An Unusual Variant of a Floating Forearm Injury: A Case Report and Review

HAND
2018, Vol. 13(6) NP32–NP38
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DOI: 10.1177/1558944718789411
hand.sagepub.com

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Abstract

Background: “Floating forearm” injuries, perilunate injuries, with an elbow dislocation, are rare and challenging to treat. **Methods:** We present the case of an unusual variant of a floating forearm injury, trans-scaphoid perilunate fracture dislocation and elbow dislocation, with a concomitant open both-bone forearm fracture after a fall from a ladder. Treatment involved irrigation and debridement of the forearm wound, open reduction and internal fixation of the forearm and perilunate injury, and closed reduction of the elbow. **Results:** At final follow-up, he had returned to his previous occupation. Radiographs demonstrated fully healing fractures without evidence of osteonecrosis or degeneration. **Conclusions:** A review of the presentation, evaluation, and management of this rare injury pattern is provided.

Keywords: floating forearm, both bone, trans-scaphoid, perilunate, elbow dislocation, Herzberg

Introduction

Simultaneous perilunate injury and elbow dislocation, the so-called “floating forearm”, is an extremely rare injury pattern.^{1,3,6–8} Even more unusual is a concomitant both-bone forearm fracture in addition to a floating forearm injury.⁷ This case report illustrates the surgical treatment and outcome of a combined trans-scaphoid perilunate fracture dislocation (TS-PLFD), open both-bone forearm fracture, and simple elbow dislocation within the same extremity.

Case Report

A 19-year-old right-hand dominant male fire alarm technician fell 10 feet from a ladder and landed on his outstretched right upper extremity with the elbow and wrist in extension. Upon examination, there was deformity and instability at the wrist, forearm, and elbow. A 2 × 2 mm punctate wound was present within the volar forearm. There was no asymmetry to sensation in comparison with the uninjured extremity. Radial artery pulse was present; there was nonprogressive paresthesias within the median nerve distribution, and forearm compartments were soft.

Plain radiographs demonstrated a dorsal TS-PLFD⁶ and an apex volar, mid-diaphyseal, both-bone forearm fracture (Figure 1) in addition to a posterolateral elbow dislocation without evidence of fractures (Figure 2).

The patient was immediately given intravenous antibiotics for his open both-bone forearm fracture and was urgently taken to the operating room. Intra-operative closed reduction was performed of the TS-PLFD, as described by Tavernier,

and the elbow, with traction and an anteriorly directed force to the olecranon with slight flexion of the elbow.⁹

The forearm wound was incorporated into a volar Henry approach to the radial shaft. The radius was anatomically reduced with standard AO principles and stabilized with an 8 hole, 3.5 mm limited contact-dynamic compression (LC-DC) plate (Depuy-Synthes, Warsaw, Indiana). The ulna shaft was approached through the interval between the flexor carpi ulnaris and the extensor carpi ulnaris, reduced, and stabilized with an 8 hole, 3.5 mm LC-DCP plate (Depuy-Synthes, Warsaw, Indiana). The volar incision was closed primarily while a negative-pressure wound dressing was applied to the ulnar forearm incision, due to progressive muscle edema with soft forearm compartments. The injured extremity was provisionally immobilized in a posteriorly based plaster splint with the elbow in 90° flexion, forearm in neutral rotation, and the wrist in neutral flexion-extension.

On postoperative day 5, the patient underwent treatment for his TS-PLFD. A dorsal approach to the carpus was performed utilizing an ulnarly based retinacular flap through the third to fifth extensor compartments. A ligament sparing capsulotomy was performed in addition to a posterior inter-

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Figure 1. Dorsal trans-scaphoid perilunate fracture dislocation. Posterior-anterior (a) and lateral (b). Open both-bone forearm fracture. Lateral (c).

Figure 2. Simple posterior elbow dislocation. Posterior-anterior (a) and lateral (b).

osseous nerve neurectomy. Open reduction was performed on the comminuted scaphoid waist fracture, an anti-rotation

Kirschner wire (K-wire) (0.045 inch) was placed, and an antegrade headless compression screw was inserted (Figure

Figure 3. Dorsal approach to the carpus. S = scaphoid; L = lunate; T = triquetrum; C = capitate; green arrow = ruptured dorsal lunotriquetral ligament; blue arrow = comminuted scaphoid waist fracture.

3). A K-wire (0.045 inch) was inserted through the distal pole of the scaphoid into the capitate to neutralize the flexion force onto the scaphoid. Similarly, the lunotriquetral joint was reduced and transfixed with 2 parallel K-wires (0.045 inch).

The dorsal lunotriquetral ligament was avulsed from the triquetrum and was repaired, after decorticating the dorsal-radial triquetrum, with two 1.0 mm mini Juggernaut suture anchors (Biomet, Warsaw, Indiana). The proximal half of the dorsal intercarpal ligament was utilized for a distally based capsulodesis to the triquetrum by securing it to the prior suture anchor. The remainder of the capsulotomy was repaired with 3-0 nonabsorbable suture. The extensor retinacular flap was repaired with 3-0 absorbable suture, and the extensor pollicis longus tendon was left transposed.

An extended carpal tunnel release was then performed. The volar lunotriquetral ligament was repaired with 3-0 nonabsorbable suture. All K-wires were cut below the dermal layer and all incisions were closed with 4-0 nonabsorbable sutures. The forearm wound was irrigated, debrided, and primarily closed in a delayed fashion. Examination of the elbow under anesthesia revealed a full flexion-extension arc without any instability. The affected extremity was placed into a sugar-tong plaster splint. Immediate postoperative radiographs are shown in Figure 4.

At 2 weeks postoperative, a short-arm thumb spica cast with the interphalangeal joint free was placed. Occupational therapy was initiated for unrestricted elbow (flexion-extension) and forearm (supination-pronation) range of motion (ROM). At 6 weeks postoperative, the patient denied pain or instability with elbow active and passive ROM from 10°

to 100°. At 10 weeks postoperative, a computed tomography (CT) scan confirmed union across the scaphoid waist fracture, at which point all buried pins were removed and the wrist was placed into a removable orthosis.

Occupational therapy was progressed to include wrist active and passive ROM and transition to full weight bearing. At 6 months postoperative, the patient denied pain and had returned to his occupation. Final radiographs of the wrist, forearm, and elbow demonstrate healing of all injuries without osteonecrosis of any carpal bone or degenerative changes within the wrist (Figures 4 and 5). Elbow ROM exhibited 0° to 130° of flexion, forearm supination to 55° and pronation to 80°, wrist flexion-extension arc was 70° (45° to 25°), and he could form a full composite fist (Figures 6 and 7).

Discussion

This case presentation demonstrates the surgical treatment and outcome of a rare floating forearm injury pattern, perilunate injury with concomitant elbow dislocation, with the unusual addition of an open both-bone forearm fracture.^{1,3,6,8}

The proposed mechanism of injury that produces a floating forearm pattern involves a high-energy axial load on an outstretched upper extremity with an extended wrist. The case reports by Chen et al³ and Kandis et al⁶ postulate that the concomitant elbow dislocation is caused by a high-energy axial force on a semi-flexed elbow, but Chen also states that same injury pattern can occur with elbow hyperextension. The patient in our case report upholds the proposed mechanisms, with an injury pattern consisting of a fall with an extended elbow and wrist with sufficient force to produce a TS-PLFD and elbow dislocation.

A high index of suspicion is necessary to detect an occult perilunate injury in the setting of a high-energy elbow dislocation and/or both-bone forearm fracture.^{1,3,6-8} All of the previously described cases presented after high-energy trauma, motorcycle crash, or fall from height, where the initial resuscitative and surgical treatments were focused on the more apparent and life-threatening injuries.^{1,3,6-8} Although the elbow dislocations were recognized on presentation in all cases, the diagnosis of the perilunate injury was delayed in 3 out of 6 cases (ranging from 1 day to 6 weeks), which is consistent with the reported high rate of delay in diagnosis in up to 25% for all perilunate injuries.⁵ Once the perilunate injury has been detected, there should be a low threshold for CT scan to identify any associated carpal fractures or variants to the more typical greater and lesser arc injuries.² Acuity of diagnosing the perilunate injury and the characteristics of this injury have the most influence on treatment as open reduction and ligament repair may be inappropriate or extremely difficult in chronic injuries due to soft tissue contractures and degenerative change. In addition, patients with an occult perilunate injury

Figure 4. Immediate postoperative wrist radiographs. Posterior-anterior (a) and lateral (b). Six months postoperative wrist radiographs. Posterior-anterior (c) and lateral (d).

Figure 5. Six months postoperative forearm radiographs. Posterior-anterior (a) and lateral (b). Six months postoperative elbow radiographs. Posterior-anterior (c) and lateral (d).

Figure 6. Six months postoperative elbow range of motion. Flexion (a) and extension (b).

Figure 7. Six months postoperative wrist range of motion. Flexion (a) and extension (b). Six months postoperative forearm range of motion. Supination (c) and Pronation (d).

may be at risk for the development of compartment syndrome or acute carpal tunnel syndrome.⁸

In managing a floating forearm and concomitant both-bone forearm fracture, surgical treatment can be considered separately for each component of the injury. In each of the previously described cases, the elbow dislocation was successfully treated via closed reduction and splinting, with early ROM.^{1,3,6-8} However, the pattern of wrist injury dictates the treatment options for the perilunate fracture dislocation. Out of the 6 reported cases of floating forearms, 3 patients^{3,6,8} demonstrated a dorsal perilunate dislocation and 3 patients^{1,3} demonstrated a dorsal TS-PLFD. Patients with a trans-scaphoid pattern were all treated with open reduction and internal fixation. Each of the 3 patients with a perilunate injury that did not involve a scaphoid fracture was treated differently. One patient was treated with nonoperative management (closed reduction and long arm cast),⁶ 1 patient was treated with closed reduction and percutaneous pinning of the perilunate injury,⁸ and 1 patient was treated with a proximal row carpectomy due to delayed presentation and an irreducible wrist.³ The one previously described case of floating forearm plus both-bone forearm fracture was treated with closed reduction of the elbow and open reduction internal fixation (ORIF) of the forearm, scaphoid, and associated capitate fractures along with open reduction and pinning of the perilunate injury (no ligamentous repair).⁷ We treated our patient similarly; however, we also addressed the significant ligamentous injuries that are known to accompany perilunate injury patterns, with repair of the volar and dorsal lunotriquetral ligament.

Patients who sustain a floating forearm injury can be expected to make a functional recovery, as outcomes are typically good.^{1,3,6,7} Patients return to their preinjury occupation with normal elbow ROM and wrist ROM reaching flexion and extension arcs of 0° to 30° and 0° to 60°, respectively, with grip strength ranging from 70% to 100% of the uninjured extremity.^{1,3,6,7} Outcomes were reportedly similar when follow-up was adequate, including the patient recognized late and treated with a salvage procedure; however, no validated outcome measure was reported for any of the cases. The one previously described case of floating forearm plus both-bone forearm fracture had similar outcomes as described above and achieved bony union of the scaphoid, capitate, radius, and ulna.⁷ At final follow-up, the patient had full elbow ROM and wrist ROM of 0° to 50° and 0° to 30° for flexion and extension, respectively.⁷ Despite the addition of a both-bone forearm fracture to a floating forearm injury pattern, our patient was able to return to work with similar wrist and elbow ROM.

When treating a both-bone forearm fracture in addition to a floating forearm injury, it is challenging to determine the ideal surgical approach, order of fixation, and rehabilitation protocol. Sound orthopedic principles dictate that fractures and dislocations should be reduced emergently, but, beyond

this, there is no treatment algorithm available. Limb-threatening injuries take priority in timing of treatment (eg, open fractures, compartment syndrome, acute carpal tunnel syndrome). The surgical approach to the forearm is dictated by the location of the fracture and surgeon preference.^{4,10} However, the ideal surgical approach to a perilunate injury is controversial as volar, dorsal, and combined approaches have all been successfully employed.⁵ It may be beneficial to stage surgical management of the forearm fracture and wrist injury to ensure the adequate tourniquet time and surgeon focus. Although open injuries, compartment syndrome, and acute carpal tunnel syndrome should dictate the order of management, the forearm fractures should be stabilized first to aid in the maintenance of elbow reduction and to minimize soft tissue injury that may occur due to forearm rotation while treating the perilunate injury.

In conclusion, floating forearm injuries are extremely rare, and a both-bone forearm fracture can also occur with this pattern. Each component of the injury can be treated as if it occurred in isolation while expecting good results for the patient, including return to their preinjury occupation.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

Additional informed consent was obtained from all patients for which identifying information is included in this article.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Askar H, Erturk C, Altay MA, et al. Bipolar dislocation of the forearm (floating forearm). *Acta Orthop Traumatol Turc*. 2014;48(1):102-105.
2. Bain GI, Pallapati S, Eng K. Translunate perilunate injuries—a spectrum of this uncommon injury. *J Wrist Surg*. 2013;2: 63-68.
3. Chen WS. Concurrent perilunate dislocation in patients with elbow dislocation: case reports. *J Trauma*. 1994;37:504-507.
4. Henry AK. *Extensile Exposure*. 2nd ed. Baltimore, MD: Williams & Wilkins; 1970.

5. Herzberg G, Comtet JJ, Linscheid RL, et al. Perilunate dislocations and fracture-dislocations: a multicenter study. *J Hand Surg Am.* 1993;18:768-779.
6. Kandis H, Yucel I, Saritas A, et al. Floating forearm: perilunar and elbow dislocation without a fracture. *J Coll Physicians Surg Pak.* 2010;20(10):697-698.
7. Masmejean E, Cognet JM. Bipolar dislocation of the forearm: elbow and perilunate dislocation. *Rev Chir Orthop Reparatrice Appar Mot.* 2001;87(5):499-502. (In French)
8. Prasad K, Dayanandam B, Gakhar H, et al. Concomitant elbow and perilunate dislocation: floating forearm. *Internet J Orthop Surg.* 2007;8(1). <http://ispub.com/IJOS/8/1/10950>. Accessed July 3, 2018.
9. Tavernier L. *Les Déplacements Traumatiques du Semilunaire.* Lyon, France: Thèse; 1906. (In French)
10. Thompson JE. Anatomical methods of approach in operations on the long bones of the extremities. *Ann Surg.* 1918;68:309-329.