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

Dong Kyu Moon, Jin Sung Park*, Young Jin Park, Soon Taek Jeong

Department of Orthopaedic Surgery and Institute of Health Sciences, Gyeongsang National University School of Medicine and Gyeongsang National University Hospital, Jinju, Republic of Korea

**A R T I C L E   I N F O**

Article history:
Received 20 April 2018
Received in revised form 19 July 2018
Accepted 23 July 2018
Available online 26 July 2018

Keywords:
Distal radius
Physeal fracture
Physeal arrest
Corrective osteotomy
Ulnar shortening osteotomy

**A B S T R A C T**

**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 phyysis is often involved in these fractures, 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.

© 2018 The Authors. Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

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 phyysis [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 phyysis [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 dorso-radial displacement of distal fragment of radius (Salter-Harris type I injury), and distal ulnar fracture without involvement of physs (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-
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, 2). 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 measure 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

---

**Table 1**

| Wrist dorsiflexion/palmarflexion | Deviation radial/ulnar | Forearm rotation supination/pronation |
|----------------------------------|------------------------|-------------------------------------|
| Preop(Rt./Lt.)                  | 75/80                  | 30/30                               | 45/80                              |
| Postop(Rt./Lt.)                 | 80/80                  | 30/30                               | 80/80                              |

---

**Fig. 1.** A, Gross picture of left distal forearm at the time of injury demonstrate a Gustilo-Anderson type II open fracture. B, Anteroposterior (AP) and lateral radiographs 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.
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.
Sources of funding

All authors declare that they did not receive any source of funding by any mean to run this case report. They wrote this paper and they edit it on their own fund.

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.

Registration of research studies

Researchregistry UIN: 3960

Guarantor

Dr. Jin Sung Park.

Acknowledgements

This is to declare that all authors have no conflict of interest and this case report was not funded by any organization or charity or by any mean.

References

[1] P.H. Randsborg, P. Gulbrandsen, J. Saltte Benth, E.A. Sivertsen, O.L. Hammer, H.F. Fuglesang, et al., Fractures in children: epidemiology and activity-specific fracture rates. J. Bone Jt. Surg. Am. 95 (7) (2013) e42.
[2] D.C. Mann, S. Rajnaira. Distribution of physical and nonphyseal fractures in 2,650 long-bone fractures in children aged 0–16 years, J. Pediatr. Orthop. 10 (6) (1990) 713–716.
[3] C.A. Peterson, H.A. Peterson, Analysis of the incidence of injuries to the epiphyseal growth plate, J. Trauma 12 (4) (1972) 275–281.
[4] G. Cannata, F. De Maio, F. Mancini, E. Ippolito, Physeal fractures of the distal radius and ulna: long-term prognosis, J. Orthop. Trauma 17 (3) (2003) 172–179, discussion 9–80.
[5] R.B. Salter, W.R. Harris, Injuries involving the epiphyseal plate, J. Bone Jt. Surg. Am. 45 (3) (1963) 587–622.
[6] S. Houshian, A.K. Holst, M.S. Larsen, T. Torfing, Remodeling of Salter-Harris type II epiphyseal plate injury of the distal radius, J. Pediatr. Orthop. 24 (5) (2004) 472–476.
[7] E. Larsen, D. Vittas, S. Tarp-Pedersen, Remodeling of angulated distal forearm fractures in children, Clin. Orthop. Relat. Res. 237 (1988) 190–195.
[8] S. Low, M. Muhlendorf-Fodor, T. Pillukat, K.J. Prommersberger, J. van Schoonhoven, Ulnar shortening osteotomy for malunited distal radius fractures: results of a 7-year follow-up with special regard to the grade of radial displacement and post-operative ulnar variance, Arch. Orthop. Trauma Surg. 134 (1) (2014) 131–137.
[9] J. Oskam, K.M. Bongers, A.J. Karthaus, A.J. Friema, H.J. Klases, Corrective osteotomy for malunion of the distal radius: the effect of concomitant ulnar shortening osteotomy, Arch. Orthop. Trauma Surg. 115 (3–4) (1996) 219–222.
[10] W.T. Page, R.M. Szabo, Distraction osteogenesis for correction of distal radius deformity after physeal arrest, J. Hand Surg. 34 (4) (2009) 617–626.
[11] G.S. Pannu, M. Herman, Distal radius-ulna fractures in children, Orthop. Clin. N. Am. 46 (2) (2015) 235–248.
[12] K. Sato, T. Nakamura, T. Iwamoto, Y. Toyama, H. Ikegami, S. Takayama, Corrective osteotomy for varially malunited distal radius fracture, J. Hand Surg. Am. 34 (1) (2009) 27–33, e1.
[13] R.C. Srinivasan, D. Jain, M.J. Richard, F.J. Leversedge, S.K. Mithani, D.S. Ruch, Isolated ulnar shortening osteotomy for the treatment of extra-articular distal radius malunion, J. Hand Surg. Am. 38 (6) (2013) 1106–1110.
[14] B.S. Lee, J.L. Esterhai Jr, M. Das, Fracture of the distal radial epiphysis. Characteristics and surgical treatment of premature, post-traumatic epiphyseal closure, Clin. Orthop. Relat. Res. 185 (1984) 90–96.

Fig. 5. Clinical pictures at final follow-up demonstrate range of motion of both wrist.
[15] H. Kihara, A.K. Palmer, F.W. Werner, W.H. Short, M.D. Fortino, The effect of dorsally angulated distal radius fractures on distal radioulnar joint congruency and forearm rotation, J. Hand Surg. Am. 21 (1) (1996) 40–47.
[16] F.W. Werner, R.R. Glisson, D.J. Murphy, A.K. Palmer, Force transmission through the distal radioulnar carpal joint: effect of ulnar lengthening and shortening, Handchir. Mikrochir. Plast. Chir. 18 (5) (1986) 304–308.
[17] J.M. Abzug, K. Little, S.H. Kozin, Physeal arrest of the distal radius, J. Am. Acad. Orthop. Surg. 22 (6) (2014) 381–389.
[18] K.J. Prommersberger, J. Van Schoonhoven, U.B. Lanz, Outcome after corrective osteotomy for malunited fractures of the distal end of the radius, J. Hand Surg. Br. 27 (1) (2002) 55–60.
[19] D.L. Fernandez, Correction of post-traumatic wrist deformity in adults by osteotomy, bone-grafting, and internal fixation, J. Bone Jt. Surg. Am. 64 (8) (1982) 1164–1178.
[20] R.A. Agha, A.J. Fowler, A. Saetta, I. Barai, S. Rajmohan, D.P. Orgill, for the SCARE Group, The SCARE Statement: consensus-based surgical case report guidelines, Int. J. Surg. 34 (2016) 180–186.