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Monteggia type-I equivalent fracture in a fourteen-month-old child: A case report

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Abstract

BACKGROUND

Monteggia and equivalent lesions are relatively rare but result in severe injuries in childhood, typically affecting children between 4 and 10 years old. The diagnosis and treatment of an equivalent Monteggia lesion is more complicated than those of a typical Monteggia fracture. This type of lesion may be challenging and may lead to serious complications if not treated properly. Pediatric Monteggia equivalent type I lesions have been reported in a few reports, all of which the patients were all over 4 years old.

CASE SUMMARY

A 14-mo-old boy was referred to our clinic after falling from his bed 10 d prior. With regard to the clinical examination, an obvious swollen and angular deformity was noted on his right forearm. Plain radiographs and reconstructed computed tomography scans showed a Monteggia type I fracture and dislocation. Magnetic resonance imaging (MRI) confirmed a type I Monteggia equivalent lesion consisting of ulnar fracture and Salter-Harris type I injury in the proximal radius. The radial head was still in the joint, and only the radial metaphysis was displaced anteriorly. Open reduction and pinning of both displaced radial and ulnar fractures achieved an excellent result with full function.

CONCLUSION

We recommend MRI examination or arthrography during reduction, especially if the secondary ossification center has not appeared.

Key Words: Children; Monteggia fracture-dislocation; Monteggia equivalent lesion; Radial neck fracture; Ulnar fracture; Case report

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Core Tip: We reviewed a case of Monteggia type I equivalent fracture in a 14-mo-old child. This is the youngest patient to suffer from this injury. For patients aged less than 5 years, plain radiograph and reconstructed computed tomography scans cannot distinguish Monteggia fractures and Monteggia equivalent fractures in patients with unossified radial heads. As a result, fractures may be misdiagnosed or neglected, leading to poor clinical and radiographic results. Therefore, magnetic resonance imaging (MRI) should be routinely performed. We recommended MRI examination or arthrography during reduction if cartilage fracture is suspected, especially if the secondary ossification center has not appeared.

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INTRODUCTION

Monteggia fracture-dislocation is characterized by a simultaneous ulnar fracture and radial head dislocation. Such an injury is relatively rare and represents less than 5% of upper extremity fractures[1-3]. However, this type of lesion may be challenging and lead to serious complications if not treated properly[4]. Moreover, Monteggia lesions are commonly observed in children between 4 and 10 years old[1]. This injury was delineated first by Monteggia in 1814. Based on the direction of radial head dislocation, the Bado classification is widely accepted[4]. In addition, Bado further classified certain injuries as equivalents or variants to Monteggia lesions because of their similar radiographic pattern and biomechanism of injury. Relevant lesions can be identified on equivalent Monteggia lesions, such as olecranon fractures or radial neck or head fractures. The diagnosis and treatment of an equivalent Monteggia lesion is more complicated than those of a typical Monteggia fracture. Among them, fractures of the proximal ulna with radial neck fractures are the most common type I equivalent Monteggia fractures.

We report an unusual case of a Monteggia type I equivalent fracture associated with a fracture of the proximal 1/3 of the ulnar shaft and a Salter-Harris type I injury in the proximal radius in a 14-mo-old boy. The ossified center of the radial head was invisible on radiography for a child of this age, making this injury easy to misdiagnose and neglect.

CASE PRESENTATION

Chief complaints

A 14-mo-old boy was referred to our clinic after falling from his bed 10 d prior.

History of present illness

Pain and swelling of the right elbow and forearm occurred immediately after falling. Rather than going to the hospital, the patient applied a traditional Chinese medicine herbal ointment of unknown composition. Due to the lack of improvement in the right elbow and forearm, an X-ray was performed at a local clinic 9 d after the fall and showed fracture of his right ulnar. Then, he was subsequently transferred to our hospital.

History of past illness

The patient had no previous medical history.

Personal and family history

The patient denied any family history and had no notable past history.

Physical examination

An obvious swollen and angular deformity was noted on his right forearm. There was no neurovascular compromise in the extremity.

Laboratory examinations

Laboratory data were unremarkable except for a decreased hemoglobin level at 9.8 g/dL. Electrocardiography was performed, and there was no sign of cardiac injury.

Imaging examinations

Anteroposterior and lateral views of the affected forearm revealed a short oblique fracture of the ulnar shaft and misalignment between the metaphysis of the proximal radius and the capitellum of the humerus (Figure 1A and B). Reconstructed computed tomography (CT) scans showed an anteriorly displaced radial metaphysis (Figure 1C and D). The child was initially diagnosed with a Monteggia type I fracture and dislocation. However, he had not yet developed an ossification center at the radial head, and the secondary ossification center of the proximal radius was still invisible. Considering the possibility of a cartilaginous radial head injury, an magnetic resonance imaging (MRI) scan was performed. Interestingly, MRI confirmed a Salter-Harris type I fracture of the radial head epiphysis (Figure 1E). The radial head was still in the joint, and only the radial metaphysis was displaced anteriorly.

FINAL DIAGNOSIS

According to Bado's classification, a diagnosis of a Monteggia type I equivalent fracture was made; however, the injury mimicked the classic Monteggia type I fracture.

TREATMENT

The fracture was manipulated under general anesthesia, but reduction of the ulna failed because of callus formation. Therefore, open reduction was performed, and the ulna was fixed with an intramedullary 1.5 mm Kirshner (k)-wire. Additionally, an arthrogram of the elbow joint was performed, revealing that the radial neck fracture and the radial head were tilted in the elbow joint (Figure 2A and B).

Therefore, we further chose a posterior oblique approach for the radial head, and the annular ligament was intact. After confirming the physeal injury to the proximal radius (Salter-Harris I), the fracture was reduced under direct vision, and a 1.5 mm percutaneous k-wire was used to stabilize the radial head. However, the fracture was unstable during range-of-motion testing; thus, a 2 mm intramedullary k-wire was inserted percutaneously to stabilize the fracture.

Intraoperative arthrogram images revealed a satisfactory reduction of the radial head and stable reduction for ulnar fracture (Figure 2C and D). Then, a long-arm cast was applied. The patient was immobilized for 6 wk postoperatively. The long-arm cast and K-wire were both removed 6 wk after the operation.

OUTCOME AND FOLLOW-UP

At the five-year follow-up, radiographs revealed the successful union of both bones. The radial head was ossified without secondary necrosis or growth arrest of the proximal radial physis (Figure 3). No limitation of elbow flexion and extension or forearm pronation and supination was observed (Figure 4).

DISCUSSION

Giovanni Batista Monteggia (1814) first described the fracture of the proximal third of the ulna and an anterior dislocation of the radial head. Bado[5] proposed a classification system based on the direction of radial head dislocation. Bado[5] also described certain injuries of similar radiographic patterns, mechanisms of injuries, or methods of treatment as Monteggia equivalent lesions, in which associated fractures of

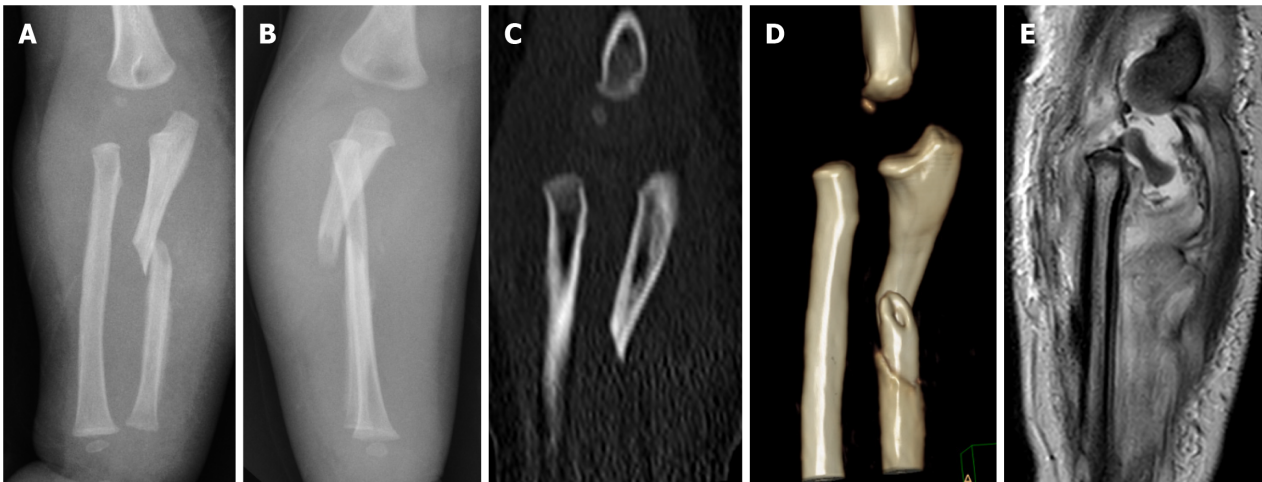


Figure 1 Images before surgery. A and B: Plain radiographs in the anteroposterior (A) and lateral (B) views of the affected forearm. There was a short oblique fracture of the ulna. The congruency of the radiocapitellar joint misalignment led to a suspicion that a Monteggia fracture dislocation existed; C and D: Multiplanar computed tomography reconstruction (C) and three-dimensional reconstruction scans (D) of the right elbow, indicating that the proximal metaphysis of the radius was anteriorly displaced; E: Magnetic resonance imaging showing a Salter-Harris type I fracture of the radial head epiphysis. The cartilaginous radial head was tilted by 60° but remained intra-articular.

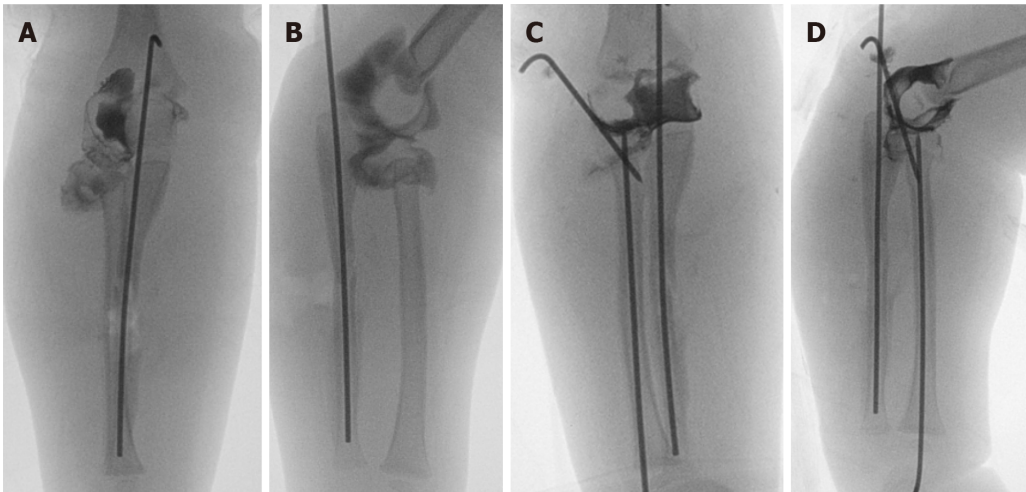


Figure 2 Intraoperative images. A and B: Intraoperative anteroposterior (AP) (A) and lateral (B) arthrogram showing a Salter-Harris type I fracture of the radial head epiphysis. After the ulnar fracture was reduced, the radial metaphysis and capitellar alignment seemed restored. However, the cartilaginous radial head was still tilted; C and D: AP (C) and lateral (D) arthrograms showing almost anatomical reduction of the fracture of the ulna and fracture of the radial neck.

the radial neck were included[5].

In a retrospective study by Olney and Menelaus[6], out of 102 children with acute Monteggia lesions, type I equivalent lesions were the third most common lesion in acute Monteggia lesions following classic type I and type III Monteggia lesions, suggesting that Monteggia variants may be more common than previously thought. Type I equivalent lesions constitute 59% of Monteggia equivalent lesions in the literature[7], and lesions involving the proximal radius accounted for 14% among acute Monteggia lesions and are the most common type I equivalent Monteggia fractures[6]. However, this lesion has been reported in only a few studies in the English literature, mainly case reports, in which the patients were all over 4 years old [8-13]. A summary of published case reports of pediatric Monteggia type-I equivalent lesions involving proximal radial fracture is illustrated in Table 1.

Even though Monteggia type I equivalent lesions involving ulnar fracture associated with an anteriorly displaced fracture of the neck of the radius in 6-year-old children have been previously reported by Soin *et al*[8], Zrig *et al*[9] and Faundez *et al* [10], the radial head remained in normal alignment to the capitellum, and there was no growth plate involvement.

Table 1 A summary of published case reports which described pediatric Monteggia type I equivalent lesions involving proximal radial fracture

Ref.	Age of patient	Position of ulnar fracture	Type of proximal radius fracture	Visibility of radial head ossified	Imaging	Treatment
Soin <i>et al</i> [8], 1995	6 years	Middle third	Transverse fracture through the neck of the radius	Yes	AP and lateral radiographs	Closed reduction of both ulna and radius
Zrig <i>et al</i> [9], 2011	6 years	Junction of the proximal and middle third	Transverse fracture through the neck of the radius	Yes	AP and lateral radiographs	Closed reduction of both ulna and radius
Drosos <i>et al</i> [11], 2012	6 years	Proximal third	SH-I	Yes	AP and lateral radiographs	Closed reduction and pinning of both ulna and radius
Faundez <i>et al</i> [10], 2003	6 years	Junction of the proximal and middle third	Transverse fracture through the neck of the radius	Yes	AP and lateral radiographs	Closed reduction and pinning of both ulna and radius
Clark <i>et al</i> [12], 2017	5 years	Proximal third	Comminuted fracture of radial head and neck	No	AP and lateral radiographs and CT	Closed reduction and pinning of ulna. Open reduction and pinning of radial head
ElKhouly <i>et al</i> [13], 2018	10 years	Proximal third	SH Type II	Yes	AP and lateral radiographs	Closed reduction of both ulna and radius, nailing of ulnar fracture
The present case	1 year	Middle third	SH-I	No	AP and lateral radiographs, CT and MRI	Open reduction of both ulna and radius

SH: Salter Harris injury; AP: Anteroposterior view; CT: Computed tomography; MRI: Magnetic resonance imaging.

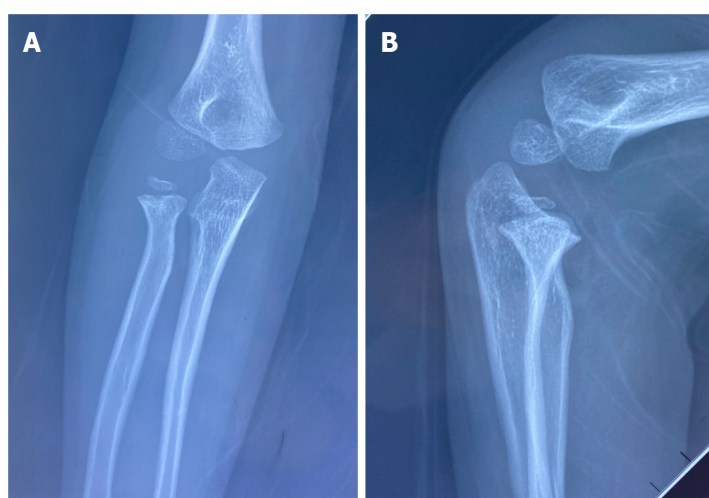


Figure 3 Follow-up images. Radiographs at the 5-year follow-up revealed successful union of both bones. A: AP radiograph view; B: lateral radiograph view.

However, fracture through the growth plate is more likely to occur than radial head dislocation in skeletally immature patients[4]. Thus, Drosos *et al*[11] illustrated a variant associated with Salter-Harris (SH) type I injury of the radial head in a 6-year-old girl with an ossified radial head, and plain radiographs allowed both assessment and control of reduction. Reina *et al*[14] described another variant accompanied by a diaphyseal ulnar fracture and a proximal physeal injury with a posteriorly displaced proximal radius in a 13-year-old adolescent. They pointed out that a good diagnosis was necessary, and surgeons should be aware of initial radiographs and should look for associated lesions such as SH type I injury of the radial head.

Nonetheless, it is generally accepted that the ossification center of the radial head is visible at 5 years of age[15]. For patients aged less than 5 years of age, visualization of the anatomy of the fracture is difficult because of the absence of a secondary ossification center of the radial head. As a result, fractures may be misdiagnosed or



Figure 4 Functional results at the 5-year follow-up.

neglected. Due to the gradual emergence of secondary ossification centers around the elbow, missing diagnoses and misdiagnoses of pediatric elbow injuries are not infrequent[16]. Hence, occult fractures involving an unossified radial head can be completely invisible at the initial evaluation except for disruptions in the surrounding soft tissue planes[17]. Clark *et al*[12] reported a Monteggia equivalent lesion with a comminuted radial head and neck fractures in a 5-year-old child. Only a small radiodense fleck of metaphyseal bone was noted because of the lack of ossification centers of the radial head in this child and the difficulty in visualizing the radial head even in intraoperative arthrogram, and the radial fracture could not be reduced after multiple attempts. Then, the patient underwent a CT scan of the elbow for evaluation. The radial head and neck were found to be both comminuted fractures, and open reduction of the radial head and neck was conducted. The author advised that surgeons should not hesitate to order a CT scan to diagnosis accurately and aid guidance of correct fixation that cannot be explained by plain films[12]. In addition, arthrography also provides a clear definition of the lesion, allowing both assessment and control of operative reduction, and was utilized in a case with a child younger than 5 years of age with a radial neck fracture and a nonossified radial epiphysis[18].

We reported a case of a Bado type I Monteggia equivalent fracture in a child aged 14 mo. To the best of our knowledge, this is the youngest patient to suffer from this injury. Furthermore, none of the reported studies have encompassed the variant described in this case report, where the radial head is unossified and invisible on plain radiography and CT. Sometimes a small fleck of metaphyseal bone around the proximal radial diaphysis can be seen, indicating SH II fracture or transverse fracture through the neck of the radius. In a study by Čepelík *et al*[19], the proximal radial physeal separation of SH type II was the most common among equivalents in their study. ElKhouly *et al*[13] reported a variant associated with SH type II injury and anterior radial head dislocation in a 10-year-old boy and proposed that Monteggia equivalent lesions with an SH fracture of the proximal radius are an unstable fracture configuration.

However, regarding SH I and SH III fractures of the radial head, the fracture line is invisible. As a result, plain radiography and CT cannot distinguish Monteggia fractures and Monteggia equivalent fractures in patients with unossified radial heads; therefore, MRI should be routinely performed. In the current case, the radial head was found to be completely separated from the neck under the assistance of MRI, and the diagnosis of a Monteggia equivalent fracture was demonstrated.

The recommended management for most Monteggia and equivalent lesions in children is closed reduction as long as the dislocated radial head can be reduced and remains stable[1,20]. However, displaced radial neck fractures with angulation greater than 30 usually require surgery, including closed reduction under sedation or anesthesia, percutaneous reduction, open reduction and fixation[21]. Anatomical reduction is indicated in the case of type I Monteggia with an inability to maintain the reduction after closed reduction but is simultaneously required to avoid subsequent limitation of motion[22,23]. If inadequate treatment is applied, equivalent lesions may lead to poor clinical and radiographic results[2]. Čepelík *et al*[19] warned of worse results in the treatment of Monteggia equivalents, and operative treatment was indicated in most patients in this group[19]. As reported by Olney and Menelaus, 10 of the 14 (71.4%) patients with Monteggia type I equivalent lesions involving the proximal radius required surgery[6].

In summary, the Monteggia equivalent lesion with a fracture of the radial neck and head in our patient is uncommon and has never been reported before. Therefore, it is extremely easy to misdiagnose, particularly in a child younger than 5 years of age with a cartilaginous radial head. If cartilage fracture is suspected, MRI or arthrography during reduction is strongly recommended.

CONCLUSION

This is the youngest patient to suffer from this injury. Furthermore, none of the reported studies encompassed the variant described in this case report. An accurate diagnosis to differentiate Monteggia and Monteggia equivalent lesions with Salter-Harris type I fracture of the radial head epiphysis in a child younger than 5 years of age is critical. We recommend MRI examination or arthrography during reduction, especially if the secondary ossification center has not appeared.

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