Posttraumatic Bifid Ulna in a Pediatric Galeazzi-Equivalent Forearm Fracture

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We report an unusual clinical presentation and surgical treatment of a Galeazzi-equivalent fracture in which initial closed treatment failed. This case was unique and challenging secondary to the formation of a neoulna volar to an unreduced periosteal sleeve injury, resulting in a bifid radiographic appearance. *(J Hand Surg Am. 2019;44(9):802.e1-e8. Copyright © 2019 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Bifid ulna, corrective osteotomy, Galeazzi, malunion, neoulna.

Online Exclusive

A GALEAZZI FOREARM INJURY IS A fracture in the distal third of the radius with an associated distal radioulnar joint (DRUJ) disruption.[1] This injury is less common in the pediatric population than in adults.[2] A Galeazzi-equivalent fracture has been described in which an epiphyseal separation of the distal ulna occurs in conjunction with a radial shaft fracture, instead of a true DRUJ dislocation.[3] The Letts and Rowhani classification describes the direction of dislocation and distinguishes between pure DRUJ dislocations and distal ulna physeal fractures.[3] An apex-dorsal radial fracture is associated with a volar dislocation of the distal radius relative to the ulna. The converse is true for apex-volar radial fractures (dorsal dislocation of the distal radius relative to the ulna).[1,2,4]

Only a small number of Galeazzi-equivalent fractures have been reported.[2–7] In the acute setting, closed reduction and above-elbow casting in supination is the preferred treatment if a reduced DRUJ and acceptable radial alignment can be maintained.[5] An adequate lateral radiograph to assess DRUJ reduction and radial alignment is important to achieving an optimal outcome. During closed reduction, the surgeon should attempt to palpate for persistent subluxation because we believe a lateral wrist radiograph taken in supination can often superimpose the radius on the ulna, giving the appearance of a reduction. To ensure that poor reduction of the radius is not the reason for failure, radial alignment also should be evaluated in fractures in which closed reduction of the DRUJ fails. Injuries in which closed reduction cannot achieve acceptable alignment of the radius are treated with open reduction internal fixation of the radius with closed reduction of the DRUJ.[2] Open reduction and stabilization of the ulna styloid or DRUJ should be considered if instability persists.[2]

We report an unusual clinical presentation and surgical treatment of a Galeazzi-equivalent fracture in which closed treatment failed. This case was unique and challenging because of the formation of a neoulna volar to the native ulna. This neoulna grew along an unreduced periosteal sleeve injury, resulting in a bifid radiographic appearance.

CASE REPORT

The patient was a 15-year-old male who sustained a left Galeazzi-equivalent forearm fracture with an associated ulnar styloid fracture (Fig. 1). Initial treatment included an attempted closed reduction followed by immobilization in a long-arm cast for 6 weeks. Follow-up radiographs demonstrated that the DRUJ remained unreduced. In retrospect, the ulnar styloid was in a position of residual volar and proximal displacement relative to the distal ulna after the attempted closed reduction (Fig. 2).

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FIGURE 1: Injury radiographs of a left Galeazzi-equivalent fracture with an associated ulnar styloid fracture (arrows) and apex dorsal distal third radial shaft fracture with an associated volarly dislocated distal radius.

FIGURE 2: Follow-up anteroposterior (left) and lateral (right) radiographs after attempted closed reduction demonstrate continued absence of an ulnar styloid (solid arrow) and significant ulnar-positive variance. The distal fragment containing the ulnar styloid can be seen at an anatomical position relative to the distal radius (hollow arrows on both views). New bony formation that will mature into the neoulna can be appreciated at this time on the lateral view (rectangular arrow). These are clues to an inadequate reduction.

FIGURE 3: Anteroposterior (left) and lateral (right) radiographs of the Galeazzi-equivalent fracture that went on to malunion with persistent DRUJ disruption. There is now a bifid ulna with the neoulna extending from the anterior ulnar cortex (arrows).

The patient presented to us 2 months after the initial injury because of limited supination and pronation. Active and passive supination and pronation were both 15°. He had full flexion and extension of his wrist and elbow. His neurovascular examination was normal. Plain radiographs demonstrated a malunion of his Galeazzi-equivalent fracture with persistent DRUJ disruption. There also was an apparent distal bifid ulna (Fig. 3). A computed tomography scan revealed a neoulna that appeared to articulate at the sigmoid notch of the distal radius. The native ulnar styloid was attached to the neoulna, creating the bifid appearance. The native ulnar shaft was dorsal relative to the radius, consistent with a Galeazzi-equivalent fracture with a distal ulna epiphyseal separation. The native ulna also appeared to have a preserved articular surface (Fig. 4). The surgical plan was to correct the radial malunion and reduce the native ulnar shaft to the native ulnar styloid by excising most of the neoulna.

The patient was placed supine and an above-elbow tourniquet was used. Examination under anesthesia findings were similar to the preoperative findings (Video A; available on the *Journal*'s Web site at www.jhandsurg.org). The distal radial shaft was exposed using a flexor carpi radialis approach. The center of rotation of angulation was identified on the radius, using fluoroscopy. Given that the deformity was principally in the sagittal plane, a volar opening wedge osteotomy was performed. Fluoroscopy confirmed that adequate correction could be obtained.

The distal ulna was exposed using a straight incision over the ulnar border to access the dorsal native and volar neoulna. The extensor carpi ulnaris (ECU) tendon was identified proximally and traced distally. This tendon was found lying between the neoulna and the native ulna (Fig. 5). The flexor carpi ulnaris was found volar to the neoulna and the ulnar neurovascular bundle was identified and protected. The native ulna was exposed in a subperiosteal fashion, dorsal to the ECU tendon. The native ulna was found to be dorsal to the dorsal radial-ulnar ligaments, which was likely a barrier to attempts at closed reduction. The distal extent of this bone

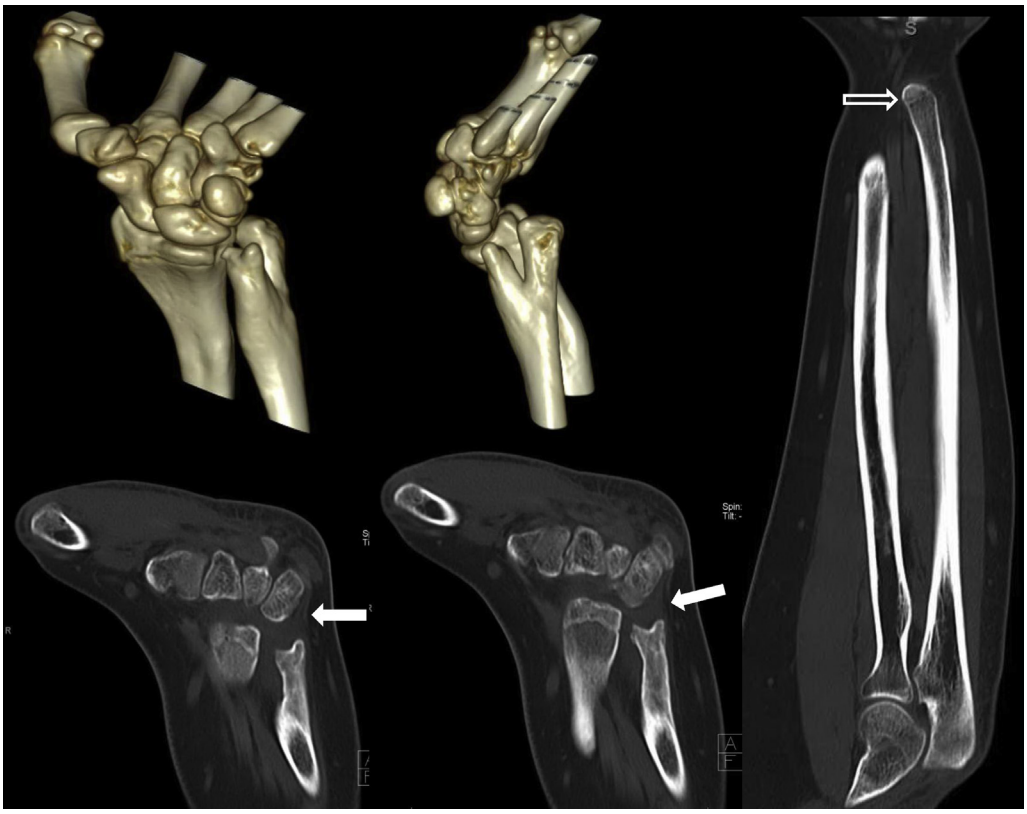

FIGURE 4: Computed tomography scans with 3-dimensonal reconstruction of the bifid ulna (top left). The neoulna appears to be reduced at the sigmoid notch of the distal radius while the native ulna is dorsal relative to the anteriorly dislocated distal radius. Coronal computed tomography images (bottom left) reveal soft tissue attachment to the ulna styloid likely representing the TFCC and ulnar ligaments (solid arrows). Computed tomography scan of the native ulna (right) reveals an absent ulnar styloid as well as a preserved radial articular surface supported by the presence of the distal ulnar physis (hollow arrow).

revealed articular cartilage corresponding to the region that underlies the articular disc of the triangular fibrocartilage complex (TFCC). The articular disc and ulnar styloid were absent from the native ulna.

The neoulna was then exposed in a subperiosteal fashion volar to the ECU tendon. The native ulna styloid was attached to the distal neoulna. This was confirmed by the location of the ECU tendon as it coursed through its subsheath and into the sixth dorsal compartment dorsal to the ulnar styloid. An osteotomy was performed at the junction of the native ulnar shaft and neoulna to allow mobilization of both fragments (Fig. 6). Distal exposure of the ulnar styloid revealed the ulnar ligamentous complex (Fig. 7). The stalk of the neoulna was excised, leaving 2 to 3 mm of bone proximal to the ulnar styloid.

Attention was then returned to the opening wedge radial osteotomy. A 7-hole metadiaphyseal distal radial plate was used for stabilization. Given the patient's age and the fact that he was close to skeletal maturity, obtaining optimal distal fixation was prioritized over preserving the distal radial physis. The sigmoid notch of the distal radius could now be reduced to the native ulna. The ulnar styloid was then reduced and secured to the native ulnar shaft with a 0.062-inch Kirschner wire. The ECU tendon and the DRUJ were stable with pronation and supination. The periosteum was approximated, and skin incisions were closed in a layered fashion. A postoperative examination with the patient under anesthesia revealed improved supination and pronation (Video B; available on the *Journal*'s Web site at www.jhandsurg.org). Postoperative radiographs demonstrated stable initial fixation and reduction (Fig. 8).

The limb was immobilized after surgery with a sugar-tong orthosis with the forearm in supination for 6 weeks. Mobilization and progressive physical therapy began at 6 weeks and continued for 6 months. The distal ulnar pin was removed at 8 weeks. Follow-up radiographs 5 months after surgery demonstrated a healed osteotomy with maintenance of radial alignment and DRUJ reduction. The patient could perform pain-free active supination and pronation to 65° and 80°, respectively (Fig. 9 and Video C; available on

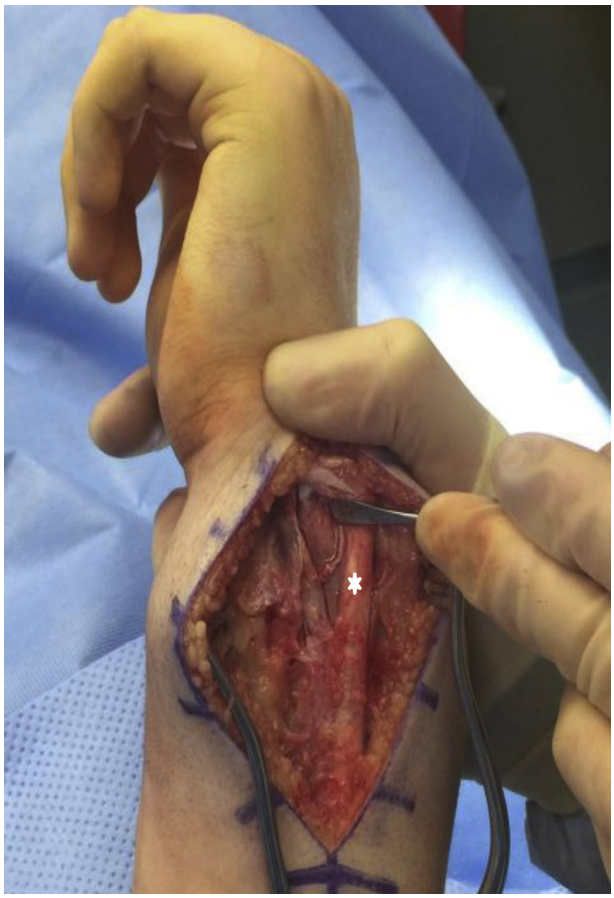

FIGURE 5: The ECU tendon (*) was found between the neoulna and the native ulna. The freer elevator is pointing to the volar neoulna and the native ulna is dorsal and hidden by the ECU tendon.

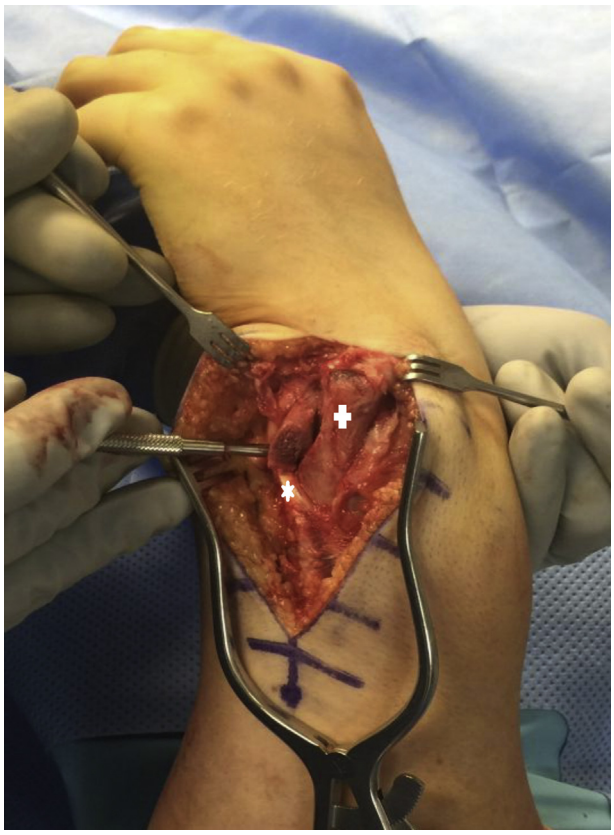

FIGURE 6: Osteotomy was made at the bifurcation between the dorsal native ulna (+) and the volar neoulna, prior to its resection. The native ulna styloid that is attached to the distal aspect of the neoulna was preserved (not shown). The ECU tendon was moved volar to the bifid ulna (*).

the *Journal*'s Web site at www.jhandsurg.org). Final follow-up at 18 months after surgery demonstrated radiographs with a completely healed ulnar styloid fragment (Fig. 10) and pain-free active wrist motion that is nearly symmetric to the patient's uninjured contralateral side, with only a mild deficit observed at terminal pronation (Video D, available on the *Journal*'s Web site at www.jhandsurg.org).

DISCUSSION

We report a Galeazzi-variant fracture in which closed treatment failed and resulted in a posttraumatic bifid ulna. The neoulna was most likely a result of a periosteal sleeve injury with subsequent ossification under the periosteum, in the setting of an unreduced ulna and associated ulnar styloid fracture (Fig. 11).[8] The ulnar styloid fracture remained attached to the periosteal sleeve and distal radius. The majority of the TFCC and ulnar ligaments were preserved because of their attachment to the ulnar styloid.[9]

FIGURE 7: Distal exposure of the neoulna revealed soft tissue attachments of the TFCC and ulnar ligaments (arrow).

FIGURE 8: Immediate postoperative radiographs with maintenance of DRUJ reduction and radial correction.

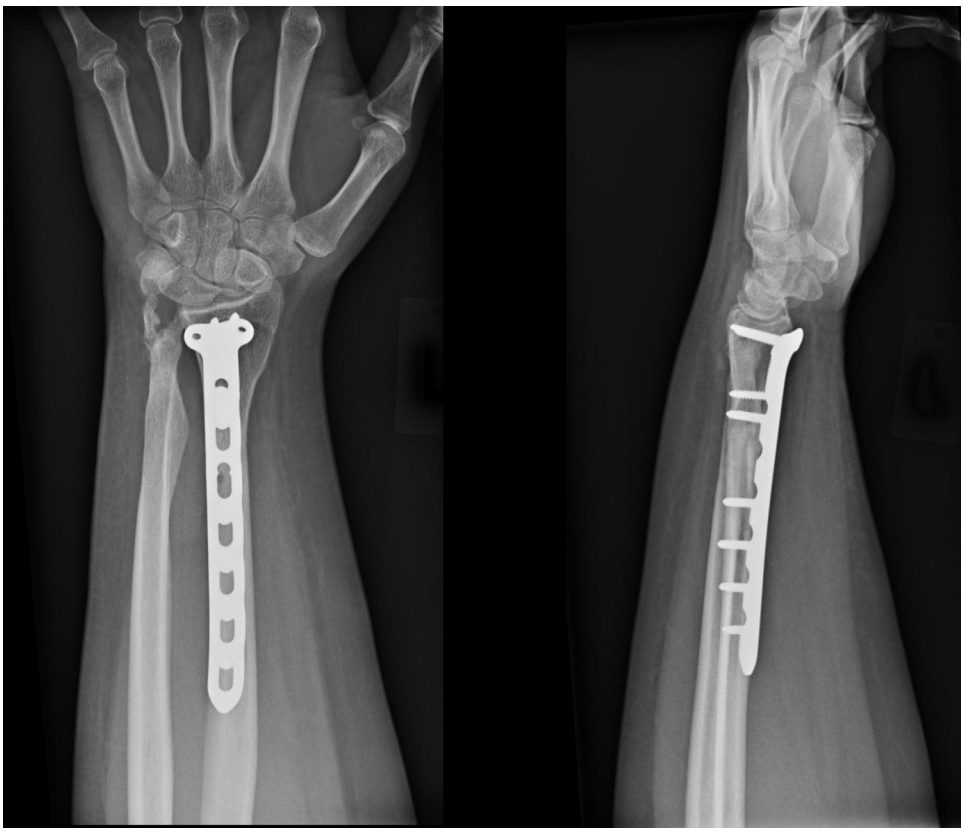

FIGURE 9: Five-month postoperative radiographs demonstrate a healed radial osteotomy site and maintenance of the ulnar styloid position. Some resorption of the styloid fragment has occurred, but the patient remains asymptomatic with good range of motion (Video C; available on the *Journal*'s Web site at www.jhandsurg.org).

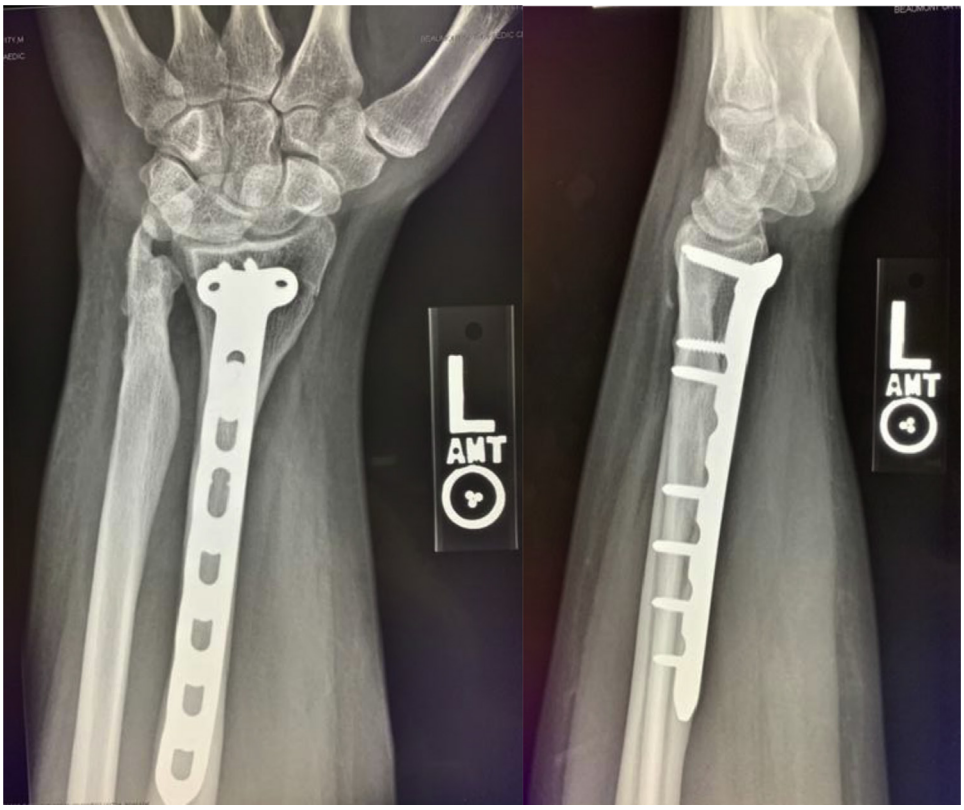

FIGURE 10: Eighteen-month postoperative radiographs demonstrate union of the ulnar styloid fragment and maintenance of DRUJ reduction.

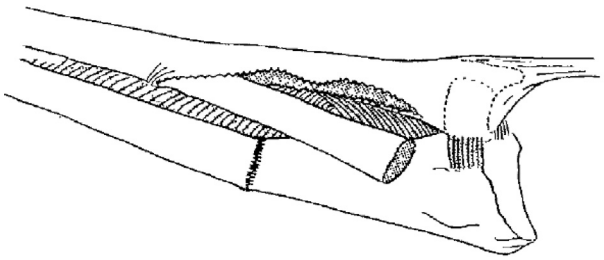

FIGURE 11: An unreduced ulna with an associated periosteal sleeve and distal ulnar physeal injury will result in a bifid appearance after ossification under the periosteal tube. This leads to the creation of the neoulna. The TFCC and ulnocarpal ligaments remain intact. (Reprinted with permission from Imatani J, Hashizume H, Nishida K, Morito Y, Inoue H. The Galeazzi-equivalent lesion in children revisited. *J Hand Surg Br.* 1996;21[4]:455–457.[8])

Therefore, we believed it was important to preserve the styloid when excising the neoulna to maintain these structures. It also was important to recognize that the distal ulna articular cartilage was with the native ulna in this injury pattern. As a result, this was preserved to optimize stability and reduction by maintaining ulnocarpal and DRUJ congruity.

A previous case report documented a posttraumatic bifid ulna 1 year after surgical treatment of a metaphyseal distal radial fracture in a 19-year-old man.[10] The authors concluded that a posttraumatic osteochondroma developed from a distal ulna epiphyseal fracture. However, it is possible that this developed from a mechanism similar to that in our case. There are several reasons to suspect this. First, despite the patient's age, his injury films demonstrate a Galeazzi-equivalent fracture pattern with dorsal subluxation of his distal ulna. Second, the authors noted the bony growth projected toward the wrist joint rather than away, which is uncharacteristic for osteochondromas. Finally, the authors also noted that computed tomography and magnetic resonance imaging demonstrated that the TFCC was intact and attached to the smaller component (indicating the ulnar styloid) whereas the larger component was devoid of soft tissues, which also was present in our case.

This case highlights the importance of properly evaluating the lateral radiograph to ensure reduction of a Galeazzi-equivalent fracture. Recognizing an ulnar styloid injury with a large amount of displacement can be a radiographic clue of the Galeazzi-equivalent

fracture pattern. Therefore, returning the ulnar styloid to a near anatomical position relative to the distal ulna will indicate successful reduction of the DRUJ. A previously described block to reduction in which the ECU tendon can wrap around the ulna and become entrapped by an avulsed ulnar styloid should be considered if the DRUJ remains unreduced despite obtaining acceptable radial alignment.[6,7] A large postreduction ulnar-positive variance, as seen in our case, also can be a clue that closed reduction of the DRUJ has failed (Fig. 2). Contralateral films can be obtained for comparison if there is uncertainty.

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REFERENCES

1. Walsh H, McLaren C, Owen R. Galeazzi fractures in children. *J Bone Joint Surg Br*. 1987;69(5):730–733.
2. Elibrahimi A, Boussakri H, Elidrissi M, Shimi M, Elmrini A. Galeazzi-equivalent lesion: report of a case and review of literature. *SM J Orthop*. 2016;2(2):1033.
3. Dello Russo B, Miscione H. Delayed diagnosis and management of injuries involving the distal radioulnar joint and distal ulna in the pediatric population: recognition and conduct. *J Child Orthop*. 2009;3(6):465–472.
4. Eberl R, Singer G, Schalamon J, Petnehazy T, Hoellwarth ME. Galeazzi lesions in children and adolescents: treatment and outcome. *Clin Orthop Relat Res*. 2008;466(7):1705–1709.
5. Suthar A, Kothari A. Galeazzi-equivalent pronation type injury with splitting of ulnar epiphyseal plate into two fragments—a rare case report and review of literature. *J Orthop Case Rep*. 2014;4(4):25–28.
6. Mitsui Y, Yagi M, Gotoh M. Irreducible Galeazzi-equivalent fracture in a child: an unusual case. *J Orthop Trauma*. 2009;23(1):76–79.
7. Alexander AH, Lichtman DM. Irreducible distal radioulnar joint occurring in a Galeazzi fracture—case report. *J Hand Surg Am*. 1980;6(3):258–261.
8. Imatani J, Hashizume H, Nishida K, Morito Y, Inoue H. The Galeazzi-equivalent lesion in children revisited. *J Hand Surg Br*. 1996;21(4):455–457.
9. Ishii S, Palmer AK, Werner FW, Short WH, Fortino MD. An anatomic study of the ligamentous structure of the triangular fibrocartilage complex. *J Hand Surg Am*. 1998;23(6):977–985.
10. Jones C, Li H, Ellahee N. An anomalous bifid distal ulna: a case report. *Int J Surg Case Rep*. 2013;4(11):939–941.