SCIENTIFIC ARTICLE

A Stepwise Algorithm for Surgical Treatment of Type II Displaced Pediatric Phalangeal Neck Fractures

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Purpose To evaluate a stepwise reduction algorithm including closed, percutaneous, and open reduction techniques followed by percutaneous pin fixation for displaced pediatric phalangeal neck fractures.

Methods Sixty-one consecutive children (mean age, 9.4 y; range, 2−18 y) presenting with closed, type II displaced phalangeal neck fractures were treated using the following algorithm. If satisfactory reduction was achieved with closed reduction, percutaneous pinning (CRPP) was performed. If not achieved, then percutaneous reduction and pinning (PRPP) was performed using a temporary intrafocal joystick for reduction and for osteoclasis as needed. If percutaneous reduction failed, open reduction and percutaneous pinning (ORPP) was performed. Using the Al-Qattan system, radiographic and clinical outcomes were retrospectively graded for union, deformity, range of motion, and function.

Results Satisfactory alignment was achieved in all 61 fractures, by CRPP in 49 and PRPP in 12. No fracture required open reduction. Mean number of days from injury to surgery was 8 days for CRPP and 17 days for PRPP. All fractures treated after 13 days required percutaneous pinning. Fifty-three patients were followed for at least 1 year or until full functional recovery was achieved, with 45 excellent, 4 good, 1 fair, and 3 poor results. Four complications accounted for the fair and poor results, including 1 flexion contracture, 1 nonunion following pin track infection, and 1 case of avascular necrosis following a severe crush injury in the CRPP group and 1 flexion contracture following PRPP.

Conclusions Our stepwise algorithm for surgical treatment of closed, type II displaced pediatric phalangeal neck fractures produced 92% good to excellent results while minimizing the need for open reduction even in late-presenting fractures. *(J Hand Surg Am. 2014;39(3):467−473.*

Type of study/level of evidence Therapeutic IV.

Key words Pediatric, percutaneous fixation, percutaneous reduction, phalangeal neck fractures.

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PHALANGEAL NECK FRACTURES account for 13% of finger fractures in children.[1] Based on the Al-Qattan classification, phalangeal neck fractures can be nondisplaced (type I), displaced with bone-to-bone contact at the fracture site (type II), and displaced with no bone-to-bone contact (type III).[2] The majority of these fractures are displaced, and displaced fractures can cause considerable functional problems if not reduced anatomically.[3−5] Similarly, reduced fractures have a strong tendency to re-displace unless stabilized by pin fixation.[2,4] Therefore,

current recommendations for the treatment of such fractures dictate timely reduction and pin fixation to stabilize the fracture.[2,6–9]

Although there is little question that pin fixation is required to stabilize the fracture once reduced, the best method for reduction is debatable. Some authors recommend open reduction,[2,8,10] and others recommend closed reduction.[6,7,9] Proponents of open reduction cite the inability to adequately correct the deformity by closed means in all cases, whereas proponents of closed reduction cite the risk of avascular necrosis of the phalangeal condyles following open reduction.[9] A complicating factor is that many children present to the hand surgeon 2 to 3 weeks after injury. By then, closed reduction is often unsuccessful, but open reduction may carry an even greater risk of injuring the blood supply to the healing fracture fragments.[9] For this reason, a percutaneous reduction technique has been described as an alternative to open reduction when closed reduction is unsuccessful, with a theoretically lower risk of avascular necrosis compared with open reduction.[9,11]

However, the roles and efficacies of the various reduction techniques have not been elucidated, as previous retrospective studies reporting the results of treatment of phalangeal neck fractures have included a variety of treatment strategies and/or a small number of patients,[2–4,8–11] which has led to a lack of consensus regarding treatment strategies.[12]

The primary purpose of the study was to evaluate the effectiveness of a stepwise algorithm to obtain reduction incorporating closed, percutaneous, and open reduction techniques in a consecutive series of patients with closed, type II displaced phalangeal neck fractures. The secondary purpose was to report the clinical results of those patients treated with this algorithm.

MATERIALS AND METHODS

Treatment algorithm

Since 2004, the senior author (R.C.) has used a stepwise treatment algorithm for closed, type II displaced phalangeal neck fractures in children (Fig. 1). Non-displaced or minimally displaced fractures with normal adjacent interphalangeal joint motion and no coronal or rotational deformity were treated conservatively with close follow-up to ensure maintenance of satisfactory alignment until healing. Fractures with initial displacement sufficient to affect adjacent joint motion or produce coronal or rotational deformity were treated with an attempt at closed reduction in the operating room. If satisfactory reduction was achieved, percutaneous interfragmentary pins were placed to stabilize the fracture (Fig. 2). The size of the stabilizing K-wires was dependent on the child's age and ranged from 0.7 to 1.1 mm. One or 2 K-wires were passed obliquely from distal to proximal to stabilize the fracture. A crossed pin configuration was used for transverse fractures, and a parallel or divergent configuration was used for oblique fractures. A single K-wire was used in very distal fractures or small fragments in which 2 pins could not be placed. The number of pins used for each patient was not recorded. Regardless of pin number or configuration, the pins were placed with the adjacent interphalangeal joint in as little flexion as possible to minimize the risk of a flexion contracture.

If, however, closed reduction was unsuccessful at achieving satisfactory alignment, percutaneous reduction was performed using a temporary intrafocal K-wire for reduction and percutaneous osteoclasis as needed and as described by Waters et al.[11] Specifically, a K-wire was placed by hand under fluoroscopic guidance into the fracture site at the concavity of the deformity. Depending on the direction of displacement (dorsal, dorsoradial, or dorsoulnar), the K-wire was placed either through or around the central extensor apparatus so that the K-wire was inserted into the concave side of the fracture in the plane of maximum deformity. A sweeping motion was used to disrupt fracture callus. Then the K-wire was driven by hand through the fracture site until the tip was just distal and palmar to the distal end of the far cortex of the proximal fragment, such that the palmar cortex of the proximal fragment could be used as a fulcrum for levering the distal fragment into position. The adjacent interphalangeal joint was simultaneously flexed as necessary to assist in the reduction. The size of the K-wire was dependent on the child's age and ranged from 0.9 to 1.4 mm.[11] If percutaneous reduction was successful, percutaneous interfragmentary pins were placed as described previously. Open reduction was reserved for fractures that could be reduced by neither closed nor percutaneous methods and when the criteria for remodeling were not met, as described by Cornwall and Waters[13] (Fig. 1). Regardless of the method of reduction, the patients were immobilized in a cast following pinning.

Patients were seen in the office at 4 to 5 weeks after surgery. If clinical and radiographic union was apparent, both the cast and the K-wires were removed, and range of motion exercises were started at home. Patients returned to the office at 6 to 7 weeks