Three Cases of Pediatric Monteggia Fracture-Dislocation Associated With Acute Plastic Bowing of the Ulna

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Monteggia fracture-dislocation with acute plastic bowing of the ulna is rare in children. For fresh injuries, manual repositioning of the dislocated radial head is initially attempted. When this reduction fails, there are 3 treatment options: open reduction of the humeroradial joint, immobilization of the humeroradial joint or proximal radioulnar joint with a wire, and manual correction of ulna bowing. However, there is no consensus as to which option is best.

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Recently, we treated 3 children with Monteggia fracture-dislocation with acute plastic bowing of the ulna. In 2 cases, we attempted to correct the ulnar bowing manually (we were successful in 1 case). In the study reported here, we evaluated the importance and the necessity of manual correction of ulnar bowing within the early postinjury period.

Case Reports

Case 1

A 5-year-old boy fell from a 2-meter height and injured his right forearm. He was immediately referred to our hospital. A plain film obtained on first medical examination showed dislocation of the radial head and acute plastic bowing of the ulna, which was categorized as an anterior bend of type A, according to the classification of Letts and colleagues.[1]

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Lincoln and Mubarak[2] measured maximum ulnar bow (MUB), the distance between the imaginary line connecting the 2 ends of the ulna and the part of the ulna that is bowed, as an index indicating the presence or absence of ulnar bowing. MUB was 5 mm on the affected side versus 1 mm on the unaffected side (Figure 1).

Five days after injury, we attempted to manually reposition the dislocated radial head with the patient under general anesthesia; this repositioning was unsuccessful. Then an attempt was made to correct the ulnar bowing manually. With the affected forearm in supination and the surgeon standing on the right side of the patient, the surgeon placed both his thumbs on the top of the bowed ulna. Using the top of the bowed ulna as a fulcrum, he corrected the bowing slowly, over approximately 10 minutes, by applying the principle of lever (Figure 2). After correction, MUB was decreased to 3 mm, enabling manual repositioning of the radial head. However, when the surgeon removed his hands from the radial head, subluxation persisted, and the repositioned radial head was not stable. Therefore, the humeroradial joint was percutaneously immobilized with a 1.8-mm-diameter Kirschner wire (K-wire).

Three weeks after surgery, the wire was removed. After 4 weeks of postoperative cast immobilization, exercise to improve elbow range of motion (ROM) was initiated. One year 1 month after surgery, a plain film showed no redislocation of the radial head, and the presence of cortical hypertrophy at the ulnar concavity. MUB returned to its

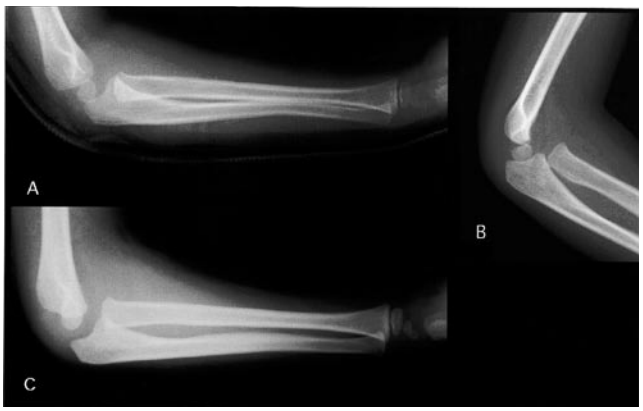

Figure 1. Lateral forearm **(A)** and elbow **(B)** plain films obtained on first medical examination of case 1 show dislocation of the radial head and acute plastic bowing of the ulna on the affected side. Maximum ulnar bow (MUB) was 5 mm. **(C)** After 1 year 1 month, lateral forearm films show cortical hypertrophy at the ulnar concavity side of the ulna and reduced MUB (1 mm).

Figure 2. Manual correction of ulnar bowing. The surgeon places both of his thumbs on top of the bowed ulna and then, using the top of the bow as a fulcrum, applies the principle of lever to carry out the correction slowly, over approximately 10 minutes.

Figure 3. **(A)** Lateral forearm plain films obtained on first medical examination of case 2 show dislocation of the radial head and acute plastic bowing of the ulna on the affected side. Maximum ulnar bow (MUB) was 6 mm. **(B)** After 2 years 7 months, lateral forearm films show persisting MUB (1 mm).

normal level, 1 mm. Elbow ROM was not restricted, and the patient was able to engage in daily activities and play sports without difficulty.

Case 2

A 3-year-old girl fell from a 1-meter height and injured her left forearm. A plain film obtained on first medical examination showed dislocation of the radial head and acute plastic bowing of the ulna, which was categorized as an anterior bend of type A, according to the classification of Letts and colleagues.[1] MUB was 6 mm on the affected side versus 1 mm on the unaffected side (Figure 3). The same day, with the patient under general anesthesia, we were successful in manually repositioning the dislocated radial head (manual correction of ulnar bowing was therefore unnecessary).

After 4 weeks of postoperative cast immobilization, exercise to improve elbow ROM was initiated. Two years 7 months after surgery, a plain film showed no redislocation of the radial head and the presence of cortical hypertrophy at the ulnar concavity. Some MUB was corrected, but

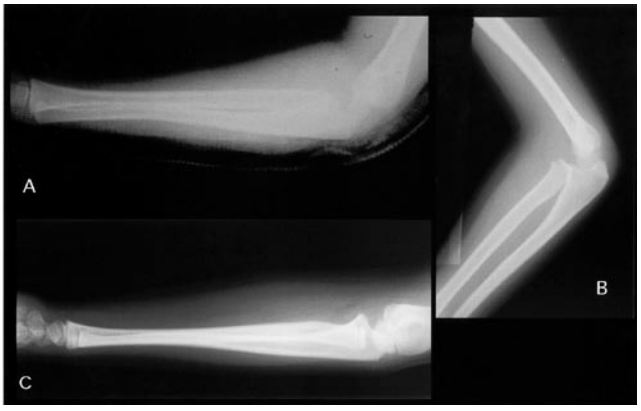

Figure 4. Lateral forearm **(A)** and elbow **(B)** plain films obtained on first examination of case 3 show dislocation of the radial head and acute plastic bowing of the ulna on the affected side. Maximum ulnar bow (MUB) was 5 mm. **(C)** After 1 year 9 months, lateral forearm films show persisting MUB (2 mm).

2-mm MUB persisted. Elbow ROM was not restricted, and the patient was able to engage in daily activities and play sports without difficulty.

Case 3

A 6-year-old girl fell from a 1-meter height and injured her left forearm. She was initially diagnosed with a contusion of the elbow joint, and the elbow was immobilized in a cast at another hospital. Two weeks after injury, she was referred to our hospital because of restricted elbow ROM.

A plain film obtained on first medical examination showed dislocation of the radial head and acute plastic bowing of the ulna, which was categorized as an anterior bend of type A, according to the classification of Letts and colleagues.[1] MUB was 5 mm on the affected side versus 1 mm on the unaffected side (Figure 4). The day after our first medical examination (ie, 15 days after injury), with the patient under general anesthesia, we were successful in manually repositioning the dislocated radial head. However, subluxation persisted, and the repositioned radial head was not stable when the surgeon removed his hands from the radial head. Furthermore, manual correction of ulnar bowing was also unsuccessful. Therefore, after repositioning of the radial head, the humeroradial joint was percutaneously immobilized with a 1.8-mm-diameter K-wire.

After 4 weeks of postoperative cast immobilization, the K-wire was removed, and exercise to improve elbow ROM was initiated. One year 9 months after surgery, elbow ROM was not restricted, and the radial head had not redislocated, according to plain films. The patient was able to engage in daily activities and play sports without difficulty. Cortical hypertrophy at the ulnar concavity was observed. Some MUB was corrected, but 2-mm MUB persisted.

Discussion

There are few reports of pediatric Monteggia fracture-dislocations with acute plastic bowing of the ulna. Blount's case report was introduced by Borden[3] in 1974. Blount reported the concept of traumatic bowing, a child's forearm bone

deformity caused by minute bone fractures but without any fracture lines. This acute plastic bowing is caused by an external force exceeding the longitudinal elasticity limit of a child's bone, and a gentle flexure involving a wide area is observed. Bone fracture lines are not seen on plain films, but there is a microscopic cortical bone fracture, with its characteristic absence of a prominent periosteal callus.

In 1985, Letts and colleagues[1] proposed a new classification of Monteggia fracture-dislocation with plastic bowing of the ulna in which an anterior dislocation categorized as type 1 in the Bado classification was further categorized into type A of anterior bend, type B of greenstick fracture, and type C of complete fracture. They reported that most cases of traumatic dislocation of the radial head in children were categorized only into types A and B. Accordingly, the actual number of patients with plastic bowing of the ulna is possibly higher than reported.

In addition, Lincoln and Mubarak[2] reported that the isolated traumatic dislocations of the radial head in the absence of concurrent ulnar fracture in previous reports were probably misdiagnosed and probably associated with acute plastic bowing of the ulna. They further classified type 1 in the Bado classification of Monteggia fracture associated with anterior dislocation of the radial head into 4 subtypes. They also reported that the isolated dislocation of the radial head mentioned in previous reports is equivalent to type A, which is a subtype of their classification. Furthermore, they recommended measuring MUB to identify bowing of the injured and uninjured ulnas in a lateral plain film of the forearm. If MUB is larger in an injured ulna than in the uninjured ulna, there is ulnar bowing, because MUB of an uninjured ulna does not exceed 0.1 mm.

To the best of our knowledge, there are 42 reported cases of children with Monteggia fracture-dislocation with acute plastic bowing of the ulna[1,3-5] (including our 3 cases). In reviewing the reports on the 31 cases in which treatment methods were described, we found that manual correction of the ulna had been attempted in 15 cases, only 3 of which required open reduction or immobilization with K-wire in addition to repositioning of the radial head. Eleven (69%) of the other 16 patients required open reduction or immobilization with K-wire in addition to repositioning of the radial head (that percentage is high). Furthermore, of the 10 patients who had follow-up observations reported and who were not subjected to manual correction of the ulna, 9 had persistent ulnar bowing, and 1 had MUB return to normal 5 years 6 months after surgery.

In case 1 of our study, manual repositioning of the dislocated radial head was unsuccessful initially. However, after successful manual correction of the ulna, repositioning of the radial head became possible. In cases 2 and 3, in which manual correction of ulna bowing was unsuccessful or not performed, ulnar bowing continued 2 to 3 years after injury. On the basis of these results, we expect that self-correction of ulnar bowing takes a long time. In addition, Borden[3] reported the possibility of developing limited forearm rotation because of persistent ulnar bowing.

Manual Correction of Ulnar Bowing: Procedure and Timing

With the patient's forearm in a supine position, the surgeon can manually correct ulnar bowing by gradually applying a relatively anterior pushing force to the ulna at the forearm convexity with both hands or using a knee as a support. Chamay[6] reported that a force comparable to 100% to 150% of body weight, which is nearly equal to the external force that caused the injury, is sufficient for correction. To prevent a complete fracture, however, it is very important to perform this procedure with optimal care and radiographic monitoring.

In addition, Ozawa and colleagues[7] reported that manual correction of ulnar bowing was difficult in 2 patients left untreated for 9 and 20 days after injury. In our case 3, manual correction performed 15 days after injury was unsuccessful. We believe that manual correction should be performed only on fresh injuries, those sustained within approximately 1 week.

Conclusions

Accordingly, for fresh injuries, we conclude that ulnar bowing, which is the main cause of dislocation of the radial head, should be corrected manually within approximately 1 week after injury when initial manual reduction of the radial head is unsuccessful. The result is that the radial head is repositioned and stabilized. Therefore, open reduction of the radial head and wedge osteotomy of the ulna can be avoided if K-wire immobilization of the humeroradial joint is required.

Author's Disclosure Statement and Acknowledgement

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