A Case of Coronal Intra-articular and Epiphyseal Fractures of the Metacarpal Head in Early Adolescence

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Abstract

Intra-articular metacarpal head fracture is relatively rare. We report a case of coronal intra-articular and epiphyseal fractures of Salter–Harris type IV injury in the metacarpal head of the index finger. Surgery was performed by a dorsal approach. The volar fragment that was displaced proximally was gently reduced while bending the metacarpophalangeal (MP) joint, and it was fixed with cortical screws inserted proximal to the articular cartilage facilitating early rehabilitation. We consider the mechanism of injury to be a force applied from the distal phalanx that was transmitted unevenly to the volar side when the MP joint was slightly flexed. A three-dimensional computed tomography scan was useful in making the precise diagnosis, confirming the fracture pattern and planning fixation of the fracture.

Keywords

- coronal fracture
- epiphyseal fracture
- metacarpal head
- adolescence

Introduction

Metacarpal fracture commonly occurs in the shaft, base, or neck, and the incidence of intra-articular fracture is relatively rare. We report a case of coronal intra-articular and epiphyseal fractures of the metacarpal head in early adolescence that required surgical treatment.

Case Report

A 14-year-old male patient injured his right index finger while practicing baseball. On plain radiographs, an intra-articular fracture of the metacarpal head was suspected, and the patient was referred to our hospital (►Fig. 1). Computed tomography (CT) revealed a “Salter–Harris type IV” displaced coronal intra-articular and epiphyseal fractures (►Fig. 2). The volar fragment involved more than 20% of the articular surface and was displaced proximally. Therefore, we decided that open reduction was necessary.

The patient was surgically treated under brachial plexus anesthesia. A dorsal incision was made over the

metacarpophalangeal (MP) joint. The extensor tendon was incised between the extensor indicis proprius and extensor digitorum communis tendons, and the joint capsule was dissected longitudinally to expose the joint. The volar fragment that was displaced proximally was gently reduced using a small elevator while bending the MP joint. The reduction was easily maintained manually at the fully flexed position of the MP joint. Then, 1.7 mm diameter cortical screws were inserted from the dorsal side to the volar side so as not to cross the epiphyseal line. Three screws were used for the purpose of preventing rotation of the fragment and hold them as a plane, not a line. The screws were set so that they would not penetrate the contralateral cortex to prevent irritation upon flexion of the MP joint (►Fig. 3). The joint capsule and extensor tendon were repaired with absorbable thread. The postoperative radiographs showed an acceptable reduction (►Fig. 4). The hand was splinted with the MP joint in slight flexion to protect the sutured extensor tendons, and exercise of the proximal interphalangeal (PIP) and distal interphalangeal joints was started immediately after surgery. After 2 weeks, the splint was removed, and active range-of-motion exercises

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Fig. 1 The fracture of the metacarpal head was suspected from the anteroposterior (left) and oblique (right) radiographs.

Fig. 2 Computed tomography revealed a Salter–Harris type IV displaced coronal intra-articular and epiphyseal fractures. Sagittal plane (left); lateral 3D CT (center); volar 3D CT (right). CT, computed tomography; 3D, three-dimensional.

of the MP joint were started. Four months after surgery, the bone union was confirmed with radiographs, and the screws were removed with local anesthesia. A CT scan taken after the removal of the screws showed an adequate reduction of the articular surface and bone union of the fracture site (►Fig. 5). One year after surgery, the range of motion of the MP joint was 70 degrees in flexion and 10 degrees in extension. The MP joint flexion was 80 degrees for the contralateral side. The radiographs showed no sign of aseptic necrosis of the metacarpal head (►Fig. 6). The patient had no pain or complaints.

Discussion

Metacarpal fracture commonly occurs in the shaft, base, or neck, and the incidence of intra-articular fracture is relatively rare at 3 to 5%.^{1,2} In a series of 103 intra-articular metacarpal fractures, McElfresh and Dobyns³ classified them into the following groups: (1) epiphyseal; (2) collateral ligament avulsion; (3) osteochondral; (4) oblique (sagittal); (5) coronal (vertical); (6) horizontal (transverse); (7) comminuted; (8) boxer's fracture into joint; (9) loss of substance; and

Fig. 3 Intraoperative findings. The volar fragment was displaced proximally (left, arrow). The fragment was gently reduced while bending the MP joint, and it was fixed using cortical screws inserted proximal to the articular cartilage (right). MP, metacarpophalangeal.

Fig. 4 Postoperative X-ray shows a favorable reduction and the positioning of the cortex screw. Anteroposterior (left) and lateral (right) views.

(10) avascular necrosis. In this case series, only four cases were coronal fractures and one of which was a palmer fracture as in our case, which went on to avascular necrosis after reduction and pinning with Kirschner wires. Four cases were epiphyseal fractures, all undisplaced “Salter–Harris type III,” and were treated successfully with conservative therapy. They also noted that intra-articular fractures occurred most commonly on the index finger, suggesting that the index finger’s position as a border digit with less mobility in flexion compared with the little finger is the reason.³ Our case also occurred in the index finger. We propose the following

mechanism of injury (► **Fig. 7**): with the MP joint deeply flexed, the force applied from the distal phalanx is transmitted evenly to the metacarpal head and is likely to cause a fracture in the neck. When MP joint is slightly flexed, the force applied from the distal phalanx is transmitted unevenly to the volar side, causing a coronal fracture. Weiss and Hastings have hypothesized the mechanism of unicondylar fracture of the proximal interphalangeal joint to occur with dorsal or palmer subluxation of the joint combined with flexion/extension component.⁴ We believe that the fracture in our report occurred through a similar mechanism.

Fig. 5 A CT scan taken after the removal of screws showed an adequate reduction of the articular surface and union of the fracture site. Sagittal plane (left) and volar 3D CT (right). CT, computed tomography; 3D, three-dimensional.

Fig. 6 The radiographs 1 year after surgery showed no sign of aseptic necrosis of the metacarpal head. Anteroposterior (left) and lateral (right) views.

Salter–Harris types I and II fractures frequently demonstrate remarkable remodeling potential, whereas Salter–Harris types III and IV fractures often require surgical repair and may be more frequently associated with later problems of growth and posttraumatic arthritis.⁵ Surgical treatment

for displaced MP joint metaphyseal fractures with articular involvement fractures is recommended,⁶ though there are no clear definition for degree of displacement. Open reduction and internal fixation is recommended for intra-articular fractures of the PIP joint with the involvement of more than

Fig. 7 Schematic drawing of hypothesized mechanism for fractures of the metacarpal head. With the MP joint deeply flexed, the force applied from the distal phalanx (left, arrow) is likely to cause a fracture in the neck (line). When the MP joint is slightly flexed, the force applied from the distal phalanx (right, arrow) is transmitted unevenly to the volar side, causing a coronal fracture (line). MP, metacarpophalangeal.

20% of the articular surface or an articular step-off more than 1 mm to prevent pain and osteoarthritis,⁷ and we applied the criteria in our case. Tan et al reported five cases of coronal fractures of the metacarpal head that were treated using a cortical screw.⁸ The head of the screw was placed intra-articularly and countersunk 1 mm to prevent protrusion of the screw head into the MP joint. Lee et al reported five cases of coronal fractures that were treated operatively either with Kirschner wire or a headless screw, depending on the size of the fragment.⁹ In our case, fixation was performed using cortical screws as we assumed from the CT scan taken before surgery that the screws could be inserted proximal to the articular cartilage. Surgery was performed as planned and early rehabilitation was possible. Headless compression screw placed dorsal to volar would be an option for this fracture pattern to prevent the second operation.

Hand fractures in the pediatric population can be difficult to diagnose. Chew and Chong¹⁰ reported that the misdiagnosis rate is as high as 8% (16 of 204). In our case, the fracture was coronal, intra-articular, and epiphyseal requiring an accurate reduction. Although the fracture of the metacarpal head was diagnosed by anteroposterior and oblique radiographs, the fracture pattern was not obvious. A three-dimensional CT scan was useful in making the precise diagnosis, confirming the fracture pattern and planning fixation of the fracture.

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Conflict of Interest

None declared.

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