Management of Proximal Interphalangeal Joint Fracture Dislocations

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KEYWORDS

• Proximal interphalangeal joint • Fracture-dislocation • Dynamic external fixator
• Volar plate arthroplasty • Hemihamate arthroplasty

KEY POINTS

- Fracture dislocations of the proximal interphalangeal (PIP) joint can have dramatic consequences for hand range of motion, especially when untreated.
- Dorsal fracture dislocations with a volar lip fracture are far more common than volar fracture-dislocations, which occur with a dorsal lip fracture.
- PIP joint fracture dislocations are commonly classified based on the amount of articular involvement on a lateral radiograph (Kiefhaber and Stern classification).
- Treatment of PIP fracture dislocations is based on stability of the joint, the size of the fracture fragment, and associated soft tissue injuries.
- Treatment options for PIP joint fracture dislocations include closed reduction and splint or taping, closed reduction and percutaneous pinning, open reduction with internal fixation, volar plate arthroplasty, hemihamate arthroplasty, and arthrodesis.

INTRODUCTION

Fracture dislocations of the proximal interphalangeal (PIP) joint of the finger are often caused by axial load applied to a slightly flexed joint. The most common injury pattern is a dorsal fracture dislocation with a volar lip fracture of the middle phalanx. Unfortunately, these injuries are too frequently written off by the patient or providers as a so-called jammed finger and are left untreated. The soft-tissue stabilizers of the PIP joint (collateral ligaments, volar plate, central slip of the extensor tendon) are often concomitantly injured, contributing to the swelling, pain, and instability of these fracture patterns. A late-presenting PIP joint fracture dislocation has a poor chance of regaining range of motion equivalent to the unaffected fingers, with unfavorable prognosis for achieving full composite fist formation and normal function of the hand. Thus, the physician must recognize these injury patterns, obtain the proper imaging, and understand the treatment algorithm of PIP joint fracture dislocations. This article is provided as a reference for the current understanding and best practices in treating PIP joint fracture dislocations.

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ANATOMY

Proper function of the PIP joint is important to normal hand function. This is an inherently stable joint owing to the anatomic constraints that surround it.

The collateral ligament complex of the PIP joint is composed of the proper collateral and the accessory collateral ligaments. The proper collateral ligaments originate from the lateral and slightly dorsal aspect of the proximal phalangeal head just proximal to the articular surface. Its fibers course obliquely distal and volar to insert on a tubercle at the longitudinal axis of the middle phalanx, just distal to the proximal articular surface. The accessory collateral ligament arises slightly proximal and volar to the proper collateral ligament, and takes a more volar course to insert on the lateral aspect of the volar plate. In a simplified sense, the proper collateral ligament tightens with flexion, whereas the accessory collateral tightens with extension.

The anatomy of the volar plate has implications for the joint contractures that commonly occur following PIP joint fracture dislocations. The volar plate is a thick fibrocartilaginous structure that functions to prevent hyperextension of the PIP joint. It is tethered to the proximal phalanx by the checkrein ligaments proximally and laterally. The central and proximal area between these checkrein ligaments is untethered and mobile. With flexion of the PIP joint, this central-proximal part of the volar plate invaginates to allow for a greater flexion amplitude.[1] Thus, prolonged flexion and scarring of the proximal volar plate following fracture dislocation will limit the motion of the volar plate, leading to flexion contracture.[2]

Distally, the volar plate is firmly anchored onto the middle phalanx only at its lateral margins. The central portion between these distal attachments is the relatively thin fibrous portion that does not provide much structural support.

As the extensor tendon traverses the proximal phalanx, it divides into 3 slips: 2 lateral and the medial.[3] The lateral slips progress distally to join the lateral bands, whereas the medial slip (central slip) inserts into the dorsal aspect of the middle phalanx. All 3 slips act in concert to extend the PIP joint. The central slip is often disrupted from the middle phalanx during a volar fracture dislocation because the dorsal lip fragment on which it inserts is sheared off by the proximal phalangeal head. In this injury pattern, the lateral bands are no longer tethered to the extensor tendon via the triangular ligament and are thus permitted to subluxate volarly. As the lateral bands migrate volar, they shorten due to the loss of their tether to the middle phalanx. Their new contracted position volar to the axis of rotation of the PIP joint causes both a flexion at the PIP joint and extension at the distal interphalangeal (DIP) joint, causing the injury pattern known as the acute boutonniere deformity.

The articular surfaces, collateral ligaments, extrinsic tendons, and volar plate all act to confer stability to the joint. The volar plate, collateral ligaments, and central slip form a box around the PIP joint that imparts inherent strength. Each of these restraining structures originates and/or inserts in close proximity to the articular margins of the joint. Therefore, periarticular fractures can dislodge these soft-tissue restraints from the respective phalanx and lead to gross instability.

MECHANISM OF INJURY

PIP joint fracture dislocations can be divided most simply into volar, dorsal, and pilon fracture dislocations. Dorsal fracture dislocations occur far more often than their volar counterparts. As identified by Kiefhaber and Stern,[4] volar and dorsal fractures dislocations result from either shearing or avulsion, or a combination of the 2, whereas pilon fractures are pure axial loading injuries.

Mechanism of Dorsal Fracture Dislocations

Dorsal fracture dislocations (**Fig. 1**) are commonly produced by axial load with the joint held in a mild degree of flexion. The longitudinal force causes the volar lip of the middle phalanx to shear off as it impacts the head of the proximal phalanx. Patients often describe a jammed finger occurring when a ball impacts the tip of an outstretched finger. Unfortunately, these patients often reset the finger themselves and do not seek treatment until the resultant stiffness and swelling becomes unbearable, weeks to months after the initial injury.

Dorsal fracture dislocations can also occur following hyperextension injuries at the PIP joint. Rapid hyperextension leads to separation of the distal volar plate from its insertion on the middle phalanx, often with a bony avulsion.[5] However, disruption of the volar plate is not sufficient to produce dorsal dislocation unless the proper collateral ligament is also disrupted.

Mechanism of Volar Fracture Dislocations

Volar fracture dislocations (**Fig. 2**) occur far less frequently than dorsal dislocations. In these cases, the dorsal lip of the middle phalanx is sheared off by axial force applied to an extended finger, as opposed to the flexed position that leads to volar lip fractures in dorsal dislocations. The mechanism of volar fracture dislocations is thought to include