Percutaneous Reduction and Fixation of Displaced Phalangeal Neck Fractures in Children

John W. Karl, MD, MPH, Neil J. White, MD, and Robert J. Strauch, MD

Background: Several methods have been reported for fixation of displaced phalangeal neck fractures in children. The purpose of this study is to present a technique for the closed reduction and percutaneous fixation of displaced phalangeal neck fractures and the clinical results of 4 patients treated by this method.
Methods: Four consecutive patients with displaced phalangeal neck fractures were treated with closed reduction and single intramedullary Kirschner wire placed percutaneously with a novel technique.
Results: The average age at injury was 5 years 9 months (range, 23 mo to 10 y). Three patients were male and 1 was female. Two patients had fractures of the proximal phalangeal neck, whereas the other 2 had fractures of the middle phalangeal neck. After an average follow-up of 18 weeks, all patients had nearly full pain-free flexion and extension of the affected digit.
Conclusions: The described technique is a simple, reproducible and effective treatment for displaced phalangeal neck fractures in children.
Level of Evidence: Level IV. Therapeutic study, case series.

Key Words: children, fracture, phalangeal neck, percutaneous fixation

(*J Pediatr Orthop* 2012;32:156–161)

Fractures of the phalangeal neck occur almost exclusively in children and are rare. In a series of 263 children with finger fractures, Leonard and Dubravcik[1] found only 38 phalangeal neck fractures. These fractures can be nondisplaced (type I), partially displaced, but maintaining some bony contact (type II), or completely displaced with no bony contact (type III) (Fig. 1).[2] The most common mechanism of injury is trapping the hand in a closing door, which delivers a transverse crush injury to the digit, shearing the phalangeal neck. The distal fragment can be completely dorsally displaced and yet seem normal on routine anteroposterior (AP) x-rays (Fig. 2), so it is essential to get a true lateral view when this type of fracture is suspected.[3]

Type I fractures can be treated adequately with splinting for 3 to 4 weeks.[2,4] Displaced fractures, however, are unstable and usually require reduction and fixation.[2,3,5,6] The distal fragment is small and easily rotates on the intact collateral ligaments making it difficult to maintain adequate reduction without internal fixation.[2,5–8] Traditionally, these fractures were thought to be unable to remodel to any significant extent,[9,10] though more recent reports of successful remodeling have been described.[11–14] Nevertheless, reduction and fixation of displaced phalangeal neck fractures is still recommended as a malunion can lead to a bony flexion block and significant loss of joint motion.[15]

When possible, closed reduction of displaced unstable phalangeal neck fractures, followed by percutaneous pinning is the preferred treatment.[2–4,6,7,16] Open reduction and internal fixation of displaced fractures is required when adequate closed reduction is not achieved.[1–3,7,8,15,17]

We describe a technique for closed reduction and percutaneous Kirschner wire (K-wire) fixation of displaced phalangeal neck fractures that is technically straightforward and seems to be effective, and present a series of cases treated with this technique. This method can be utilized for fractures of both the proximal and middle phalangeal necks.

METHODS

Four patients presented with phalangeal neck fractures and were treated with this technique between August 2008 and September 2010. We obtained institutional review board approval and performed a comprehensive chart review for each patient. We collected information including patient demographics, mechanism of injury, radiographs, operative reports, and follow-up evaluations.

OPERATIVE TECHNIQUE

Middle Phalanx

For fractures of the neck of the middle phalanx, anatomic reduction can be obtained with manual pressure exerted dorsally over the phalangeal head, with the finger extended and the distal interphalangeal (DIP) joint flexed. The maneuver can be thought of as similar to that of a supracondylar humeral fracture; translation and rotation are corrected with flexion of the distal joint and dorsal finger pressure over the fragment. The reduction needs to be confirmed on a high-quality lateral fluoroscopic view. We prefer to use the C-arm in the horizontal plane.

From the Department of Orthopedic Surgery, Columbia University Medical Center, New York, NY.
The authors declare no conflict of interest.
Reprint: Robert J. Strauch, MD, 622W. 168th Street, New York, NY 10032. E-mail: robertjstrauch@hotmail.com.

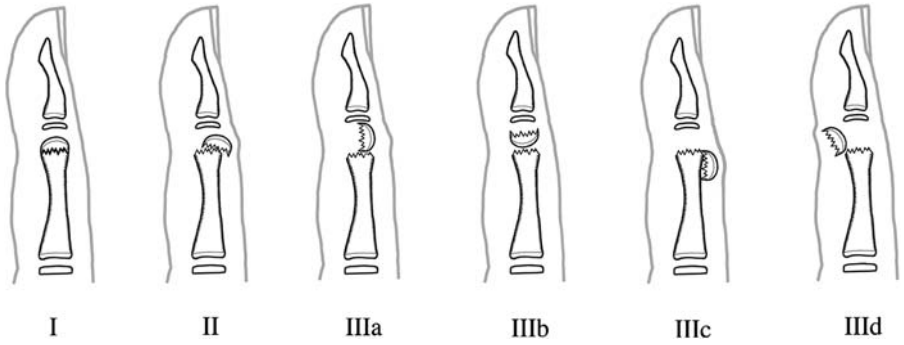

FIGURE 1. Classification of phalangeal neck fractures. Type I fractures are nondisplaced. Type II fractures are displaced with some remaining cortical contact. Type III fractures are displaced with no cortical contact. Adapted from Al-Qattan.[2]

Rotation of the finger must be confirmed clinically. If reduction can be obtained with near anatomic limits, the following technique may be performed.

A K-wire is held dorsally over the injured finger and a 0.028 or 0.035 K-wire is selected depending on the size of the finger. We use a sterile marking pen to mark the midline on AP and lateral views to aid with targeting.

The K-wire is dorsally inserted percutaneously into the center of the articular surface of the involved phalangeal head with the DIP joint flexed (Fig. 3A). The wire is then driven across the fracture and into the isthmus of the middle phalanx. It is continued through the physis of the middle phalanx, across a flexed proximal interphalangeal (PIP) joint and out the skin (Fig. 3B). Under fluoroscopy the wire is withdrawn proximally until its distal end is buried within the phalangeal head. At this time, if the reduction is suboptimal, the wire can be backed up slightly proximal to the fracture and the reduction maneuver can be repeated (Fig. 3C). The DIP joint is then placed into neutral extension and the wire driven across this joint and out the tip of the finger (Fig. 3D). The wire is then withdrawn distally until the proximal end is slightly distal to the growth plate of the base of the middle phalanx (Fig. 3E).

Final fluoroscopic views are taken in AP, lateral, and 45-degree oblique planes. The pin is cut and bent, and

FIGURE 2. Displaced type II fracture of the middle phalangeal neck in a 7-year-old boy. Note that the displacement is not visible on the AP view and can only be appreciated on a lateral of the finger.

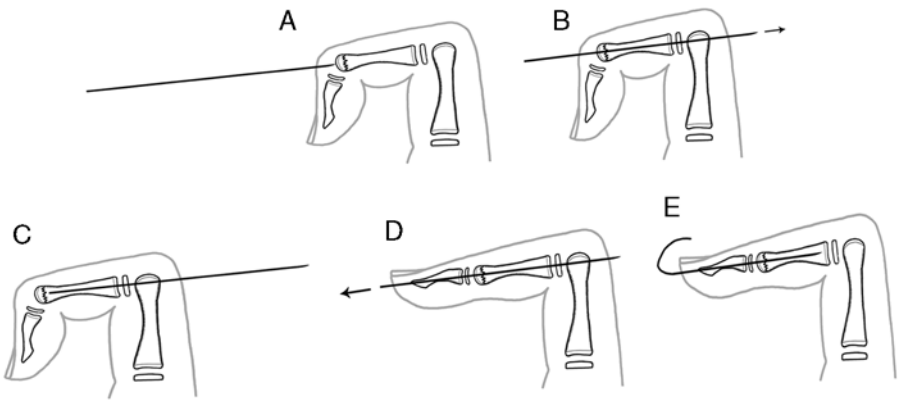

FIGURE 3. Steps to technique. Engage the single K-wire on the reduced phalangeal head with the DIP joint maximally flexed (A). Drive the K-wire across the fracture and out skin through a flexed PIP joint (B). The reduction can be adjusted at this time (C) before extending the DIP and directing the wire distally (D, E).

a sterile bulky dressing is applied. A volar splint is applied to protect the affected finger and both neighboring fingers. We generally include the wrist in the intrinsic plus position.

The pin is removed at 3 weeks after surgery in young children and 4 weeks in those reaching skeletal maturity. Range of motion exercises are begun immediately. The finger is protected during activity and at school for an additional 2 weeks with a dorsal Alumafoam splint.

Proximal Phalanx

For fractures of the neck of the proximal phalanx, the procedure is carried out as above with a few modifications.

FIGURE 4. AP and lateral view 21 days postoperative.

The reduction is obtained in a similar manner via flexion of the PIP joint. The K-wire is driven through the proximal phalangeal head, across the reduced fracture, and across the flexed metacarpophalangeal (MCP) joint. The K-wire is withdrawn proximally until the distal tip is buried within the phalangeal head. The PIP joint is then extended and the K-wire is driven distally across the PIP joint and into the medullary canal of the middle phalanx. The MCP joint is held in a flexed position by the K-wire until the fracture is healed. The K-wire can be removed in the clinic at 3 to 4 weeks by drawing it proximally through the MCP joint.

RESULTS

There were 3 male patients and 1 female patient with an average age of 5.9 years (range, 23 mo to 10 y). Two patients had fractures of the proximal phalangeal neck while the other 2 had fractures of the middle phalangeal neck. After an average follow-up of 18 weeks, all patients had pain-free full or near-full flexion and extension of the affected digit.

Case 1 was a 7-year-old right-hand–dominant male who was sitting on the floor when a chair fell and landed on his right hand, resulting in a displaced phalangeal neck fracture of his right ring middle phalanx (Fig. 2).

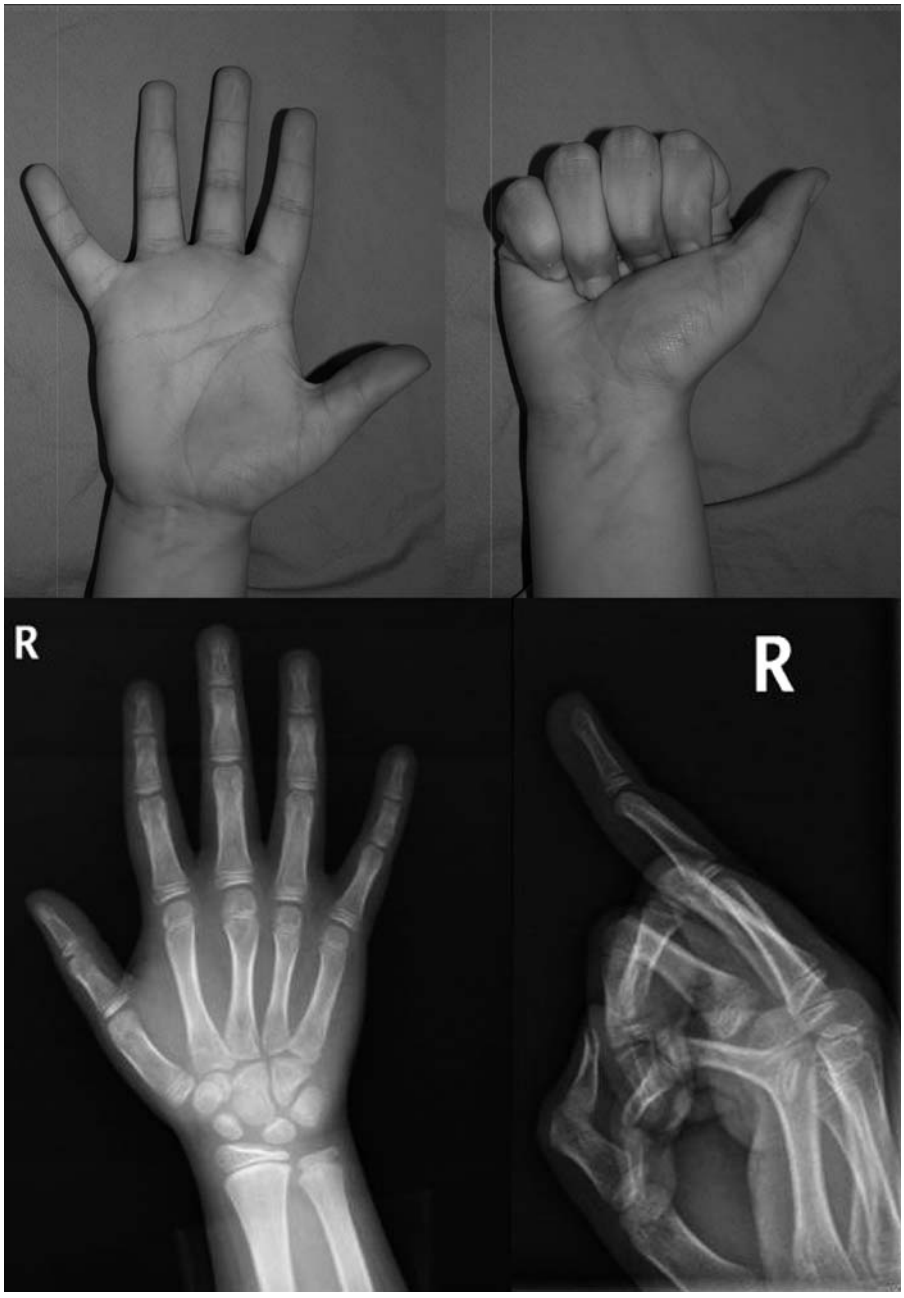

FIGURE 5. Clinical and radiographic images at 6 months postoperative.

The above technique was employed 3 days after the injury (Fig. 4). At 6 months postoperative he had regained full function of the hand and lacked only 5 degrees of DIP flexion as compared with the contralateral side (Fig. 5). There was no evidence of growth disturbance (Fig. 5).

Case 2 was a 9-year-old right-hand–dominant male who accidentally hit his hand on a wall playing soccer. He sustained a completely displaced phalangeal neck fracture of his right index proximal phalanx, treated with the described technique 3 days after the injury. At 7 weeks postoperative, he had full range of motion of the right index finger (Fig. 6).

Case 3 was a 4-year-old female who fell off a bed while playing with her father and suffered a displaced proximal phalangeal neck fracture of her right middle finger, which was repaired with the above technique 7 days after injury. The K-wire was removed at 3 weeks postoperative. The patient did not return for future follow-up visits, but the patient's mother later telephoned, reporting the patient had full motion of her hand and could make a tight fist.

Case 4 was a 23-month-old male who had his right hand caught in a closing door, sustaining a laceration to distal tip of his ring finger and a middle phalangeal neck fracture of the small finger. The laceration was closed in the emergency room and the patient was taken to the operating room 4 days after injury where his fracture was treated with the technique described. At 2 months, the patient had near-normal flexion and extension and at 8 months had full motion and use of the digit.

DISCUSSION

For displaced phalangeal neck fractures in children, closed reduction and internal fixation should be the first line of treatment. However, for fractures that are not reducible by closed techniques, open reduction and internal fixation may be required.[2–4,7,8] Although the literature suggests that most completely displaced fractures require open techniques, we have found that open reduction is rarely needed. In our experience, gentle traction on the fingertip with forceful joint flexion has produced appropriate reduction in the majority of cases. Open surgery requires soft tissue dissection which can cause joint stiffness and decreased range of motion, and can disrupt the fracture hematoma and blood supply, which can slow healing, resulting in nonunion and potential necrosis of the small distal fragment.[16]

Many closed techniques have previously been described. Dixon and Moon[3] describe using a 22-G needle to lever the distal fragment back into place, followed by percutaneous pinning. This is similar to techniques described by both Crofoot and colleagues,[16,18] where a separate intrafocal K-wire is used to achieve reduction of the fracture before pinning.

Crofoot and colleagues[4,16] prefer using crossed, retrograde K-wires for fixation. Al-Qattan,[2] however, notes that a single orthograde-retrograde K-wire is adequate fixation, but does not describe the technique for wire placement. Leonard and Dubravcik[1] also used a single longitudinal K-wire and found it did not interfere with interphalangeal joint function, nor did it cause degenerative arthrosis of the transfixed joints or cause growth plate arrest. Kozin and Waters[6] describe using longitudinal K-wires inserted through the articular surface, but no further details are given.

In our experience placement of a single K-wire from the tip of the finger has been cumbersome and often requires multiple passes. A slight malangulation in the wire trajectory is amplified significantly upon reaching the fracture, and the K-wire can often hinder anatomic reduction if it is off-center. Further, as we use joint flexion as our primary reduction maneuver, placement of a single K-wire from the fingertip is difficult to initiate while maintaining reduction. Although crossed K-wires do create a sound construct, we have found it challenging to percutaneously place crossed K-wires across a narrow transverse fracture line while maintaining reduction. Placement of the initial wire is difficult due to a small margin for error and again, multiple passes may be required.

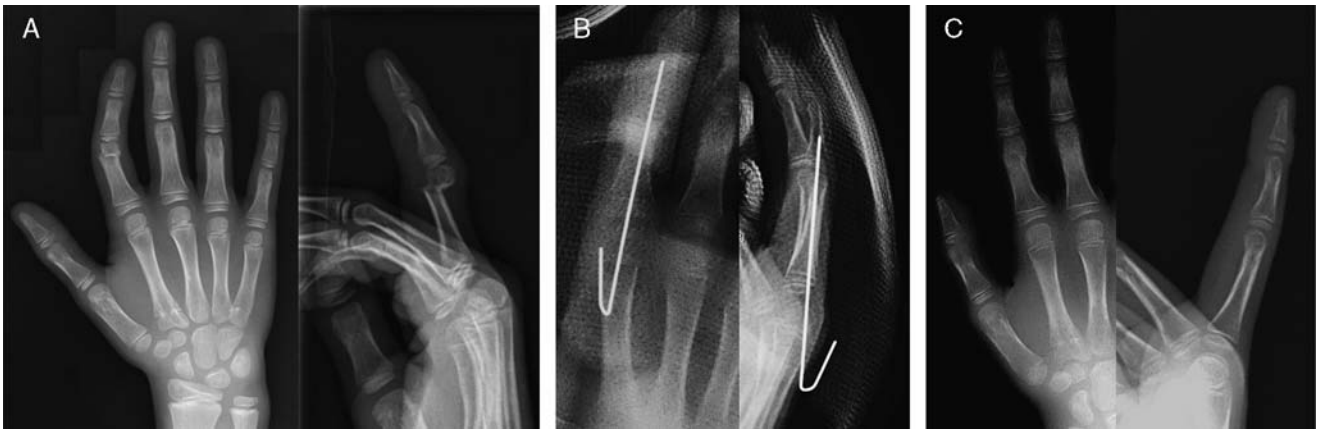

FIGURE 6. A, Displaced type II fracture of the proximal phalangeal neck in a 9-year-old boy. B, AP and lateral views immediately postoperative. C, AP and lateral views 1 month postoperative.

The technique described above does require the violation of an uninjured joint and of the proximal or middle phalangeal physis. It also ensures, however, fixation with a single pass with the K-wire, and allows for DIP or DIP joint flexion for maintenance of the reduction while the K-wire is being passed. The reduction can be improved by taking the K-wire proximal to the fracture without a second pass. Furthermore, the DIP joint is secured in a comfortable, neutral position while healing occurs for middle phalangeal neck fractures, and the MCP joint is kept in a "safe," flexed position for proximal phalangeal neck fractures. We feel that the potential physeal concerns of this technique are minimal and, in our opinion, less significant than the potential downside caused by either opening the joint or passing multiple K-wires though the fracture fragment. Although not emphasized in the literature, our experience suggests that, when open reduction is required, displaced phalangeal neck fractures have the potential to become a significant intraoperative struggle that can lead to suboptimal results.

In conclusion, we have described a relatively simple, percutaneous technique for reduction and fixation of middle and proximal phalangeal neck fractures that may be added to the armamentarium of surgeons involved in treating these injuries. As shown in our case series, it is effective for displaced fractures of the proximal or middle phalangeal neck in children.

REFERENCES

1. Leonard MH, Dubravcik P. Management of fractured fingers in the child. *Clin Orthop Relat Res*. 1970;73:160–168.
2. Al-Qattan MM. Phalangeal neck fractures in children: classification and outcome in 66 cases. *J Hand Surg Eur Vol*. 2001;26:112–121.
3. Dixon GL, Moon NF. Rotational supracondylar fractures of the proximal phalanx in children. *Clin Orthop Relat Res*. 1972;83:151–156.
4. Campbell RM Jr.. Operative treatment of fractures and dislocations of the hand and wrist region in children. *Orthop Clin North Am*. 1990;21:217–243.
5. Wallace R, Topper SM, Eilert RE. Management of phalangeal neck fractures in children. *Mil Med*. 2006;171:139–141.
6. Kozin SH, Waters PM. Fractures and dislocations of the hand and carpus in children. In: Rockwood CA, Beaty JH, Kasser JR, eds. *Rockwood and Wilkins' Fractures in Children*. 7th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2010.
7. Kang HJ, Sung SY, Ha JW, et al. Operative treatment for proximal phalangeal neck fractures of the finger in children. *Yonsei Med J*. 2005;46:491–495.
8. Leonard MH. Open reduction of fractures of the neck of the proximal phalanx in children. *Clin Orthop Relat Res*. 1976;176–179.
9. Barton NJ. Fractures of the phalanges of the hand in children. *Hand*. 1979;11:134–143.
10. Simmons BP, Peters TT. Subcondylar fossa reconstruction for malunion of fractures of the proximal phalanx in children. *J Hand Surg Am*. 1987;12:1079–1082.
11. Al-Qattan MM, Rasool MN, El Shayeb A. Remodelling in a malunited phalangeal neck fracture. *Injury*. 2004;35:1207–1210.
12. Cornwall R, Waters PM. Remodeling of phalangeal neck fracture malunions in children: case report. *J Hand Surg Am*. 2004;29:458–461.
13. Hennrikus WL, Cohen MR. Complete remodelling of displaced fractures of the neck of the phalanx. *J Bone Joint Surg Br*. 2003;85:273–274.
14. Mintzer CM, Waters PM, Brown DJ. Remodelling of a displaced phalangeal neck fracture. *J Hand Surg Br*. 1994;19:594–596.
15. Hastings H II Simmons BP. Hand fractures in children. A statistical analysis. *Clin Orthop Relat Res*. 1984;188:120–130.
16. Crofoot CD, Saing M, Raphael J. Intrafocal pinning for juxtaarticular phalanx fractures. *Tech Hand Up Extrem Surg*. 2005;9:164–168.
17. Wood VE. Fractures of the hand in children. *Orthop Clin North Am*. 1976;7:527–542.
18. Waters PM, Taylor BA, Kuo AY. Percutaneous reduction of incipient malunion of phalangeal neck fractures in children. *J Hand Surg*. 2004;29:707–711.