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CASE REPORT

Entrapment of the flexor digitorum profundus following paediatric forearm fractures

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The complications of closed and open reduction of paediatric both-bone forearm fractures have been well established. These include malunion, refracture, neurovascular insult, compartment syndrome, infection, and soft tissue/nerve entrapment. We describe two cases of small and ring finger flexion contractures as a complication of closed and operative treatment of healed paediatric both-bone forearm fractures. In both instances, tethering of the flexor digitorum profundus and fibrotic scar tissue interposed at the ulna fracture site was noted at the time of exploration. Evidence of a characteristic fracture pattern at the time of injury, persistent ulnar cortical defect after fracture healing, and delayed identification of the contractures following cast removal are key features in identifying and treating these complications.

Keywords : tendon entrapment ; forearm fractures ; child.

INTRODUCTION

Both-bone forearm fractures account for over 50% of the fractures sustained in the pediatric patient population (*7*). In the overwhelming majority of cases, these injuries are treated non-operatively with excellent return to pre-injury function. In certain situations, such as failure to achieve or maintain a satisfactory reduction, an unstable fracture pattern, multi-trauma, soft tissue entrapment, compartment syndrome and open injuries, operative management is indicated (*1,3*). Despite the successful outcomes seen in the majority of paediatric both-bone forearm fractures, several well-known complications such as infection and hardware concerns, are seen exclusively after operative intervention. Others are seen regardless of the treatment method. These include neurovascular injury, compartment syndrome and malunion ; they may occur following either closed or open treatment. We report two cases of flexion contractures of the small and ring fingers following both-bone forearm fractures in paediatric patients. One patient was treated with closed reduction and casting. The second patient was treated with flexible intramedullary rods. In each case, the cause was tethering of the flexor digitorum profundus and fibrotic scar tissue interposed at the fracture site.

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Figs. 1a/1b. — Pre-reduction both-bone forearm fracture

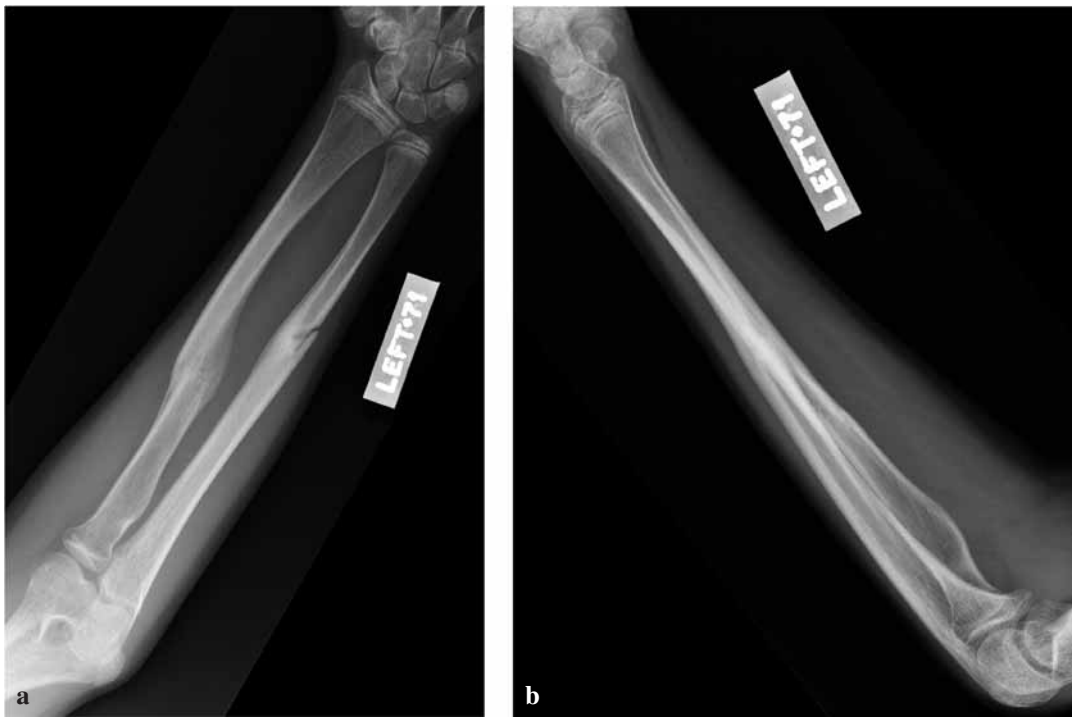
This resulted in a persistent cortical defect noted on radiographs in both patients. Aside from the digital flexion contractures which necessitated operative tissue release, both patients healed uneventfully.

CASE REPORTS

Case 1

A 13-year-old female fell off a pommel horse during gymnastics and landed onto her outstretched dominant left hand. She had immediate pain and deformity of the left forearm. In the emergency department, she reported numbness in the tips of her fingers, but otherwise had no other complaints. On physical examination, her left forearm had soft compartments. There was an obvious deformity at her forearm, and her skin was intact. Distally, her sensation was intact grossly in the median, ulnar, and radial nerve distributions. Radial and ulnar pulses were normal. Her pre-reduction injury radiographs demonstrated a both-bone forearm fracture, with the spiked fragment of the proximal ulna (fig 1).

The patient underwent a closed reduction of her both-bone forearm fracture under conscious sedation in the Emergency Department, and was placed in a long arm cast. The post-reduction neurovascular examination in the cast was normal. She had no pain with passive extension of the fingers. Active or passive range of motion of her fingers was not documented in the medical record. After six weeks in a long arm cast, radiographs demonstrated a healed both-bone forearm fracture with abundant callus formation present. After the cast was removed, a flexion contracture of the small finger at the distal and proximal interphalangeal joints was noted. The flexion contractures were increased with wrist extension and decreased with wrist flexion. In addition, a puckering of the skin along the ulnar and volar surface of the mid-forearm was identified. Forearm pronation and supination measured 70°. Post-operative radiographs obtained four months after closed reduction demonstrated healed radius and ulna fractures, with a persistent osseous defect (fig 2). Conservative measures including extensive hand therapy were attempted, but this failed to correct the digital contracture (fig 3). Four months



Figs. 2a/2b. — AP and lateral left forearm radiographs four months following reduction demonstrating the persistent osseous defect in the mid-ulnar shaft.

following injury, the girl underwent an outpatient procedure to correct the digital flexion contractures involving her small finger. The flexor digitorum profundus (FDP) was found to be interposed and scarred down at the level of the mid ulnar shaft, at the same location as the persistent cortical defect identified on the radiographs (fig 4). The adherent tissue of the FDP was released in a subperiosteal fashion, and intra-operatively full extension of the small finger was obtained with the wrist in a neutral position. The patient had additional hand therapy beginning one week post-operatively. Full extension of the small finger, at both the PIP and DIP joints, in neutral and extended positions of the wrist was achieved six weeks out from her procedure.

Case 2

An 8- year- old male fell on his outstretched left non-dominant upper extremity while playing. In the emergency department, a grade one open both-bone forearm fracture was diagnosed, having a one centimeter open wound on the ulnar and volar aspect of his left forearm. This appeared to be an "inside-out" open fracture. The child's neurovascular examination was normal. After appropriate antibiotics and tetanus prophylaxis were administrated , the child underwent an irrigation and debridement of his open both-bone forearm fracture, and placement of flexible intramedullary titanium rods after unsuccessful attempts at closed reduction. He had difficulty achieving full active extension of his left small finger at his first post-operative follow-up visit at two weeks. He was able to achieve full passive extension of his small finger. The flexible intramedullary rods were removed after seven weeks, after healing of the both-bone forearm fracture was noted. At ten weeks follow-up, the patient had flexion contractures of both the left small and ring fingers. The small finger was more severely affected with involvement of both the PIP and DIP joints. The radiographs demonstrated a spike of bone from the ulna fracture site

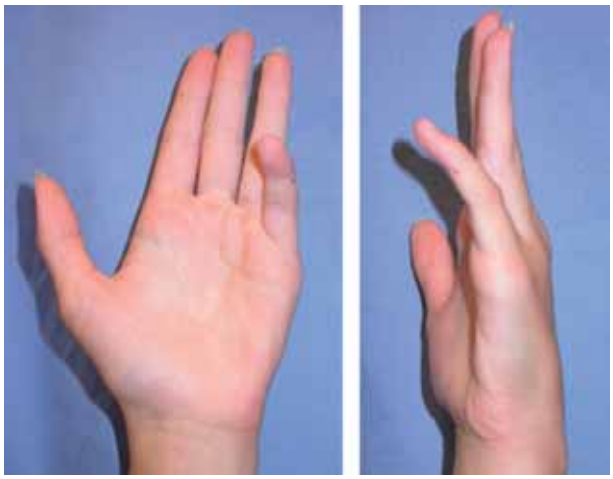


Fig. 3. — Clinical presentation of left small finger flexion contracture four months following closed reduction and extensive physical therapy.

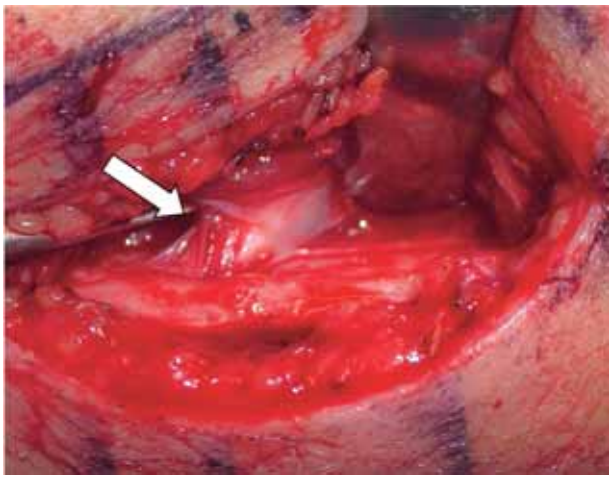


Fig. 4. — Intra-operative view depicting tethered FDP (arrow) adherent to ulna at previous fracture site.

that had not healed or remodeled. This was suspected to be the point of interposed or adherent FDP tissue. Aggressive hand therapy was attempted without correction of the digital flexion contractures. The patient underwent release of the scarred and interposed FDP at the site of the previous ulnar shaft fracture. Intra-operatively, full extension was achieved of both the small and ring fingers. At three months follow-up (and nine months from his index injury and procedure), full extension of both fingers was maintained.

DISCUSSION

The majority of paediatric both-bone forearm fractures occur after a fall on an outstretched upper extremity, and are treated by closed reduction and casting (*1,7*). Flexible intramedullary rod stabilization or formal open reduction and internal fixation, on rare occasions, may be necessary after failed attempts at closed reduction. Regardless of the treatment, entrapment of the flexor digitorum profundus musculotendinous unit has been identified as a rare, but treatable complication of pediatric both-bone forearm fractures (*1,2,4-6,8-11*). Littlefield *et al* described five patients that were noted to have finger flexion contractures after forearm fractures. Initially, they were incorrectly deemed to be mild Volkmann's ischaemic contractures (*8*). This complication following closed or open reduction of both bone forearm fractures has been described as a pseudo-Volkmann's contracture (*2*). These patients do not demonstrate the classic signs and symptoms of a compartment syndrome, such as pain out of proportion to the injury and nerve palsies (*10*). Following failed conservative therapy, which included rigorous hand therapy, the patients had successful release of adherent fibrous tissue at the fracture site and the adjacent muscle bellies. There was no evidence of ischaemic musculature at the time of surgical exploration (*8*).

Hendel (*5*) noted that early features on physical examination may be present and suggest imminent flexor muscle entrapment following both-bone forearm fractures. He advised clinicians to passively test a patient's finger extension at full wrist extension. If pain or stiffness is noted, these children should be sent for stretching hand therapy. Shaw and Murphy (*10*) noted entrapment of the muscle belly, as well as the muscle tendon of the flexor digitorum profundus in two cases of finger flexion contractures following a paediatric both-bone forearm fractures. A mechanical block may sometimes occur at the time of injury or manipulation, since minimal fibrosis is noted at the time of surgery. If an acute block is not identified early, then fibrosis may occur at the fracture site with a resultant contracture after the fracture has healed (*6,10*).

Several authors have suggested paying careful attention to the digital physical examination immediately following reduction of both-bone forearm fractures (*2,5,9,11*). Deeney *et al* (*2*) stated that if a patient is unable to achieve full passive extension of the fingers following closed reduction and a compartment syndrome has been ruled out as a possible cause, the patient should undergo an immediate re-manipulation to free the entrapped musculotendinous tissue. Operative release of the interposed tissue is recommended if closed re-manipulation of the fracture fails to correct the digital contractures. The authors also identified the characteristic pattern of a short oblique fracture of the ulna with a spike of the proximal fragment in all seven cases studied. This spike of bone off the anterior cortex of the proximal fragment of the ulna pierces the muscle of the FDP at the time of injury or during closed reduction (*2*). Rayan and Hayes (*9*) identified an ulnar cortical defect in a patient with a digital flexion contracture following a both-bone forearm fracture, suggesting tissue entrapment. This was similar to the pattern of ulna fractures seen in our two patients.

Digital flexion contractures following paediatric both-bone forearm fractures are a recognized, although uncommon complication following closed and operative treatment. Often, the identification of digital contractures is delayed 4-6 weeks following the injury, after the removal of either splints or casts after closed or open reduction. In some reported cases, this may not be brought to the attention of the treating surgeon for years (*2*). In the two patients we have treated, the radiographic findings coupled with flexion contractures of one or more fingers were key features in identifying this complication and its underlying cause. The first patient also displayed mild puckering at the fracture site, also suggestive of soft tissue adherence or tethering of underlying fascia or muscle. The second patient had decreased ability to actively extend his fingers one week following flexible intramedullary rod placement. Although aggressive hand therapy was attempted, both patients ultimately required operative release of their contractures.

In summary, two patients are reported with obvious digital flexion contractures following healed paediatric both-bone forearm fractures. The characteristic fracture pattern at the time of injury, persistent ulnar cortical defect after fracture healing, and delayed identification of the contractures following cast removal were present in both patients. They responded poorly to non-operative hand therapy. Early operative release of the tethered FDP should be considered after non-operative attempts to correct the flexion contractures have failed.

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