Fracture of the proximal phalanx of the little finger in children: a classification and a method to measure the deformity

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Objective: To develop an improved method for measuring the deformity caused by fracture of the proximal end of the proximal phalanx of the little finger in children.

Design: A prospective case study.

Setting: Regional hospitals with an orthopedic service.

Patients: Forty-two children with a proximal phalangeal fracture of the little finger and 42 children without a phalangeal fracture, who acted as a control. The type of deformity resulting from the fracture was noted, and the angle of deformity was measured. Rotational deformities were measured clinically in all patients and angulation deformities were measured from radiographs. The deformities were graded and classified.

Main outcome measures: Measurements of the fracture deformity before and after manipulation.

Results: There were 38 ulnar angulation deformities, 26 dorsal angulation deformities, 10 ulnar rotation deformities, 3 palmar angulation deformities, 2 radial angulation deformities and 1 radial rotation deformity. The deformities could be graded into 6 different types.

Conclusion: The measurements of deformity made it possible to describe and classify isolated deformities and combinations of various deformities.

Objectif : Mettre au point une meilleure façon de mesurer la déformation causée par une fracture de l'extrémité proximale de la phalange proximale de l'auriculaire chez les enfants.

Conception : Étude de cas prospective.

Contexte : Hôpitaux régionaux dotés d'un service d'orthopédie.

Patients : Quarante-deux enfants qui ont subi une fracture de la phalange proximale de l'auriculaire et 42 enfants qui n'ont pas subi de fracture de la phalange et qui ont servi de témoins. On a noté le type de déformation causée par la fracture et mesuré l'angle de la déviation. Les décalages en rotation ont été mesurés en clinique chez tous les patients et les déviations ont été mesurées à partir de radiographies. Les déformations ont été cotées et classées.

Principales mesures des résultats : Mesures de la déformation causée par la fracture avant et après la manipulation.

Résultats : On a constaté 38 déviations cubitales, 26 déviations dorsales, 10 décalages en rotation cubitale, 3 déviations palmaires, 2 déviations radiales et un décalage en rotation radiale. On a pu classer les déformations en 6 types différents.

Conclusion : Les mesures de la déformation ont permis de décrire et de classer les déformations isolées et des combinaisons de déformations diverses.

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Accepted for publication Feb. 17, 1997

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Fractures of the base of the proximal phalanx are common in childhood and result in angulation and rotational deformities. Worlock and Stower[1] described the causes of hand fractures in children as those from falls, sports or fighting. Of the phalangeal fractures, the proximal phalanx was the one most commonly injured. The force causing fracture of the proximal phalangeal epiphysis was regarded as torsional in nature. Leonard and Dubravcik[2] reported failed closed reduction of a proximal epiphyseal fracture due to the interposition of soft tissue. The fracture was subsequently reduced by open reduction and internal fixation with Kirschner wires. They did not report any adverse effects such as infection or premature closure. Hastings and Simmons[3] immobilized the phalangeal fractures using an ulnar gutter or aluminum splint. Barton[4] warned readers to be careful when assessing proximal phalangeal fractures since the angulation can easily be overlooked clinically because the fracture is near the metacarpophalangeal joint. There are no detailed reports in the literature on the type of deformities caused by proximal phalangeal fractures.

The purpose of this study was to devise a method to measure and document deformities caused by a fracture of the proximal phalanx and to use the same method in the follow-up of the patients.

Patients and methods

Forty-two children (13 girls, 29 boys) who presented to the emergency department of several regional hospitals between 1992 and 1995 and had fractures of the base of the proximal phalanx and an unfused growth plate were studied. All children had sustained a Salter–Harris type II injury to the growth plate (Fig. 1). The mean age of the children was 9.1 years (range from 2 to 14 years). Another 42 children with a mean age of 9.3 years (range from 2 to 14 years) and no phalangeal fracture on anteroposterior and lateral x-ray films were assigned to the control group. Angulation and rotation were measured in these children.

FIG. 1. Salter–Harris type II fracture at the base of the proximal phalanx of the little finger with an abduction and dorsal angulation deformity.

Fractures were treated by closed reduction within 24 hours of injury. After fracture reduction, the children were treated by strapping the little finger to the ring finger. Fractures considered unstable radiologically and clinically were also immobilized in a volar slab. One closed reduction failed after two attempts: an open reduction and cross Kirschner-wire fixation was done; it was found that the fragment of the metaphysis attached to the growth plate was long and pointed and was blocking the reduction. The fingers were immobilized in radiotransparent splints with the metacarpophalangeal joint in 70° to 80° of flexion[5] for a mean period of 3 weeks but not more than 5 weeks. All children were seen in the outpatient department after 1 week. Follow-up anteroposterior and lateral radiographs were obtained, and the children were seen again at 2 weeks. In 37 children, the hand was then mobilized, after further follow-up radiography and assessment. Four other children had the finger immobilized in plaster of paris for a further 2 weeks, by which time the fracture had united successfully so that the finger could be mobilized. The child whose fracture was fixed with a Kirschner wire was brought into the hospital as a day case after 4 weeks. The plaster and Kirschner wire were removed and the little finger was mobilized.

Measurement of deformity

Fracture angle

The fracture angle was measured on standard anteroposterior and lateral films, with the x-ray tube approximately 1 m from the hand. Abduction (ulnar angulation) and adduction (radial angulation) were measured on a standard anteroposterior film. The deformity was recorded by measuring the

angulation from neutral in terms of movement of the line through the centre of the shaft of the proximal phalanx, taking the line through the base of the epiphysis as a reference (Fig. 2) to minimize the risk of an inaccurate reading due to small positional errors on the radiographs. In a patient with no angulation, this line usually runs through the centre of the shaft of the phalanx. Dorsal and palmar angulations were measured from a standard lateral radiograph by drawing a parallel line at the base of the proximal epiphysis. A line was erected from the base of the proximal epiphysis, usually passing through the centre of the epiphysis and the shaft of the proximal phalanx in patients with no deformity.

Fracture rotation

Rotational deformity was measured by sticking a tape to the base of the nail horizontally and putting the tip of the little finger opposite the 90° line on a protractor (Fig. 3). A plastic clip with a flat surface was attached to the fingertip at the base of the nail snugly and to the medial and lateral sides of the finger. A 3-cm rigid plastic tape was attached horizontally to the upper flat surface of the clip. This was done to minimize false-positive results because the surface of the nail is not flat. The angle of rotation was measured in terms of movement of the rigid tape in accordance with the type of rotational deformity. To validate the accuracy of the method used when measuring the rotation deformity, a level measuring device was used on 10 patients in the control group who had no fracture or deformity and no rotation of the nail on clinical examination. The clip was mounted over the base of the fingernail and attached to the sides of the finger securely, thus obtaining a three-point contact with the finger (surface of the base of the nail, medial and lateral borders of the finger). The finger with the clip in situ was put on a flat table surface, and the level was put on the flat upper surface of the clip. The level confirmed that the flat surface of the clip was exactly horizontal (no rotation).

Fracture classification

The deformities were measured in

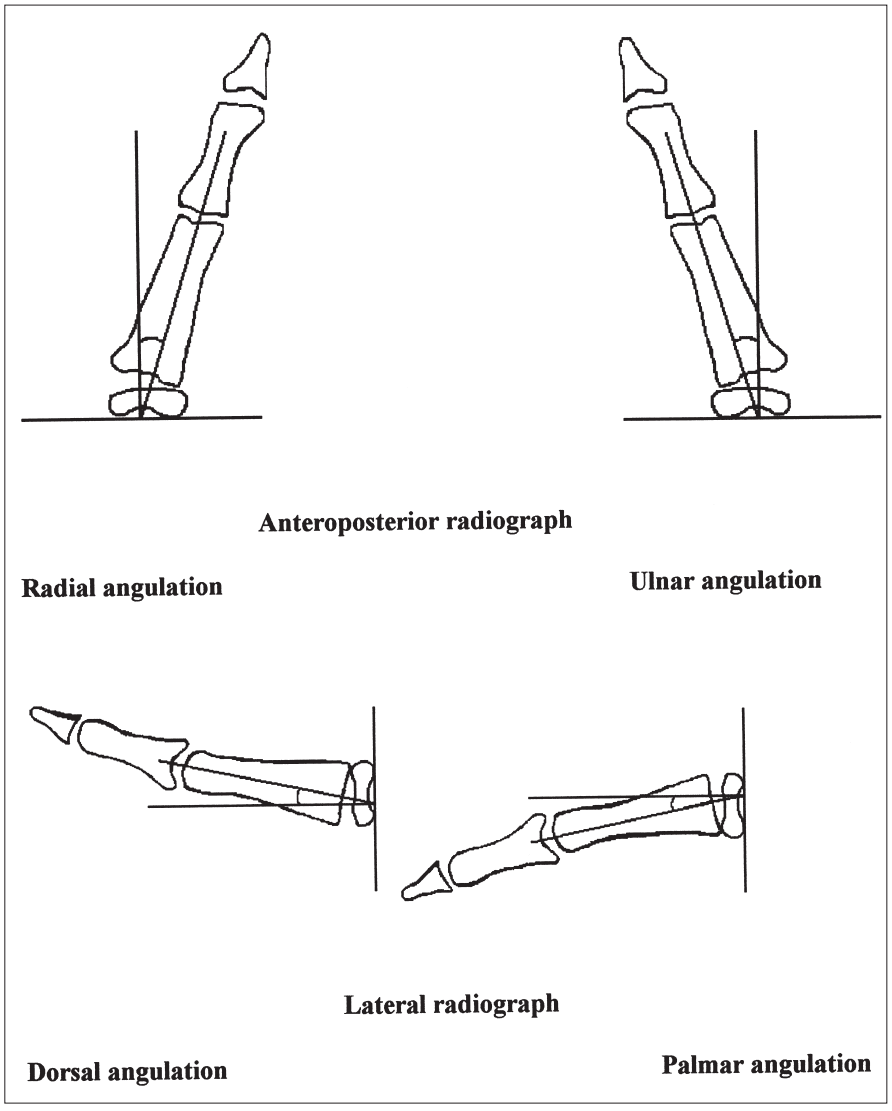

FIG. 2. Diagram to show how angulation deformities were measured from standard anteroposterior and lateral radiographs.

FIG. 3. Measuring the finger rotation with a rigid tape and a protractor.

degrees with the hand in pronation. From these measurements it was possible to devise a classification to describe the deformities alone or in combination as follows: type I — abduction (ulnar angulation); type II — adduction (radial angulation); type III — dorsal angulation; type IV — palmar angulation; type V — ulnar rotation; type VI — radial rotation.

Results

The mean, range and standard deviation for each of the 6 types of deformities, alone and in combination, are shown in Table I for the 42 children who had various phalangeal deformities. The total number of deformities was greater than the number of children because most of the deformities occurred in combination.

Two fractures slipped after 1 week. Remanipulation was successful. Ulnar angulation was the most common deformity followed by dorsal angulation, indicating that the forces producing these fractures are directed in abduction and dorsally. The position of the finger at the time of injury is also important. The fingers are abducted when one is balancing or using the hand for support when falling down. This is a significant factor in producing abduction and dorsal angulation deformities in the little finger, which has no protection on the outside.

The fracture that was fixed with a Kirschner wire had a residual abduction angulation of 12°, which was not noticeable clinically. The child regained full movement. Children regain joint movement quickly, and joint stiffness is not a common complication. All the patients regained full movement within 2 to 4 weeks after mobilization.

In 39 patients of the control group, the angle of rotation was 0°. In 3 patients, a mean ulnar rotation of 10.6° was noted, which was comparable bilaterally. In 41 of the 42 patients in the control group, the anatomic angle of the proximal phalanx was 90° (considered as 0° of deformity). In 1 patient, the adduction angle on the anteroposterior film was 20°. There was no history of injury to the finger.

Discussion

Fracture of the little finger is common in children. Landin[6] reported that fractures were the commonest hand injury in children and Worlock and Stower[1] reported that they were the second most common hand injury. The little finger is more vulnerable because it is a peripheral finger with no outside protection.

According to Hastings and Simmons,[3] the incidence of the Salter–Harris type I epiphyseal injury is 7.4%. The Salter–Harris classification describes various types of growth-plate injuries effectively,[7] but since many of the Salter–Harris type I injuries may not have a wide separation of the growth plate and may go unnoticed, the percentage of these injuries reported by Hastings and Simmons may be an underestimation. They reported the incidence of Salter–Harris type II injuries as 78.7% of all epiphyseal hand injuries.

Epiphyseal fractures of the phalanges and fractures through the metaphysis are usually easy to reduce, and closed reduction with manipulation is recommended.[8] According to Barton, if one attempt is not successful, further measures are not justified because remodelling corrects any deformity in almost all the cases. In my experience, adequate closed reduction of Salter–Harris type II fractures of the proximal phalanx is sometimes difficult when a piece of metaphysis attached to the growth plate blocks the reduction. Failure of closed reduction has also been reported by von Raffler[9] because of the interposition of flexor tendon at the fracture site. Open reduction and internal fixation with Kirschner wires is advisable in such a situation. Fracture fixation with one or two fine Kirschner wires does not interfere with the growth plates. However, multiple penetration of the growth plate with Kirschner wires should be avoided.

These fractures should be immobi-

Table I

Mean, Range and Standard Deviation of Deformities in 41 Children With Fracture of the Proximal Phalanx of the Little Finger

Type of deformity	No. of deformities	Range, °	Mean, °	Standard deviation
I — ulnar angulation. In combination with DA, PA, RR, UR	38	6–72	32	16
II — radial angulation. In combination with DA	2	20–28	24	5.6
III — dorsal angulation. In combination with UA, RA	26	15–60	33	11
IV — palmar angulation. In combination with UA	3	12–44	26	16
V — ulnar rotation. In combination with UA	10	28–38	32	3.5
VI — radial rotation. In combination with UA	1	22	22	—

DA = dorsal angulation, PA = palmar angulation, UA = ulnar angulation, RA = radial angulation, UR = ulnar rotation, RR = radial rotation

lized in radiotransparent splints and slabs, because the fracture cannot be assessed properly when the finger is in a plaster of paris cast owing to inadequate imaging. James[10] recommended a position to immobilize these fractures: the metacarpophalangeal joints are flexed and the interphalangeal joints are extended. Each joint is immobilized in the opposite position to that in which a contracture is likely to develop.

Full correction of these fractures is sometimes difficult. After closed reduction, the finger of one patient had 16° of dorsal angulation and 3° of ulnar rotation. Another had 14° of abduction angulation and 4° of ulnar rotation. One patient had a finger with ulnar rotation of 10° and another was left with a residual abduction angle of 7°. The fracture fixed with a Kirschner wire healed with a residual abduction angle of 12°. All these patients regained full movement of their little fingers without functional or cosmetic impairment. An angle of angulation of less than 20° does not result in impairment of function or movement and a rotational deformity of less than 10° will not result in functional impairment or cosmetic deformity.

In current practice, the rotation of the finger resulting from a fracture is assessed clinically with no accurate measurement and documentation. It would be helpful to standardize a method for accurate scientific measurement of the deformities for evaluating, treatment and follow-up. Therefore, a classification is needed for phalangeal fractures in relation to various types of deformity occurring as a consequence of these fractures. The method described in this paper was effective during follow-up because it detected small fracture displacements in four children (3°, 4°, 7° and 10°) that were not detected clinically.

It should be remembered that because the little finger is a peripheral digit, excessive residual angulation will leave the finger with an abduction deformity that may not be cosmetically acceptable and can result in functional impairment. Manipulation and correction of a Salter–Harris type II fracture of the proximal phalanx of the little finger is usually not difficult. The surgeon's aim should be to attain anatomic reduction. Good anteroposterior and lateral radiographs are essential for proper radiologic assessment of these fractures. Inappropriate lateral views can be misleading. It would be of benefit to design a device that would hold the hand in a desired position so as to avoid positional inaccuracies during radiography. Clinical assessment and documentation of these fractures is important in diagnosis, follow-up and medical communication.

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