



Bony mallet finger without epiphyseal plate injury in childhood



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ARTICLE INFO

Article history:

Received 1 June 2015

Received in revised form 10 July 2015

Accepted 4 August 2015

Available online 8 August 2015

Keywords:

Mallet finger
Epiphyseal line injury
Finger fracture in childhood
Salter-Harris
classification

ABSTRACT

INTRODUCTION: It is commonly thought that Salter–Harris type I or II appears in mallet fingers in childhood, with S–H type III appearing in adolescence.

PRESENTATION OF CASE: We present a case of bony mallet finger in childhood. Radiographs showed a small fragment above the distal interphalangeal joint, and this fragment was separated from the dorsal epiphysis without injury to the epiphyseal plate. Open reduction and fixation were performed and bone union was achieved without complications.

DISCUSSION: Bony mallet finger in childhood manifests as S–H types I, II, and III in typical cases. However, it depends on narrowing of the epiphysis and the strength of the axial forces on the tip of the distal phalanx. In the case of epiphysis narrowing and only small forces affecting the region, an avulsion fracture without injury to the epiphyseal plate will occur in rare cases.

CONCLUSION: We presented here a rare case of a bony mallet finger in childhood without epiphyseal plate injury.

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1. Introduction

Mallet finger commonly occurs in childhood with an epiphyseal plate injury. It takes the form of Salter–Harris (S–H) type I or II [1] in children. However, it increases in degrees to S–H type III in adolescents [2]. In brief, relationships have been observed between age and the type of epiphyseal plate injury, with this type of injury changing with age [3]. Although there is report of cases that have distal phalanx fractures localized to the metaphyseal region as childhood in adults [4], there is no case report that has bony mallet finger (fracture localized to the epiphyseal region) as adult in childhood. We present this rare injury, which was treated surgically using Kirschner wires (K-wires), and bone union was achieved without complications.

2. Presentation of case

A 12-year-old boy, who had previously been in good health, injured his right ring finger in a game of dodgeball. The ball hit from the tip of his finger. He presented to the emergency room in pain with a deformity in the distal interphalangeal (DIP) joint. The finger exhibited a mallet deformity. Radiographs revealed a small

fragment above the DIP joint (Fig. 1A). Closed reduction was not achieved by extension of this joint (Fig. 1B).

The dorsal fragment was separated from the epiphysis and attached by the extensor terminal end. There was no injury to the epiphyseal plate (Fig. 2A).

After reduction, two K-wires were inserted in parallel into the dorsal head of the middle phalanx through the proximal edge of the dorsal fragment. The DIP joint was then fixed in an extensive position by a K-wire of the same diameter (Fig. 2B and C). Five weeks after the operation, all K-wires were removed and active range of motion exercises for the DIP joint were started. Five months after the operation, radiographs showed that bone union of the dorsal epiphysis had been achieved (Fig. 3), and the active range of motion of the DIP joint was 0–60°.

The patient's parents were informed that data concerning the case would be submitted for publication, and they consented.

3. Discussion

Ossification at the epiphysis of the distal phalanx begins at 12–36 months of age. Closure of the epiphyseal line commonly occurs between 13 and 16 years of age [5]. The epiphyseal plate injury is more frequent in boys than in girls because the epiphyseal plate stays open longer in boys than in girls. Moreover, the more athletic activities of boys are more likely to cause epiphysis injuries [6]. In the structure of the distal phalanx in children, the

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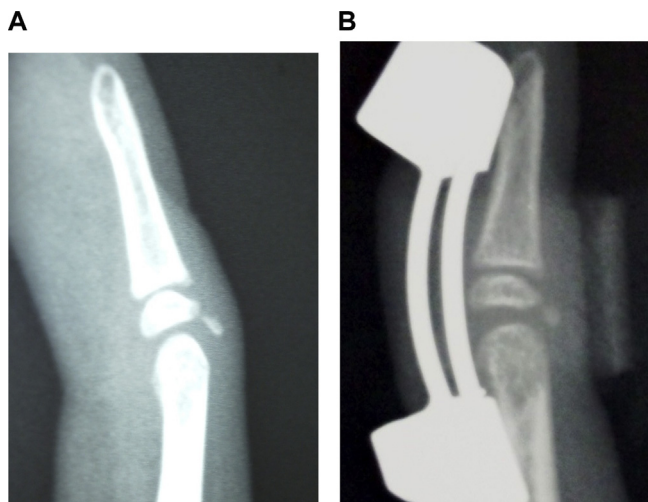


Fig. 1. Radiographs of bony mallet finger. (A) The small fragment above the distal interphalangeal joint. (B) A reduction was not achieved by closed reduction.

extensor tendon is inserted into the dorsal epiphysis only, and the flexor tendon is inserted into the volar epiphysis and metaphysis [7]. The epiphyseal plate is also more vulnerable than normal tendons or ligaments and the fibrous joint capsule [1]. Mallet finger in children is caused by a disproportion at the entheses of the two tendons and the vulnerability of the epiphyseal plate.

This injury has been classified into four types: shearing, avulsion, splitting, and crushing. S–H types I and II are the shearing-avulsion type. S–H type III is also the same type including fracture of the epiphysis by an intra-articular shearing force [1]. In S–H types I and II, an axial force is exerted on the tip of the finger. The repulsive forces against this force appear from the head of the middle phalanx. At the same time, the epiphysis is momentarily fixed by traction from the two tendons (Fig. 4A). Balance is broken by the traction from the deep fibers of the flexor tendon in response to the repetitive force. The tip of finger then flexes and the epiphyseal plate is separated (Fig. 4B). In S–H type III in adolescence, the epiphyseal plate is already starting to narrow and exhibit mild sclerosis. Therefore, repulsive forces directly affect the intra-articular shearing force at the epiphysis and cause a fissured

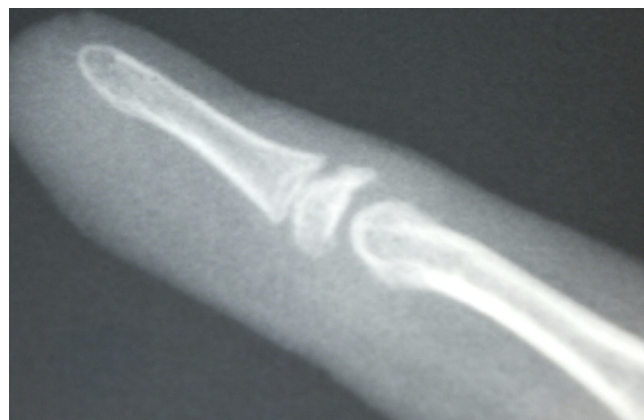


Fig. 3. Radiograph 5 months after surgery. Bone union of the dorsal epiphysis was achieved.

fracture (Fig. 4C). Part of the dorsal epiphyseal plate then separates due to the flexuous motion of the finger (Fig. 4D).

Although our patient was a child, radiographs revealed narrowing of the epiphyseal plate. This corresponded to that seen in adolescents. Therefore, although S–H type III was expected, an avulsion fracture of the epiphysis without injury to the epiphyseal plate occurred. This injury may have occurred for two reasons. First, axial forces at the tip of the finger were small. Second, intra-articular shearing forces from the head of the middle phalanx did not cause fissured fracture of the epiphysis. Therefore, an avulsion fracture of the dorsal epiphysis may have occurred (Fig. 4E).

4. Conclusion

Mallet finger in childhood manifests as S–H types I, II, and III in typical cases. However, it depends on narrowing of the epiphysis and the strength of the axial forces on the tip of the distal phalanx. In the case of epiphysis narrowing and only small forces affecting the region, an avulsion fracture without injury to the epiphyseal plate will occur in rare cases.

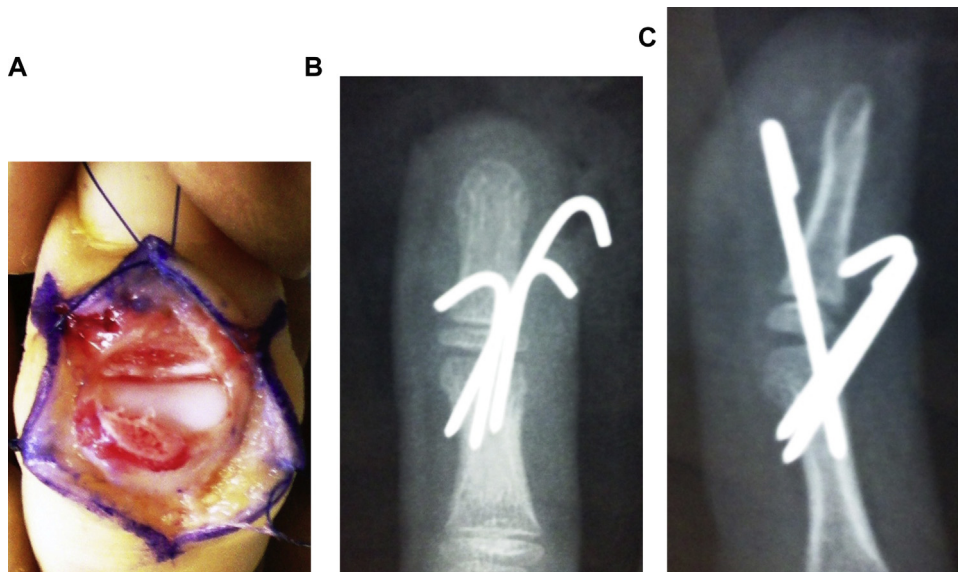


Fig. 2. Intraoperative findings and postoperative radiographs. (A) The fragment was separated from the dorsal epiphysis and attached to the extensor terminal end. There was no injury at the epiphyseal plate. (B) Frontal view. (C) Lateral view.

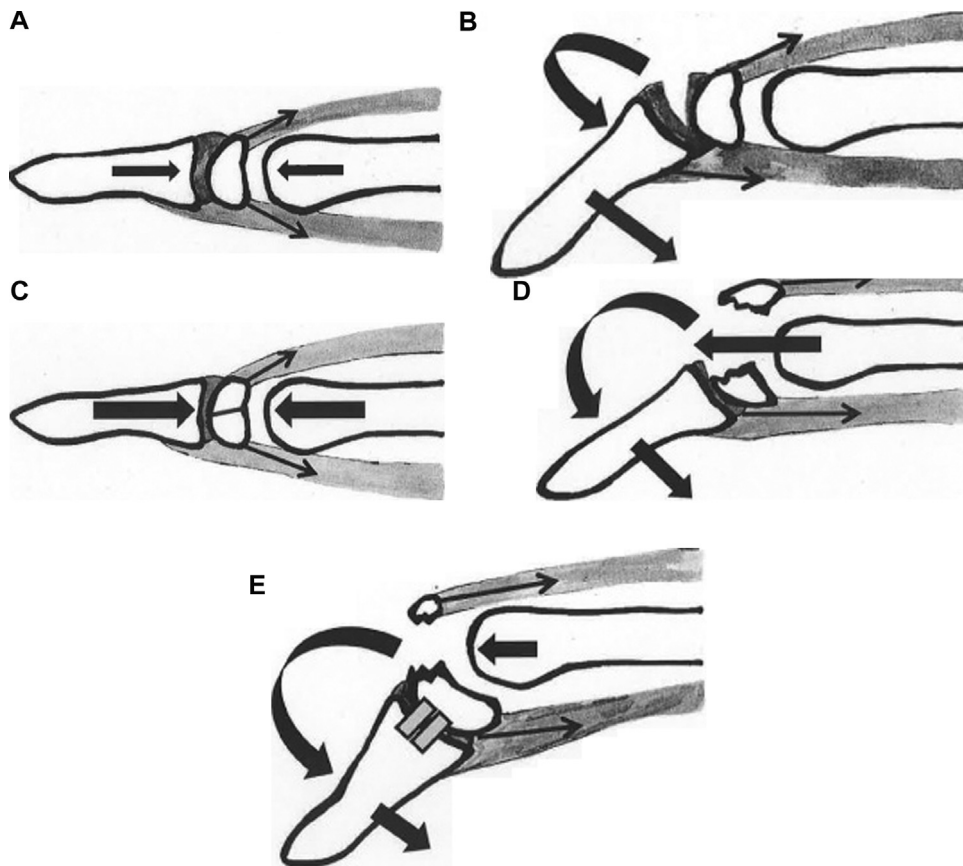


Fig. 4. The mechanism of the epiphysis injury to the distal interphalangeal joint. (A) The finger was affected by two opposed forces. At the same time, the epiphysis was momentarily fixed by the traction of the two tendons (Salter and Harris type I and II). (B) The balance was broken by the traction force of the deep fibers of the flexor tendon. The tip of finger was then flexed and the epiphyseal plate separated. (C) The epiphyseal plate was already starting to narrow and exhibited mild sclerosis. Therefore, repulsive forces directly affected the intra-articular shearing force at the epiphysis and cause a fissured fracture (S–H type III in adolescence). (D) Part of the dorsal epiphyseal plate separated due to the flexuous motion of the finger. (E) In our case, the epiphyseal plate did not separate and an avulsion fracture of the dorsal epiphysis only occurred.

Conflict of interest

None.

Funding

None.

Consent

Written informed consent was obtained from patient for publication of this case report and accompanying images. A copy of the written consents are available for review by Editor-in-Chief of this journal on request.

Authors contributions

All authors have contributed significantly, and that all authors are in agreement with the content of the manuscript.

Cheolsun Han, Kiyohito Naito, Yoichi Sugiyama and Osamu Obayashi performed operation and ward management; Cheolsun Han, Kiyohito Naito and Kazuo Kaneko diagnosed; and Cheolsun Han and Kiyohito Naito wrote the paper.

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