Minimally Invasive Fixation of Phalangeal Fracture

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Abstract

In phalangeal fracture the earliest and least expensive techniques for management involve immobilization followed by protected motion with splinting. Prolonged immobilization may be necessary for healing without internal fixation. Unfortunately, more than 3 weeks of immobilization can cause finger stiffness and tendon adhesions. Every effort should be made to allow finger movement by 3-4 weeks after injury. Minimal invasive methods for reduction as (percutaneous pinning, percutaneous mini screw fixation, intramedullary rodding, external fixation) can repair and/or reconstruct phalanges with decreased trauma to the tissue and gliding planes will improve and accelerate outcomes.

Key Words: Phalangeal Fracture, diagnosis, Minimally Invasive Surgical Treatment.

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ABBREVIATION

PIP: proximal inter-phalangeal

PIPJ: proximal inter-phalangeal joint

DIP: Distal inter phalangeal

MIS: Minimal invasive surgery

K -wire: Kirschner wire

PA view: Postero- anterior view

ROM: Range of movement

MCP: Meta carpo-phalangeal joint

ORIF: Open reduction internal fixation

Introduction

Fractures of the phalanges are some of the most common injuries that are presented to the hand surgeon. Ten percent of all fractures occur in the metacarpals or phalanges;representing about 80% of all hand fractures.Until the early part of the twentieth century, these fractures were treated nonoperatively. Even today the majority of phalangeal fractures are treated conservatively. ***(Yen YM, Meals RA. 2008)***

The fingers should be examined for clinical signs of trauma, including swelling, ecchymosis, areas of tenderness and crepitation. Loss of digital length indicates fracture shortening or angulation. Of great importance, the rotational alignment of the digits should be assessed with the fingers extended and flexed. Finger extension may mask rotational malalignment because of the normal divergence of the fingers. Subtle overlap may vary from individual to individual, and comparison to the contralateral side is invaluable. Standard radiographs, including posteroanterior (PA), lateral, and oblique views, and canevaluate fractures. While advanced imaging studies are not usually indicated for these fractures. ***(Cohen MS, 2007)***

Phalangeal fractures can be classified by several characteristics. Classification criteria include the fracture pattern, fracture location, and the extent of soft-tissue and/or bone contamination. An important factor determining management is whether a fracture is stable or unstable.

The earliest and least expensive techniques for management involve immobilization followed by protected motion with splinting. Prolonged immobilisation may be necessary for healing without internal fixation. Unfortunately, more than 3 weeks of immobilisation can cause finger stiffness and

tendon adhesions. Every effort should be made to allow finger movement by 3-4 weeks after injury. When a perfect anatomic reduction cannot be obtained, the minimal invasive methods for reduction as (percutaeous pinning, percutaneous mini screw fixation, intramedullary rodding, external fixation) are useful. (***Bernstein ML, Chung KC, 2006)***

Operative procedures that can repair and/or reconstruct phalanges by minimally invasive techniques with decreased trauma to the tissue and gliding planes will improve and accelerate outcomes. Novel surgical techniques and improved technologies have enhanced the field of this surgery. Factors that have lead to advances in the hand and wrist MIS included: high image quality mini C-arm, and MIS-specific devices and implants. Although there is a steep initial learning curve, precise knowledge of the anatomy and surgical techniques will allow for safe application of these procedures and faster recovery for patients. However there is some complication as Limited ROM, pin track infections, malunion, nonunion, and delayed union. ***(Tan V, Capo JT, 2008)***

Aim of the Work

In this essay the literature will be reviewed trying to assess the advantages and disadvantage of Minimally Invasive Fixation of Phalangeal Fracture.

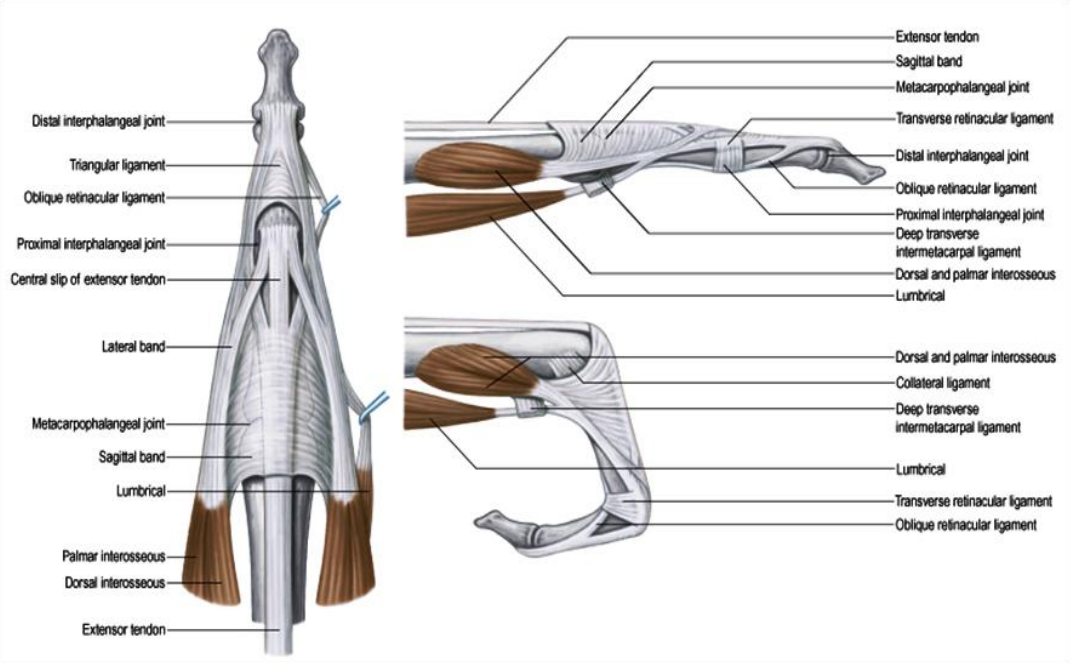
ANATOMY

The phalanges are 14 phalanges, three in each finger, and two in the thumb. Each has a head, shaft and proximal base. The shaft tapers distally, its dorsal surface transversely convex. The palmar surface is transversely flat but gently concave anteriorly in its long axis. The bases of the proximal phalanges carry concave, oval facets adapted to the metacarpal heads. Their own heads are smoothly grooved like pulleys and encroach more on to the palmar surfaces. The bases of the middle phalanges carry two concave facets separated by a smooth ridge, conforming to the heads of the proximal phalanges. The bases of the distal phalanges are adapted to the pulley-like heads of the middle phalanges. The heads of the distal phalanges are non-articular and carry a rough, crescentic palmar tuberosity to which the pulps of the fingertips are attached (Fig. 1)***(Standring S, 2008)***.

Fig 1: Standard PA projections are nicely illustrated in hand of an adult. ***(Guglielmi G. et al, 2009)***

Articular ligaments and numerous muscles are attached to the phalanges. Corresponding tendons of flexor digitorum profundus and, on its dorsal surface, extensor digitorum, are attached to the base of each distal phalanx on its palmar surface. A tendon of flexor digitorum superficialis and its fibrous sheath are attached to the sides of a middle phalanx, and a part of extensor digitorum is attached to the base dorsally. A fibrous flexor sheath is attached to the sides of a proximal phalanx, part of the corresponding dorsal interosseous is attached to its base laterally, and another dorsal interosseous is attached medially ***(Standring S, 2008)***.

The phalanges of the little finger and the thumb differ. Abductor and flexor digiti minimi are attached to the medial side of the base of the proximal phalanx of the little finger. The tendon of extensor pollicis brevis and the oblique head of adductor pollicis (dorsally), and the oblique and transverse heads of adductor pollicis, sometimes conjoined with the first palmar interosseous (medially), are attached to the base of the proximal phalanx. The margins of the proximal phalanx are not sharp, because the fibrous sheath is less strongly developed than it is in the other digits (Fig. 2) ***(Standring S, 2008)***.



(Fig. 2): Extensor mechanism of the finger***. (Standring S, 2008)***

The PIP joint is a constrained hinge joint whose stability is conferred by both the matched bone contouring at the joint interface and the capsular complex composed of stout lateral cords and mobile volar plate. The head of the proximal phalanx is cam-shaped and composed of a bicondylar head with a central groove. The doubly concave surface of the base of the middle phalanx is divided by a midline tongue to guide the joint through its eccentric arc of motion. The main lateral stabilizer of this joint is the proper collateral ligament. This ligament originates from the head of the proximal phalanx and inserts into the base of the middle phalanx ***(Gutow AP,et al, 2003)***.

The volar plate is a thick fibrocartilagenous structure distally and a thin membranous structure proximally. Distally, it has a firm attachment to the base of the middle phalanx. Proximally, it has a membranous central attachment with radial- and ulnar-sided thickened bands, the checkrein ligaments. The proper collateral ligament is joined to the volar plate by shroud-like fibers of the accessory collateral ligament. These two structures function as a composite unit to resist both the lateral and hyperextension stresses on the joint. In extension, the volar plate is tight and the collateral ligament is moderately lax ***(Gutow AP.et al, 2003)***.

As the joint flexes, the collateral ligament tightens over the larger volar condyles to seat the base of the middle phalanx firmly against the proximal phalangeal head. In flexion, the volar plate is lax. The dorsal capsule is thin and borders the proper collateral ligaments laterally. The dorsal capsule is reinforced and intimately in contact with the central tendon dorsally. The average range of motion at the PIP joint is approximately 110 degree (Fig. 3, 4) ***(Gutow AP.et al. 2003).***

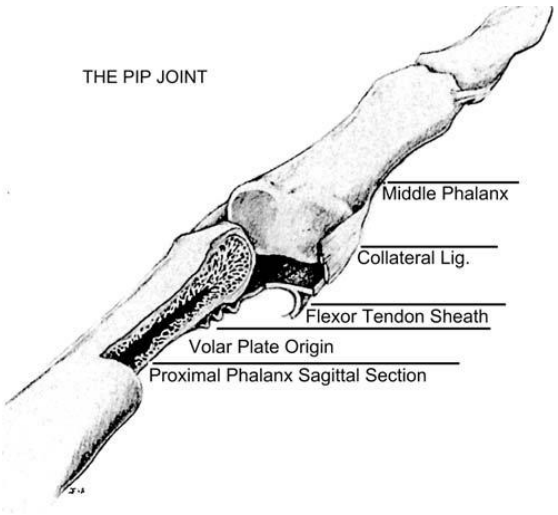


Fig3: anatomy of PIP ***(Freiberg A. et al, 2006)***

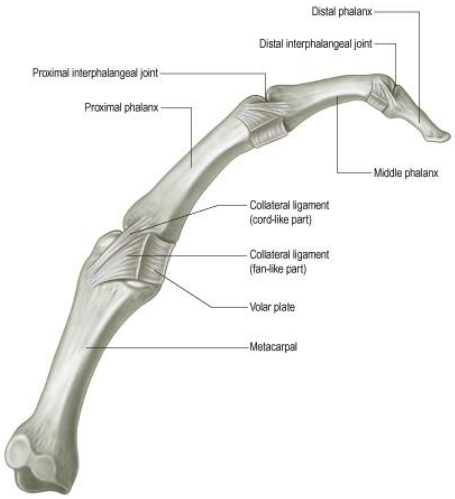


Fig 4: Metacarpophalangeal and digital joints of the left third finger: medial aspect***. (Standring S, 2008***

The metacarpophalangeal (MCP) joint is a condyloid or cam joint. The metacarpal head is eccentric, the radius and width increasing toward its palmar base. The MCP joint has a dorsal capsule that extends from the neck of the metacarpal to the base of the proximal phalanx and is reinforced by a loose insertion to the extensor tendon. The volar plate inserts on the base of the proximal phalanx with a stout attachment. Proximally, the volar plate is thin as it attaches to the neck of the metacarpal. Laterally, the volar plate is stabilized by the deep transverse intermetacarpal ligaments. The collateral ligaments complete the sides of the capsular box and are taut with flexion of the MCP joint. The stability of the MCP joint is ensured by this box-like construct. The MCP joint is weaker dorsally and ulnarly, making it vulnerable to dislocations in these directions. ***(Gutow AP.et al. 2003)***

Classification of phalangeal fractures

Mechanism of injury

Will influence the presenting fracture pattern and finger deformity. The direction of fracture angulation is determined by the imbalance across the fracture site between flexor and extensor forces. A direct blow to the dorsum of the digit will yield a transverse fracture and, depending on the magnitude of the impact, variable degrees of comminution. Combination of bending and axial compression will produce a comminuted fracture with an associated butterfly fragment. A twisting injury will cause a spiral fracture with the fracture line oriented 45 degrees to the shaft of the bone. Combination of torque and axial load will produce a short oblique fracture with variable comminution. ***(Wolfe SW .et al, 2011).***

Fractures of the Distal Phalanx

Distal phalangeal fractures are the most commonly encountered fracture in the hand. Distal phalangeal fractures can be classified into tuft fractures, shaft fractures, and intra-articular injuries.

- Tuft Fractures

Tuft fractures usually occur secondary to a crushing injury and are often associated with laceration of the nail matrix or pulp or both. Closed tuft fractures are frequently associated with a painful subungual hematoma.

- Shaft Fractures

There are two types of shaft fractures: transverse and longitudinal. Non displaced transverse fractures are sufficiently stabilized by the surrounding soft tissue and do