Irreducible Dislocation of the Radial Head Associated With Pediatric Monteggia Lesions

Muneaki Abe, MD, PhD
Hozumi Kumano, MD, PhD
Akihiko Kinoshita, MD
Shinji Hirofuji, MD, PhD

From the Department of Orthopedic Surgery, Shiroyama Hospital, Habikino, Japan (Dr. Abe, Dr. Kumano, and Dr. Kinoshita), and the Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Japan (Dr. Hirofuji).

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Abstract

Background: In pediatric patients with Monteggia lesions, the radial head can be reduced manually when displacement of the fractured ulna is corrected. Occasionally, however, a dislocated radial head could not be reduced manually even when the length and/or angulation of the fractured ulna had been corrected. We can find such cases in the literature, but those are single case reports. We encountered 17 cases of irreducible dislocation of the radial head in pediatric Monteggia lesions during the past 43 years. The purposes of this study were to identify the characteristics of our cases and to discuss the factors that inhibited reduction of the radial head.

Methods: Of 109 children treated for Monteggia lesions between 1972 and 2015, we encountered 17 cases of irreducible dislocation of the radial head. The patients' ages averaged 7.1 years, ranging from 2.6 to 12.1 years. Directions of the radial head dislocation were anterior in five cases, anteromedial in four, lateral in one, and anterolateral in seven. Most of the patients were referred to us from local orthopaedic clinics because of irreducibility of the radial head. We reduced the radial head surgically and confirmed the causes of irreducibility.

Results: In 10 of the 17 cases, the problem was identified as pseudoreduction. In those cases, the radial head was reduced in a supination position but redisplaced in a pronation position. Causes of irreducibility were traced to the annular ligament in 15 cases, biceps tendon in 1, and posterior interosseous nerve in 1.

Conclusions: In cases of pediatric Monteggia lesions, we should pay attention to patients in whom the dislocated radial head is not reduced after closed reduction. The most frequent cause of hindered reduction was interposition of the annular ligament in the radiocapitellar joint. Here, the radial head seems to be reduced in the supination position but becomes redisplaced in the pronation position. After closed reduction, it is important to confirm whether the radial head is stable in both pronation and supination positions.

Level of Evidence: Diagnostic level IV.

Table 1**Clinical Details of 17 Cases**

Cases	Ages at Injury (yrs, mo)	Sex	Side	Type and Site of Ulna Fracture	Associated Injuries
1	11, 2	Female	Right	Plastic bowing	—
2	12, 1	Male	Right	Proximal physis	Medial epicondyle fracture
3	3, 4	Female	Right	Transverse; proximal metaphysis	PINP
4	6, 10	Male	Right	Greenstick; proximal metaphysis	PINP
5	6, 5	Female	Left	Oblique; middle third	—
6	9, 1	Male	Left	Plastic bowing	Medial condyle fracture; PINP
7	7, 9	Male	Left	Oblique; proximal metaphysis	PINP
8	6, 3	Male	Right	Greenstick; proximal metaphysis	PINP
9	5, 11	Male	Right	Greenstick; proximal metaphysis	PINP
10	6, 5	Male	Right	Transverse; proximal metaphysis	Radial neck fracture
11	6, 9	Female	Right	Plastic bowing	—
12	5, 3	Female	Left	Greenstick; proximal metaphysis	—
13	4, 2	Male	Left	Greenstick; proximal metaphysis	PINP
14	6, 9	Male	Right	Greenstick; proximal metaphysis	PINP
15	2, 7	Male	Right	Plastic bowing	Radial neck fracture
16	10, 0	Male	Left	Greenstick; proximal metaphysis	—
17	10, 10	Male	Right	Transverse, middle	—

(continued)

PIN = posterior interosseous nerve, PINP = posterior interosseous nerve palsy

Giovanni Battista Monteggia first described the anterior dislocation of the radial head associated with a fracture of the proximal third of the ulna in 1814. Bado¹ later devised a classification system for the Monteggia lesion that included four types and equivalent lesions. Since then, the literature has become replete with many reports concerning Monteggia lesions. Generally, the articles noted that when the length and angulation of the fractured ulna were reestablished, the radial head could be easily reduced in pediatric Monteggia fracture.^{2,3} Occasionally, however, the dislocated radial head could not be reduced manually even when the length and/or angulation of the fractured ulna had been corrected. We can find such cases in the literature,⁴⁻⁹ but those are single case reports.

We encountered 17 cases of irreducible dislocation of the radial head in pediatric Monteggia lesions during the past 43 years (1972 to 2015). The purposes of this study were to identify the characteristics of our cases and to discuss the factors that inhibited reduction of the radial head.

Methods

Of 109 children treated for Monteggia lesions between September 1972 and December 2015, we encountered 17 cases of irreducible dislocation of the radial head. We reviewed the clinical data from the patients' records, including outpatient and inpatient charts, plain radiographs, and intraoperative photographs for all 17 patients.

The patients' ages ranged from 2 years 7 months to 12 years 1 month

(average, 7 years 1 month). There were 12 boys and 5 girls. The right side was injured in 11 of the children, and the left side in 6 (Table 1).

The types of ulnar fracture were transverse and complete in three cases, oblique and complete in two, and greenstick and incomplete in seven. There was plastic deformation in four cases and physeal fracture of the olecranon in one case. The sites of ulnar fracture were the proximal physis in 1, proximal metaphysis in 10, and the middle third in 2.

Directions of the radial head dislocation were anterior in five patients, anteromedial in four, lateral in one, and anterolateral in seven. Posterior interosseous nerve palsy (PINP) was observed in eight patients. Other associated fractures were medial epicondylar fracture in one, medial condylar fracture in one, and radial neck fracture in two.

Table 1 (continued)

Clinical Details of 17 Cases				
Direction of Radial Head Dislocation	Causes of Irreducibility	Procedures for Ulna Fracture	Follow-up (yrs/mo)	Results (Range of Motion)
Anteromedial	Annular ligament	—	1/8	Same as the normal side
Anteromedial	Biceps tendon	—	3/4	Loss of flexion (10°); loss of pronation (20°)
Anterolateral	PIN	Intramedullary	14/4	Loss of pronation (70°)
Anterolateral	Annular ligament	—	0/9	Same as the normal side
Anterior	Annular ligament	Intramedullary	2/5	Same as the normal side
Anteromedial	Annular ligament	—	0/10	Same as the normal side
Lateral	Annular ligament	Intramedullary	0/6	Same as the normal side
Anterolateral	Annular ligament	—	0/9	Same as the normal side
Anterolateral	Annular ligament	Intramedullary	6/3	Same as the normal side
Anteromedial	Annular ligament	Intramedullary	10/1	Same as the normal side
Anterior	Annular ligament	Correction of bowing	0/6	Same as the normal side
Anterolateral	Annular ligament	—	0/7	Same as the normal side
Anterolateral	Annular ligament	Intramedullary	9/7	Same as the normal side
Anterolateral	Annular ligament	Intramedullary	5/8	Same as the normal side
Anterior	Annular ligament	—	3/9	Same as the normal side
Anterior	Annular ligament	Intramedullary	2/2	Same as the normal side
Anterior	Annular ligament	Intramedullary	1/4	Same as the normal side

PIN = posterior interosseous nerve, PINP = posterior interosseous nerve palsy

Most of the patients were referred to us from local orthopaedic clinics because of irreducibility of the radial head. The final treatment was done at our department within 7 days after the injury in most patients.

Under general anesthesia, the ulnar fracture was reduced and fixed with one or two intramedullary Kirschner wires if the fracture displaced, after which we attempted to reduce the radial head manually in a closed manner. All attempts were unsuccessful. We therefore performed open reduction of the radial head using a lateral approach, splitting the common extensor at its origin, in 15 cases. An anterior approach was used in two cases to check the posterior interosseous nerve (PIN). During surgery, we confirmed that the causes of irreducibility of the radial head were the annular ligament being trapped between the capitellum and the radial head in

15 patients, the posterior interosseous nerve being interposed between the radial head and the capitellum in 1, and the biceps tendon being wrapped around the radial neck in 1.

Postoperatively, the elbow was fixed with a long-arm plaster cast in 90° of flexion and a slightly supinated position for 3 to 4 weeks. Active range of motion of the elbow and the forearm was encouraged after cast removal.

Results

Although patient follow-up was attempted, half of them were not followed up directly. Most of the families had moved out of the area. Long-term clinical follow-up was not a primary goal of this study, as many reports have already demonstrated that Monteggia lesions in children have a good prognosis. Therefore, regarding the patients

who could not be followed up at this time, we used their final visit with us from their charts and radiographs. Finally, the mean postoperative follow-up period was 3.8 years (range, 6 months to 14 years 4 months) (Table 1).

All patients except cases 2 and 3 regained elbow and forearm motion within 3 months. No patients complained of any disability regarding the activities of daily living or sports activity, although two patients lacked some pronation (case 2 at 20° and case 3 at 70°). Seven of eight patients who had PINP regained nerve function within 4 months. Nerve function did not recover in one patient (case 3), however, so tendon transfer was undertaken, after which her wrist and finger motion became nearly normal, except for limited motion of pronation.

Radiographically, the radiocapitellar alignment was normal in all patients.

Figure 1

Anteroposterior (A) and lateral (B) radiographs (case 4) of the injury showing anterolateral dislocation of the radial head with a greenstick fracture of the proximal metaphysis of the ulna.

The carrying angle was the same as that in the opposite elbow both clinically and radiographically.

Illustrative Cases

Case 4

A 6-year-old boy sustained a fall on his hand, injuring the right elbow. A local orthopaedic surgeon diagnosed a Monteggia fracture. Attempts at closed reduction without anesthesia were unsuccessful. Three days after the injury, he was referred to us for further treatment.

Examination of the right elbow at the time of admission revealed moderate swelling and bony bulging in the antecubital fossa. Sensation in the hand was intact, and the patient could extend the wrist with radial deviation. He could not extend his thumb or the metacarpophalangeal joints of the fingers. Plain radiography revealed anterolateral dislocation of the radial head with a greenstick fracture of the proximal metaphysis of the ulna (Figure 1).

With the patient under general anesthesia, general anesthesia, we attempted to reduce the radial head manually but could not obtain stable reduction. Open reduction was then performed using a lateral approach. The radial head was not found in the joint. Intraoperatively, the annular ligament was found to be interposed and trapped between the capitellum and the radial head, thereby preventing reduction (Figure 2, A). We confirmed that the radial head had become dislocated through the disrupted sacciform recess (Figure 2, B). We therefore lifted the intact annular ligament and reduced the radial head through the disrupted sacciform recess (Figure 2, C). After reduction, the radial head was stable in both supination and pronation positions (Figure 2, D).

Figure 2

Intraoperative photographs showing findings (case 4). **A**, Note the interposed intact annular ligament and disrupted sacciform recess (arrowhead). **B**, Part of the radial head is seen through the disrupted sacciform recess. **C**, Using a small elevator, the entrapped annular ligament is pulled off from the joint space. **D**, The radial head is then reduced to its normal position.

Postoperatively, the elbow was immobilized in a plaster cast, with the elbow in 90° flexion and the forearm in a 30° supination position for 3 weeks. After removing the cast, active range of motion exercises at home were encouraged. Posterior interosseous nerve palsy recovered at 3 months after surgery. When last seen at 9 months postoperatively, the patient had regained full range of elbow and forearm motion. Radiographs showed that the radial head was in a normal anatomic position (Figure 3).

Case 12

A 5-year-old girl had fallen off a sofa and presented to an emergency department with complaints of pain and swelling in her left elbow. There was no neurovascular deficit. Radiographs revealed incomplete fracture of the proximal metaphysis of the ulna with anterolateral subluxation of the radial head (Figure 4). Closed reduction without anesthesia was attempted, but stable reduction was not obtained. Soon after, she was referred to our department.

Under general anesthesia, closed reduction was again attempted. The radial head seemed to be reduced in a supination position but subluxated in a pronation position (Figure 5). We considered that these findings indicate some type of pseudoreduction. Therefore, we decided to reduce the radial head surgically. Open reduction was performed using the same approach as in case 4. The intraoperative findings were nearly the same as in case 4. That is, the annular ligament was interposed between the capitellum and the radial head. Hence, we reduced the radial head using the same maneuver that was successful in case 4.

The patient's postoperative course after surgery was uneventful, and she resumed nearly normal elbow motion 3 months after surgery. At the final follow-up, 7 months after

Figure 3

Anteroposterior (A) and lateral (B) radiographs (case 4) obtained 9 months after reduction show that the radial head is in its correct anatomic position.

injury, she had a normal carrying angle and full range of motion of the elbow and forearm. Plain radiog-

raphy showed that the radial head was in a normal position even in pronation (Figure 6).

Figure 4

Anteroposterior (A) and lateral (B) radiographs (case 12) show anterolateral subluxation of the radial head with incomplete fracture of the proximal metaphysis of the ulna.

Figure 5

Lateral radiographs (case 12) show that the radial head is nearly reduced in a supination position (A) but anteriorly subluxated in a pronation position (B).

Figure 6

Anteroposterior (A) and lateral (B) radiographs (case 12) obtained at 7 months after open reduction show that the radiocapitellar relationship is normal even in a pronation position.

Discussion and Summary

Reports of irreducible dislocation of the radial head are rare. We reviewed

the English-language literature⁴⁻⁹ for this occurrence and found only six pediatric cases. When we extended our review to include the Japanese

literature, we found that 19 cases were reported. Most of these reports were of a single case. The details of the English- and Japanese-language cases, including the current series, are summarized in Table 2.

As shown in Table 2, the patients' ages were 2 to 12 years (mean, 6.9 years). Boys were injured twice as often as girls. There was no preponderance of the injury on the right or left side, except in our cases. The prevalence of ulnar fractures also showed some differences between the reported cases and our cases. Cases of isolated radial head dislocation without ulnar fracture were reported in both English- and Japanese-language literature, although none of our patients had an isolated dislocation. Overall, the proximal metaphyseal area was the more common site of the ulnar fracture. Plastic bowing of the ulna was also reported. Regarding the direction of the radial head dislocation, anterior dislocations were most common in the overall literature, whereas the lateral or anterolateral dislocation was seen in 47% of our cases.

Several factors that contribute to irreducibility have been reported, including displacement or entrapment of the annular ligament, anterior capsule, osteochondral fragment, biceps tendon, and PIN (Table 2). Among these factors that hinder reduction of the radial head, annular ligament entrapment is the most common. In our experience, as shown by intraoperative findings (Figure 2), the radial head had dislocated through the sacciform recess and lay anteriorly on the intact annular ligament. The interposed annular ligament between the capitellum and radial head then inhibits reduction.

Tan et al¹⁰ described pathology of the annular ligament in pediatric Monteggia fractures. They treated 35 children surgically, assessing all the radial heads. They found that the annular ligaments were intact in all patients, and the ruptures were at the

Table 2**Summary of the Reported Cases**

Variable	English Literature	Japanese Literature	Current Series
No. of cases	6	19	17
Age (yrs) (mean)	3–7 (5.5)	3–11 (7.2)	2–12 (7.1)
Sex			
Boy	2	14	12
Girl	4	5	5
Injured side			
Right	3	10	11
Left	3	9	6
Fractured site of the ulna			
Proximal physis or olecranon	1	1	1
Proximal metaphysis	—	5	10
Diaphysis	1	5	2
Plastic bowing	2	4	4
No fracture	2	4	—
Direction of dislocation			
Antero or anteromedial	6	14	9
Lateral or anterolateral	—	5	8
Cause of irreducibility			
Annular ligament	2	16	15
Anterior capsule	2	—	—
Osteochondral fragment	—	1	—
Biceps tendon	2	1	1
PIN	—	1	1
Association of PINP	—	4	8

PIN = posterior interosseous nerve, PINP = posterior interosseous nerve palsy

Figure 7

Radiographs (case 15) showing example of redislocation or pseudoreduction. **A**, The radial head is anteriorly subluxated in a pronation position. **B**, The radial head is nearly reduced in a supination position. If one examines it more precisely, however, a radiocapitellar line is seen not crossing the center of the capitellum. **C**, At 4 weeks after cast immobilization in the supination position, this lateral radiograph shows redislocation of the radial head. **D**, At 6 months after open reduction, the radial head is in the anatomic position.

lower part of the ligament (which probably means the sacciform recess). Most of the annular ligaments were interposed in the radiocapitellar joint, although the radiographs showed reduction of the radial head. These authors emphasized that radiological reduction of the radial head often does not represent anatomic reduction.

In the current series, 10 of the 17 cases were considered to be a type of pseudoreduction. In these cases, the radial head was nearly reduced in a supination position but redislocated or subluxated in a pronation position (Figure 5). Tan et al¹⁰ noted that if the forearm was pronated, the lateral face of the radial head appeared outside the annular ligament, allowing redislocation of the radial head. They emphasized that frequent radiographic examinations are therefore necessary.

In contrast to our findings and to the report of Tan et al,¹⁰ Shinohara et al¹¹ described two cases of incomplete reduction, in which the radial head was reduced in a supination position but redislocated during rotation from a neutral position to pronation position. Instead of open reduction of the radial head, they treated these cases using a hinged elbow splint. They stated that the purpose of the splint was to reduce the traction force of the biceps muscle on the radial head while allowing the soft tissue surrounding the radial head to heal and stabilize the proximal radioulnar joint.

We treated one patient (case 15) conservatively with a cast in a supination position. In this case, the radial head seemed to be reduced in a supination position, despite showing subluxation in a pronation position. Four weeks later, however, the radial head dislocated completely (Figure 7). The surgeon who treated this boy thought that the radial head was in a reduced position. If the radiocapitellar line¹² is precisely visualized, however, a line drawn along the radial shaft misses the capitellum. We

therefore emphasize that whenever reduction of the radial head is attempted, it is important to confirm that a line drawn along the radial shaft intersects the center of the capitellum. Also, if the radial head is unstable in supination and pronation positions, we recommend open reduction.

Other causes of hindered reduction, such as PIN and biceps tendon interference, seemed to be rare. Usually, recovery from associated PINP occurs spontaneously if there is early reduction of the dislocated radial head. If the PIN is entrapped in the radiocapitellar joint, preventing reduction of the radial head, spontaneous recovery cannot be expected. Thus, the PIN must be removed from the radiocapitellar joint and the radial head reduced. In case 3 of our series, we attempted closed reduction, causing the PIN to become interposed between the capitellum and the radial head. When we explored the radiocapitellar joint 5 months later, we found that the nerve was severely damaged. We had to reconstruct finger extension by tendon transfer because the nerve did not recover. Morris,¹³ Spur¹⁴, and Li et al¹⁵ reported similar experiences and emphasized that the PIN may become wrapped around the anterolaterally dislocated radial head during attempted closed reduction. Hence, exploration of the radiocapitellar joint is necessary in cases of associated PINP with irreducible radial head dislocation.

The biceps tendon is a rare cause of hindered reduction of the radial head. In all the reported cases^{6,7,16} including our case 2, the radial head displaced in the anteromedial direction. Yoshihara et al¹⁶ proposed a possible mechanism in which hyperextension of the elbow with hyperpronation of the forearm causes the tendon to cling to the radial neck. It is very difficult to identify the cause of irreducibility of the radial head preoperatively. Therefore, whenever we encountered such cases, we considered surgical confirmation mandatory.

In conclusion, we reported 17 cases of irreducible radial head dislocation in pediatric Monteggia lesions. The most frequent factor hindering reduction was interposition of the annular ligament in the radiocapitellar joint. In those cases, the radial head seemed to be reduced in a supination position but redisplaced in a pronation position. After closed reduction, it is important to determine whether the radial head is stable in both pronation and supination positions. If the radial head is irreducible or unstable during manual reduction, it is crucial to identify the cause and remove the impediment.

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