip. In addition, a transcapitellar Kirschner wire passed into the proximal radius was used to supplement stability in the early postoperative period. The strip of triceps fascia is passed around the radial neck and then through a drill hole in the ulna and sutured to itself. Eight patients were operated with a time lag of 4 months to 3 years between injury and surgical reconstruction. Only one patient out of eight required an ulnar osteotomy to correct bowing of the ulna. All patients regained a full or functional range of flexion and extension and pronation—supination except one patient with a 3 year old injury who had 45° of pronation and supination.

Another series of five late presentation Montegia injuries was reported by Fowles et al.\textsuperscript{2} The five patients were managed by open reduction of the radial head. Three had reconstruction of the annular ligament; in one the ligament was sutured and the last did not have a repair. Two had an ulnar osteotomy for correction of angulation. A Kirschner wire was used to stabilise the radial head in all patients. The average flexion arc improved by 50% as compared to the preoperative range of motion. There was lateral subluxation of the radial head in the patient who did not have reconstruction or repair of the annular ligament.

A more recent article\textsuperscript{1} from the Mayo clinic describes seven female patients treated by reconstruction over a 28 year period. The average age was 5 years and 10 months whilst the time since injury ranged from 3 months to 7 years. The prerequisite for surgery was a concave proximal radial articular surface evident on plain radiographs. One patient had significant posterior bowing of the proximal ulna and had an ulnar osteotomy and intramedullary stabilisation at the time of annular ligament reconstruction. At final follow-up, all patients were pain-free and had no elbow instability. The preoperative pronation and supination was a full or almost full range in all patients. Postoperatively, all had a functional or full range of supination but one had pronation of only 5° and two others had pronation of 40° and 45°. One patient had a restricted flexion—extension range from 40° to 95° which was previously full range. The authors recommended annular ligament reconstruction for a child of any age and after any duration of dislocation. The prerequisites for surgery were a concave proximal radial articular surface and normal contour and shape of the radius and ulna. Any significant deformity of either bone should be corrected by osteotomy at time of reconstruction.

**Ulnar osteotomy**

The ulnar osteotomy has been proposed to stabilise the radial head either on its own (through over-correction) or along with open reduction of the radial head and reconstruction of the annular ligament.

The ulnar osteotomy was first described by Judet et al.\textsuperscript{12} in 1962. Hirayama et al.\textsuperscript{11} reported a series of nine patients managed by over correction and elongation of the ulna. The patients were 2–12 years old and the injury occurred 2 months to 3 years before surgical reconstruction. The scar tissue obstructing reduction was excised and an ulnar osteotomy performed 5 cm distal to the olecranon. The ulna was distracted by 1 cm and angulated by 15° at the osteotomy site. To correct an anteriorly dislocated radial head, the ulnar osteotomy is angulated posteriorly, producing a convexity towards the posterior aspect and thus stabilising the proximal radius. Similarly, for a lateral dislocation (Type III), the osteotomy was angulated medially. No attempt was made to repair the annular ligament. A cast was applied keeping the elbow in 90° flexion and the forearm supinated. Three patients had residual loss of pronation, and one patient who was operated 3 years following the injury had a poor result with restricted extension and pronation. The remaining patients did well.

Tension in the interosseous membrane is said to stabilise the radial head following ulnar elongation osteotomy. The position of postoperative immobilisation was changed to midpronation in the later cases due to problems of residual restriction of pronation in patients immobilised in supination. Biceps tendon lengthening was required in some cases to enable full extension.

Open reduction of the radial head with ulnar osteotomy is relatively simpler than formal annular ligament reconstruction and, based on reports in the literature, seems to provide comparable results.

**Authors’ preferred treatment option**

The experience of the senior author (BWS) is based on reconstruction of the annular ligament in accordance with the recommendation and operative technique reported by Seel and Peterson.\textsuperscript{1} A lateral Kocher’s approach is used and the fibrous tissue and remnants of the annular ligament obstructing reduction are excised. Stability of
reduction is assessed. If there is a significant ulnar bowing deformity, a corrective ulnar osteotomy is done and stabilised with a four-hole plate. The lateral margin of triceps fascia is used as a graft and the strip is harvested through an extension of the approach proximally, aiming to keep the graft as long as possible.

A drill hole is made in the ulna from the posterior border to the antero-lateral edge, which corresponds to the antero-medial attachment of the annular ligament. The fascial strip is passed in the drill hole in the ulna from the back to exit anteriorly, then around the radial neck and then onto the lateral surface of the ulna to be sutured to itself at the starting point (Fig. 1A). An alternative is to make two drill holes crossing each other and after looping round the radial neck, the strip is passed back into the second drill hole and exits posteriorly to be sutured back to the starting point (Fig. 1B). The second drill hole provides a more anatomic posteromedial line of pull on the radial head.

A transcapitellar Kirschner wire may be used for additional stability in the early postoperative period if there is any concern regarding the integrity of reconstruction and the wire is removed at the time of cast removal at 6 weeks. We have not had any instances of wire breakage as long as the arm is immobilised in a cast for the same duration. Active movement is started after 6 weeks.

In patients who are operated within 3 months of injury, it may be possible to define the annular ligament and repair it.

Illustrative cases

Case 1

A 7 year old girl sustained a low energy injury to her elbow when she fell whilst playing. On X-rays, there was no obvious fracture in the forearm. The radial head dislocation was not detected and the injury was treated as an undisplaced supracondylar fracture of the humerus and a cast was applied for 3 weeks. On removal of the cast, repeat radiographs showed the dislocated radial head (Fig. 2). A referral was made to our centre and at that point, she was 5 weeks following the injury. A closed reduction was unsuccessful at that stage and an open reduction and reconstruction of the annular ligament was performed (Fig. 3). No
Osteotomy was necessary, as the shape of the radius and the ulna was normal. A transcapitellar wire was used for stability and removed after 6 weeks. At last follow-up, she had a stable elbow with a nearly full range of motion.

Case 2

A 10 year old boy sustained an injury to his forearm. The radial head dislocation was missed and the injury treated as a fracture of the ulna. Ten months following injury, he presented back to the clinic with a bony swelling on the anterior aspect of the elbow, which on radiographs (Fig. 4) was confirmed to be the dislocated radial head. At this point he was referred to our centre. There was an anterior dislocation of the radial head with an anteriorly angulated fracture of the ulna. This was managed by open reduction of the radial head, corrective osteotomy of the ulna and reconstruction of the annular ligament using the triceps fascia strip (Fig. 5). The transcapitellar wire was removed at 6 weeks when active movements were started. At
last follow-up, he had a flexion—extension range of 25–115° and had regained almost full supination but little pronation.

Summary

Dislocation of the radial head can be managed by closed reduction if recognised and treated within 3 weeks of injury. Beyond 3 weeks, open reduction is often required. If there is a delay in treatment of over 3 months, the reconstructive options to restore anatomy are either to reconstruct the annular ligament with a triceps fascia strip, or to correct the ulnar angulation by ulnar osteotomy. The two procedures can be combined for old unreduced dislocations with a significant ulnar deformity. The reported results with both these procedures are good in most patients with the main problem being restricted range of elbow movements.

Practice points

- High index of suspicion for the Monteggia injury in children with elbow or forearm trauma
- Adequate radiographic evaluation is essential
- Annular ligament reconstruction using the triceps fascia passed through drill holes in the proximal ulna is a reliable procedure

References