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Simultaneous correction of radius and ulna for secondary ulnar impaction syndrome with radial physeal arrest in adolescent: A case report and review of literatures

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ABSTRACT

INTRODUCTION: Distal radius physeal fractures are common in pediatric patients. Although most of these fractures heal without complication, some result in significant physeal arrest. If significant physeal arrest occurs, the various treatment methods can be applied depending on the severity of deformity and remaining growth of the patient.

PRESENTATION OF CASE: We present a 16-year old female with distal radial physeal arrest who presented four years after initial injury. Radiologically, forearm bone length discrepancy was 7 mm. But, she had a secondary ulnar impaction syndrome. She underwent open wedge corrective osteotomy of distal radius on volar side and ulnar shortening osteotomy, simultaneously. Early mobilization and rehabilitation were started soon after the surgery. At 18 months postoperatively, the ROM was assessed to be almost identical as the unaffected side and the patient presented with no significant symptoms.

DISCUSSION: Distal radial fracture is one of the most common fractures in pediatric population. And distal radial physis is often involved in these fracture, which can lead to physeal arrest. However, even if forearm bone length discrepancy occurs, if the difference is within 1 cm, it is often asymptomatic. In this case, the forearm bone length discrepancy was mild, but due to symptom, we performed surgical treatment.

CONCLUSION: Distal radial physeal arrest due to distal radial fracture is relatively common in children, and long-term follow-up is needed. Moreover, relatively mild deformity caused by physeal arrest may also cause symptoms, so careful observation is needed.

1. Introduction

Distal radius fracture is one of the most common fractures account for 31% of fractures in pediatric population [1]. And 15–29.5% of these fractures involve the distal radial physis [2,3]. In general, most of the distal radial physeal injuries are Salter-Harris type I and II, and their prognoses are usually good. This is because the potential remodeling ability of the child is good and most physeal injuries occur in the hypertrophic zone of physis [4,5]. However, if a significant distal radial physeal arrest and secondary wrist deformity may occur, which causes chronic pain and functional deterioration [4,6]. The degree of deformity varies according to the age at the time of injury, the physeal injury pattern, residual angulation following reduction, and mechanism of injury in terms of degree of energy [6,7]. These deformities can be treated by various methods [8–13]. We present a case of wrist deformity due to distal radial physeal arrest that occurred after a relatively rare open distal radial physeal injury and literature review. This case is reported in line with the SCARE criteria [14].

2. Presentation of case

A 12-year-old girl, who was obese and right-handed, visited the emergency room with left wrist painful swelling caused by fall while running. There was tenderness on her left wrist with silver fork deformity on physical exam. There was about 4 cm sized transverse wound at palmar aspect of wrist with bony exposure. Radiographs had presented epiphyseal plate separation and dorsoradial displacement of distal fragment of radius (Salter-Harris type I injury), and distal ulnar fracture without involvement of physis (Fig. 1). There was no neurovascular deficit. We performed emergency operation including meticulous debridement with copious saline irrigation. After meticulous debridement, open reduction and K-wire fixation was performed. We decide conservative treat-

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Fig. 1. A, Gross picture of left distal forearm at the time of injury demonstrate a Gustilo-Anderson type II open fracture. B, Anterioposterior (AP) and lateral radiopraphs of the left wrist at the time of injury demonstrate a Salter-Harris type I physeal fracture of the distal radius and metaphyseal transverse fracture of the distal ulna.

Table 1
ROM preoperatively and at the time of most recent follow up at 17months postoperatively.

	Wrist		Deviation		Forearm rotation	
	dorsiflexion	palmarflexion	radial	ulnar	Pronation	supination
Preop(Rt./Lt.)	75/80	90/90	30/30	40/50	45/80	50/90
Postop(Rt./Lt.)	80/80	90/90	30/30	50/50	80/80	80/90

ment for ulnar fracture, which was relatively stable. The wound was closed primarily and kept a drain. The wrist was immobilized with a long arm splint for 2 weeks, then short arm cast applied for 2 weeks. At sixth weeks after surgery, she had no tenderness at fracture site and union process was observed in radiographs the K-wires were removed. The motion of wrist was allowed without any limitation. She visited out-patient clinic regularly. At 6 month after surgery, narrowing of growth plate of distal radius was observed and the ulnar positive variance was measured 3 mm. At one year after surgery, growth plate of distal radius was closed but, growth plate of ulna was still open and ulnar variance was more increased. Then she visited us annually to check of change of ulnar variance. The complete distal ulnar physeal closure was observed at 2 years after the operation on radiographs, radial inclination was 21°, volar tilt was 17°, and ulnar variance was 7 mm (Fig. 2). Besides partial limitation of forearm rotation, the patient presented with no other symptoms and the patient was put to follow-up observation. At 4 years postoperatively, she complained ulnar side wrist pain and deformity of her left wrist. On physical examination, limitation of supination and pronation of forearm, and prominent ulnar head were discovered (Table 1). Radiographs presented decreased radial inclination and increased volar tilt and ulnar variance compared to the unaffected side (Fig. 3). We performed the open wedge corrective osteotomy of distal radius using volar locking plate (Synthes®). Using Henry anterior approach, distal radius was exposed, then, temporary K-wire fixation was performed on the side parallel to articular surface, open wedge osteotomy was performed with K-wire alongside with radial inclination parallel to articular surface, and defect of trapezoid shape was created. Allogenic bone was grafted for open osteotomy site. However, residual ulnar positive variance was observed following radial correction, and additional ulnar shortening osteotomy by 5 mm was performed (Fig. 4). After the surgery, short arm splint was applied for a week then the wrist motion was allowed without any limitation. Range of motion (ROM) was restored normally without pain at three month after surgery. The fixatives was removed at 18 months after surgery (Table 1) (Fig. 5).

3. Discussion

Some authors have reported that the Salter Harris classification is not very useful in predicting prognosis [4,15]. The risk factors of post-traumatic physeal arrest were reported to be high energy trauma, deep infection after open injuries, multiple attempts at reduction, and late remanipulation at more than 7 days post injury, and the age older than 10 years old [4,6,15]. In this case, she was diagnosed with salter-Harris type I physeal injury and every meaure was taken to prevent physeal arrest by the means of prevention of early infection and achievement of early reduction, but considering that the injury was open type and she was obese, the

Fig. 2. Simple radiographs A, A' At immediate postoperative. B, B' At 3 months later after injury, complete fracture union of distal ulna and partial physeal fusion of distal radius were observed. C, C' At 6 months later after injury, positive ulnar variance and complete physeal fusion of distal radius were observed. D, D' At 2 years later after injury, complete physeal closure of distal ulna and ulnar positive variance were observed.

injury mechanism could be regarded as high energy trauma. And, at the time of fracture, the patient was 12 years old. Regarding all the concerning factors related to the injury, it is considered that the remodeling potency was low.

Cannata et al. [4] reported forearm bone length discrepancy occurred in 28% after distal radius fracture. However, they found that forearm bone length discrepancy of less than 1 cm were asymptomatic. Therefore, it has been reported that a significant premature physeal arrest resulting from distal radial physeal injury occurs in 1–7% [4,15]. However, shortening deformity of the distal radius is reported to induce incongruency of the distal radioulnar joint and increase the strain of triangular fibrocartilage complex. This cause a significant decrease in forearm rotation [16]. Furthermore, it is known that 41.9% of the total axial load is transferred to ulna when the ulnar length is increased by 2.5 mm [17]. Therefore, relatively mild deformity can cause of symptoms. In this case, ulnar positive variance was only 7 mm, but it showed significant symptoms such as forearm rotation limitation and pain at ulnar styloid process.

Surgery is warranted in patients with progressive deformity or in those with symptoms such as ulnar-sided wrist pain or limited motion [18]. These deformities can be treated by various methods. Recently, some authors have reported that even if ulnar positive variance is corrected only by using isolated ulnar shortening osteotomy, good results can be obtained because there is no functional problem when the deformity is not severe [8,13]. However, it is recommended that isolated ulnar shortening osteotomy should be performed in cases of complete radial arrest without deformity because radial angulation cannot be corrected and the distal radioulnar joint arthritis may occur later [8,11]. Some authors have described good results using open wedge corrective osteotomy with free iliac bone graft as a treatment for volarly malunited distal radius [12,19]. However, if a positive ulnar variance remains after wrist deformity correction, it may cause residual pain, and concomitant ulnar shortening osteotomy should be performed if ulnar positive variance is greater than 6 mm [9,20]. In this case, evidence of growth arrest was observed from 3 months after the fracture treatment, but ulnar positive variance was only 7 mm and no symptoms were reported until the age of 16. Therefore, it was observed without any treatment and when the symptoms were complained, the growth was completed. We performed a radial corrective osteotomy and performed ulnar shortening osteotomy to correct the remaining ulnar positive variance and obtained good results.

4. Conclusion

Growth arrest should be considered in pediatric distal radius fractures. Simultaneous correction of distal radius and ulna in secondary ulnar impaction syndrome caused by growth plate injury of distal radius is a reliable surgical option.

Conflicts of interest

The authors had no any conflicts of interest.

Fig. 3. A, A' Posteroanterior (PA) and lateral radiographs of left wrist demonstrate positive ulnar variance and increased volar tilt. B, B' PA and lateral radiographs of right wrist.

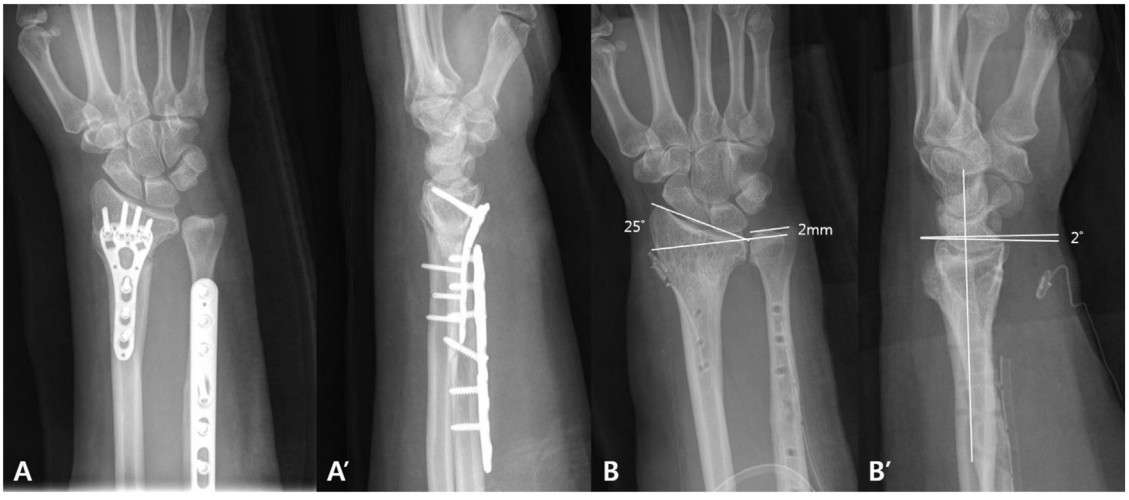

Fig. 4. A, A' postoperative AP and lateral radiographs of left wrist. B, B' AP and lateral radiographs of left wrist at final 18 months follow-up.

Fig. 5. Clinical pictures at final follow-up demonstrate range of motion of both wrist.

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Ethical approval

The retrospective case report is exempt from ethical approval in our institution.

Consent

Informed consent was taken from the patient father in order to publish this case report.

Author contribution

Dr. Jin Sung Park: is the corresponding author. He contributed in study design, data collection and analysis, writing paper, and reviewing literature.

Dr. Dong Kyu Moon: Study design, data analysis, writing the paper, and reviewing literature.

Dr. Young Jin Park: Study design, data analysis.

Dr. SoonTaek Jeong: Study design and data analysis.

All authors read and approved the final manuscript.

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