Fracture dislocations of the proximal interphalangeal joint are common injuries that, when inadequately understood, can be confusing for the physician to treat. Worse, inappropriate treatment can lead to a dysfunctional joint secondary to persistent pain, stiffness, and posttraumatic degenerative arthrosis. A thorough understanding of the biomechanics of the injured proximal interphalangeal joint, the principles of its treatment, and the available treatment options is essential to the proper management of these injuries.

Fracture Types and Mechanisms of Injury

Proximal interphalangeal joint (PIPJ) fracture dislocations can be classified into 3 types based on the fracture geometry of the base of the middle phalanx: (1) palmar lip fractures, (2) dorsal lip fractures, and (3) pilon fractures (Fig 1). These fracture patterns are the result of characteristic mechanisms of injury. Pure hyperextension may cause an avulsion fracture from the base of the middle phalanx. More commonly, however, PIPJ fracture dislocations occur as a result of an axial load, the specific fracture pattern depending on the amount of flexion of the PIPJ at the time of axial loading.

Palmar lip fractures at the articular base of the middle phalanx are the most frequently encountered PIPJ fracture dislocation type (Fig 1A). With hyperextension only, the palmar plate may rupture at its distal insertion on the middle phalanx, which can result in pure dorsal dislocation of the middle phalanx on the proximal phalangeal head. Alternatively, the palmar plate may avulse a fragment of bone from the palmar lip of the middle phalanx; these fracture fragments vary in size and displacement, but are generally not comminuted. Fracture dislocation of the PIPJ owing to axial loading of the joint in some degree of flexion results in a fracture of the category coined impaction shear fractures.1 In this category, an axial
load across the PIPJ drives the middle phalangeal base onto the proximal phalangeal head. Because of the flexed position of the PIPJ, the axial load creates a palmar to dorsal force gradient across the articular surface of the base of the middle phalanx with greater force concentrated at its palmar aspect. The palmar base of the middle phalanx is thus sheared off and, with continued displacement of the proximal phalangeal head, the palmar fracture fragment is then impacted into the underlying metaphyseal bone, nearly always causing fracture comminution.2 This fracture pattern may involve up to 80% of the palmar aspect of the middle phalanx base; by definition, however, the dorsal cortex and some portion of the dorsal articular surface of the base of the middle phalanx are spared. There may also be injury to the hyaline cartilage of the head of the proximal phalanx.

Dorsal lip fractures of the middle phalanx occur in an analogous fashion as palmar lip fractures (Fig 1B) though they are less common. Hyperflexion of the PIPJ may result in rupture of the central tendon through its substance or its insertion; the central tendon may also avulse a fragment of dorsal bone from the base of the middle phalanx. Axial load with the PIPJ in extension leads to a dorsal lip fracture of the base of middle phalanx from an impaction shear mechanism similar to that described for palmar lip fractures.2

Pilon fractures of the PIPJ have been defined by Stern et al3 as those in which both the palmar and dorsal cortical margins of the base of the middle phalanx are disrupted and the central articular surface is extensively comminuted and impacted into the underlying metaphyseal bone (Fig 1C).3 They result from a high-energy axial load applied to the PIPJ in full extension.

**JOINT STABILITY**

Fractures of the base of the middle phalanx may lead to instability of the proximal interphalangeal joint. Several anatomic and biomechanical factors must be considered in understanding the tendency toward subluxation or dislocation of the middle phalanx on the head of the proximal phalanx. An understanding of PIPJ stability is central to a functionally useful classification that is helpful in guiding appropriate treatment of PIPJ fracture dislocations.

In palmar lip fractures, the normally cup-shaped base of the middle phalanx is converted into one with a dorsal proximal to palmar distal orientation (Fig 2). Combining this anatomic alteration with the loss of the restraint of the palmar plate at the palmar base of the middle phalanx allows the central slip of the extensor tendon to subluxate or dislocate the base of the middle phalanx dorsally onto the head of the proximal phalanx. This tendency is facilitated by the pull of the flexor digitorum superficialis, which tilts the base of the middle phalanx dorsally about the articular margin of the fracture.4 Restoration of stability is predicated on reestablishing the palmar buttress by restoring the articular geometry of the palmar

![Figure 1. Proximal interphalangeal fracture dislocation types. (A) Palmar lip fracture with dorsal subluxation. A V-shaped gap can be appreciated between the head of the proximal phalanx and the intact dorsal base of the middle phalanx because of lack of articular congruency. (B) Dorsal lip fracture with palmar subluxation. (C) Pilon fracture. Both palmar and dorsal cortical margins are fractured and the central articular fracture fragments are impacted and comminuted. (Adapted and reprinted with permission.1)
base of the middle phalanx with respect to joint congruency and concentricity.

Given that the primary variable in the earlier-mentioned scenario is the fracture itself, it stands to reason, then, that the size of the fracture fragment(s) is the major determinant of stability of the injured PIPJ. Though in large part true, equally important is the determination of the clinical stability of the reduced PIPJ fracture dislocation by physical examination. After digital block anesthesia, the surgeon reduces the PIPJ and watches for subluxation or dislocation while the patient actively extends the joint. A true lateral radiograph of the PIPJ in full extension is then obtained to confirm stability of the reduction. If the joint subluxates or dislocates, it is necessary to identify the degree of flexion at which this occurs; use of fluoroscopy is especially helpful in this determination.

In an analogous way, dorsal lip fractures may result in subluxation or dislocation in a palmar direction. The pull of the flexor digitorum superficialis, no longer opposed by the central slip of the extensor tendon, acts to subluxate or dislocate the base of the middle phalanx palmarward.

**Classification**

Based on fracture pattern and joint stability, a classification system for fracture dislocations of the proximal interphalangeal joint has been established that is useful with respect to selection of the best option for treatment of these injuries (Table 1).1

**Palmar Lip-Fracture Classification**

This classification builds on previous ones that have stratified PIPJ fracture dislocations according to the percentage of fractured palmar articular surface at the base of the middle phalanx.4,5 Fractures that involve less than 30% are usually, but not always, stable; 30% to 50% are of tenuous stability; and greater than 50% are unstable (Fig 3). By adding the assessment of clinical stability to those based purely on anatomic criteria, this classification divides palmar lip fractures into 3 functional groups: stable, tenuous, and unstable.1

Stable fracture dislocations involve less than 30% of the palmar articular base of the middle phalanx, and, after reduction, the joint remains stable with the PIPJ fully extended. Congruent reduction of the PIPJ

---

**TABLE 1**

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Stability</th>
<th>Articular Surface Involvement</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmar lip fracture</td>
<td>Stable</td>
<td>&lt;30%</td>
<td>Reduced in full extension</td>
</tr>
<tr>
<td></td>
<td>Tenuous</td>
<td>30%-50%</td>
<td>Requires &lt;30° of flexion to maintain reduction</td>
</tr>
<tr>
<td></td>
<td>Unstable</td>
<td>30%-50% or &gt;50%</td>
<td>Requires &gt;30° of flexion to maintain reduction</td>
</tr>
<tr>
<td>Dorsal lip fracture</td>
<td>Stable</td>
<td>&lt;50%</td>
<td>Reduced in full extension</td>
</tr>
<tr>
<td></td>
<td>Unstable</td>
<td>Any percentage</td>
<td>Palmar subluxation/dislocation in full extension</td>
</tr>
<tr>
<td>Pilon fracture</td>
<td>Unstable</td>
<td>100%</td>
<td>Grossly unstable</td>
</tr>
</tbody>
</table>
should be shown by radiographs of the joint in this position.

Tenuous fracture dislocations of the PIPJ are those in which 30% to 50% of the palmar lip is fractured and, once reduced, are stable in reduction with less than 30° of flexion. Unstable fractures include all those involving greater than 50% of the articular surface, as well as those involving 30% to 50% that require greater than 30° of flexion to maintain reduction. (Adapted and reprinted with permission.)

Unstable PIPJ fractures dislocations include all fractures involving greater than 50% of the palmar joint surface of the middle phalanx, as well as those involving 30% to 50% that require greater than 30° of flexion to maintain congruent reduction.

Dorsal Lip Fracture Classification

Dorsal lip fractures differ from palmar lip fractures in that the position of maximal stability is in full extension. Further, it is usually necessary to immobilize the PIPJ in this position to reestablish continuity of the central slip of the extensor mechanism. In full extension, the PIPJ is either stable or unstable—thus, the tenuous group is eliminated.

Stable dorsal lip fractures are usually non- or minimally displaced avulsion fractures from the dorsal base of the middle phalanx involving up to 50% of the joint surface. Positioned in full extension, the PIPJ remains reduced with no evidence of palmar subluxation as shown by a true lateral radiograph.

Unstable dorsal lip fractures are any that permit palmar subluxation or dislocation of the middle phalangeal base with the middle phalanx in full extension.

**Principles of Treatment**

Of paramount importance in the treatment of proximal interphalangeal joint fracture dislocations is the correction of joint subluxation or dislocation and the maintenance of concentric reduction. Based on multiple studies, the best functional results are obtained by treatments in which the normal gliding arc of motion of the base of the middle phalanx about the head of the proximal phalanx is reestablished; with persistent subluxation of the PIPJ, motion occurs by hinging at the fracture margin and portends a poor result. Treatment, therefore, must be directed at correction of PIPJ subluxation and restoration of joint stability to permit a normal arc of joint motion. Whenever possible, early motion should be instituted to minimize adhesions and contractures and to enhance cartilage and soft-tissue healing. Anatomic reduction of the fractured articular surface, though desirable, is not a prerequisite for good PIPJ function.

**Treatment Options**

Treatment methods of proximal interphalangeal joint fracture dislocations are grouped into 5 broad categories: immobilization, protected motion, traction, open reduction and internal fixation, and buttress reconstruction (Fig 4).

**Immobilization**

Static splinting or transarticular Kirschner wire fixation may be used to immobilize the PIPJ in a reduced position. Though a simple technique, there are 2 major disadvantages of immobilization. Prolonged immobilization (>3 wks) often leads to significant permanent stiffness and loss of range of motion. Furthermore, in unstable fractures, this method is frequently unable to reliably restore stability to the joint and recurrent subluxation or dislocation often results after cessation of immobilization.

**Protected Motion**

With protected motion, the PIPJ is permitted to move in an arc through which the joint remains concentrically reduced, but is restricted from positions in which it is unstable. In those cases requiring only protection from hyperextension, buddy taping may be
A figure of 8 splint is the most simple method to treat a stable PIPJ fracture dislocation when a slight degree of flexion (ie, a PIPJ extension block) is required to maintain reduction. Both of these methods are advantageous in that they permit early motion.

McElfresh et al\(^5\) introduced the dorsal extension block splint—a short arm cast with an alumafoam dorsal PIPJ extension-blocking outrigger to permit unrestricted active flexion of the reduced PIPJ while blocking extension just short of the point at which the joint begins to subluxate dorsally. This splinting technique, as well as later modifications thereof\(^6,13\), maintains joint reduction during fracture consolidation and soft-tissue healing while encouraging early motion. Whether the dorsal blocking splint is forearm-, hand-, or digit-based, the critical component is the dorsal alumafoam over the proximal phalanx, the PIPJ, and the middle phalanx. The proximal phalanx must be well secured to the splint with tape to prevent over-extension of the PIPJ such as occurs if the proximal phalanx is allowed to pull away from the splint. Additionally, the splint must be bent at the PIPJ such that the middle phalanx is dorsally blocked from extending past the point at which subluxation occurs as confirmed by a true lateral radiograph.

By using the same concept, Viegas\(^14\) proposed extension block pinning to achieve the same effect. After reduction, the PIPJ is held at 90° of flexion, and a percutaneous Kirschner wire is then placed into the head of the proximal phalanx in a distal dorsal to proximal palmar direction, approximately 30° to the long axis of the bone; thus, the wire acts as a mechanical block to extension while allowing active flexion.

**Traction**

Many traction methods or devices have been developed that effectively maintain PIPJ reduction after fracture dislocation. Nearly all use longitudinal traction either alone or in combination with a palmarly directed force to maintain reduction, and most permit active or passive PIPJ motion. Robertson et al\(^15\) described a static traction system that uses 1 pin through the distal aspect of the middle phalanx to apply traction across the PIPJ while 2 other pins, 1 through the neck of the proximal phalanx and 1 through the base of the middle phalanx, pull in opposite directions, to correct dorsal subluxation. Schenck\(^10\) devised a system in which longitudinal traction is applied to a transosseous wire through the distal aspect of the middle phalanx to apply traction across the PIPJ while 2 other pins, 1 through the neck of the proximal phalanx and 1 through the base of the middle phalanx, pull in opposite directions, to correct dorsal subluxation. Schenck\(^10\) devised a system in which longitudinal traction is applied to a transosseous wire through the distal aspect of the middle phalanx to apply traction across the PIPJ while 2 other pins, 1 through the neck of the proximal phalanx and 1 through the base of the middle phalanx, pull in opposite directions, to correct dorsal subluxation. Schenck\(^10\) devised a system in which longitudinal traction is applied to a transosseous wire through the distal aspect of the middle phalanx to apply traction across the PIPJ while 2 other pins, 1 through the neck of the proximal phalanx and 1 through the base of the middle phalanx, pull in opposite directions, to correct dorsal subluxation.
provided a relocation force; movement of both about the arcuate frame permits passive motion of the PIPJ. Agee\(^1\) developed an ingenious linkage of 3 Kirschner wires and a rubber band to create a force couple that effects PIPJ reduction by simultaneously levering the base of the middle phalanx palmarly and lifting the head of the proximal phalanx dorsally. This force couple maintains joint reduction through a full active range of motion. Hastings and Ernst\(^1\) and Kasparyn and Hotchkiss\(^1\) have designed dynamic external fixators that simultaneously provide longitudinal traction, maintain joint reduction, and permit passive and active motion.\(^8\)

**Open Reduction and Internal Fixation**

Open reduction and internal fixation is a viable option for treatment of PIPJ fracture dislocations when there is little or no comminution and the fracture fragments are large enough to accommodate fixation. Lag screws, Kirschner wires, tension banding, cerclage wiring, and pull-out sutures have all been advocated alone or in combination.\(^19-23\) The use of interfragmentary compression screw technique has become more practical with the availability of smaller self-tapping screws with low profile heads. With open reduction and internal fixation, cancellous bone graft must often be used to fill a metaphyseal void left after elevation of a depressed fracture fragment.\(^8,19,22\) The use of a hyperextension gunstock volar approach to the PIPJ can provide superb joint visualization, though stable fixation, usually by miniscrews or cerclage wire, is important for early motion.\(^20\)

**Buttress Reconstruction**

Two unique methods have been designed for the treatment of unstable palmar lip fractures: palmar plate arthroplasty and hamate osteochondral autograft arthroplasty. Described by Eaton and Malerich,\(^24\) palmar plate arthroplasty involves advancement of the palmar plate into the defect at the base of the middle phalanx to resurface the damaged articular surface and to restrain dorsal subluxation of the joint (Fig 5A).\(^24\) The procedure and useful modifications have been well described in the literature.\(^24-26\) However, 3

---

**FIGURE 5.** Eaton palmar plate arthroplasty. (A) The palmar plate is advanced into the fracture defect in the base of the middle phalanx to resurface the articular surface and to restrain dorsal subluxation. (B) Dorsal subluxation may recur if advancement of the palmar plate is unable to adequately fill the void left by the palmar lip fracture. By filling this space with a slip of flexor digitorum superficialis (C) or bone graft or fracture fragments (D), the cup-shaped geometry of the middle phalangeal base and the palmar buttressing effect is reestablished. VP, palmar plate; P1, proximal phalanx; P2, middle phalanx; EXT, central tendon; FDS, flexor digitorum superficialis. (Adapted and reprinted with permission.\(^1\))
points warrant mention here. First, the PIPJ is subject to recurrent dorsal subluxation particularly if the palmar defect is not adequately filled by the thickness of the advanced palmar plate. This occurs as the head of the proximal phalanx forces the palmar plate into the fracture defect in the base of the middle phalanx thus allowing dorsal subluxation of the joint (Fig 5B). It is thus essential to provide unyielding support to the palmar plate arthroplasty by filling any distal bony void. Although a slip of flexor digitorum superficialis may be used to this effect (Fig 5C), it is better performed with bony fracture fragments or bone graft (Fig 5D). Second, redislocation is a real concern, especially when greater than 50% of the base of the middle phalanx is fractured. Finally, a dynamic external fixator can be used in conjunction with a palmar plate arthroplasty to initiate early range of motion.

In an effort to reconstruct the palmar buttress in unstable palmar lip fractures, Hastings et al have proposed a novel approach by using the anatomic similarity in contour between the palmar articular surface of the base of the middle phalanx and the hamate articulation with the bases of the 4th and 5th metacarpals (Fig 6). The PIPJ is first exposed through a volar approach to allow visualization of the fractured palmar articular base of the middle phalanx (Fig 6B). A dorsal approach is then used to expose the articulation between the hamate and the 4th and 5th metacarpals (Fig 6C). A small straight osteotome is then used to remove a rectangular segment of hamate at its distal articular margin centered between the 4th and 5th metacarpals. The width and depth of the articular surface of the segment should match the width and depth of the palmar lip defect of the base of the middle phalanx, and the height of the segment should be sufficient to permit secure fixation with small (~1.0-1.5 mm) screws. The palmar base of the middle phalanx is then sculpted with a small ostotome and rongeur to allow close fit of the hamate osteochondral autograft at its articular, cortical, and cancellous surfaces (Fig 6D). The graft is oriented such that its original dorsal surface becomes the new palmar surface and is trimmed at its radial and ulnar margins to reconstruct the outline of the palmar middle phalangeal base as viewed en face. Two small compression screws are then placed in a palmar to dorsal direction to fix the graft to the defect (Fig 6E). Care should be taken in fitting the graft to the defect to ensure that the cup-shaped sagittal profile of the articular base of the middle phalanx is recreated (Fig 6D and F). Properly performed, this technique provides immediate stability to the joint, thus, permitting early motion (Fig 6G and H).

TREATMENT OF PALMAR LIP FRACTURES

The goals of treatment of palmar lip fractures are to obtain and maintain concentric reduction of the joint to reestablish joint stability and a normal gliding arc of motion of the articular base of the middle phalanx about the head of the proximal phalanx. Use of the stability-based classification system for palmar lip fractures as outlined earlier, simplifies selection of an appropriate treatment modality.

Stable Palmar Lip Fractures

These fractures involve less than 30% of the palmar articular surface of the middle phalangeal base and clinical testing shows that the PIPJ remains congruently reduced throughout a full arc of motion. Therefore, treatment is focused on maximizing motion. Treatment options include static splinting, buddy taping, figure of 8 splint, and extension block splint. In 1 study, static splinting is not recommended for the treatment of stable palmar lip fractures because its use has been associated with increased stiffness when compared with buddy taping; its use has also been associated with loss of flexion and flexion contracture. This same study also showed that displacement and nonunion of the palmar lip fracture fragment had no bearing on the outcome of stable palmar lip fractures. Stable palmar lip fractures in which the PIPJ does not exhibit a tendency to hyperextend are treated with buddy taping to prevent re-injury while encouraging immediate motion. If the palmar lip fracture allows PIPJ hyperextension (which may result in a swan neck deformity if left uncorrected), we prefer to use a figure of 8 splint or a dorsal blocking splint that permits full active flexion but prevents the last 10° to 15° of extension to facilitate palmar plate healing. After 3 weeks, the splint is adjusted to allow an additional 10° of extension per week.

Tenuous Palmar Lip Fractures

These fractures involve 30% to 50% of the palmar articular surface of the middle phalanx base and clin-
FIGURE 6. Hamate osteochondral autograft arthroplasty. (A) Radiographs show an unstable palmar lip fracture. (B) Over 50% of palmar base of the middle phalanx was fractured resulting in a large defect (arrow). P1, proximal phalanx; P2, middle phalanx. (C) The hamate articulation with the bases of the 4th and 5th metacarpal is anatomically similar to the articular surface of the palmar base of the middle phalanx. H, hamate; 4, 4th metacarpal base; 5, 5th metacarpal base. (D) The hamate osteochondral autograft was used to reestablish the cup-shaped geometry of the base of the middle phalanx. (E) Two small lag screws (1.0 mm) were used to secure the hamate osteochondral autograft to the defect in the palmar base of the middle phalanx. Intraoperatively, congruent joint reduction in full extension has been restored. (F) Radiographs taken 2 months after hamate osteochondral autograft show a stable proximal interphalangeal joint with excellent anatomic restoration of the articular contour of the base of the middle phalanx. (G and H) Excellent active range of motion of the proximal interphalangeal joint was achieved. (Reprinted with permission.)
ical testing shows that the PIPJ maintains concentric reduction with less than 30° of flexion. Treatment is directed at maintaining concentric joint reduction whereas the palmar fracture fragments consolidate to restore the palmar buttress. Treatment options include static splint, transarticular pin, figure of 8 splint, extension block splint, extension block pin, traction devices, dynamic external fixation, and open reduction and internal fixation. Immobilization by static splint or transarticular pin is effective in restoring stability to the joint, but is too frequently associated with postimmobilization stiffness and is not recommended. Traction, dynamic external fixation, and open reduction and internal fixation are unnecessarily complex and require surgical intervention with all of its attendant risks.

We prefer the simple but effective method of extension block splinting for treatment of tenuous palmar lip fractures.5,6,13 Regardless of the specific splint design used (ie, forearm-, hand-, or digit-based), the proximal phalanx should be securely bound to the splint to prevent the digit from pulling away from the splint and inadvertently permitting more than the desired degree of extension at the PIPJ (Fig 7). Once the fracture dislocation has been reduced, and the dorsal blocking splint applied, it is important to confirm with true lateral radiographs that the PIPJ is concentrically reduced at the point of maximum extension allowed by the splint. Dorsal subluxation of the middle phalanx must be corrected by increasing the flexion angle of the splint. If greater than 30° of flexion is required to achieve and maintain reduction, the fracture dislocation should be reclassified as unstable, and an appropriate treatment method selected. The limit of extension on the splint should be increased 10° weekly with radiographic confirmation of joint reduction at each change. If subluxation recurs at any interval, the splint is restored to its previous angle. Once the PIPJ has attained full stable extension (usually 6-8 wks), the splint is discontinued, and
buddy taping used to protect the joint for another several weeks.

In a technical variation of extension block splinting, extension block pinning, as advocated by Viegas,\textsuperscript{14} may be used to treat tenuous palmar lip fractures. Active flexion of thePIPJ is encouraged during the 4- to 6-week period that the extension block pin is in place. Thereafter, active and passive range of motion exercises are used to regain full extension.

**Unstable Palmar Lip Fractures**

This group of fractures involves all those involving greater than 50% of the palmar articlar surface of the middle phalanx base and those involving 30% to 50%, which require more than 30° of flexion to maintain concentric reduction of the PIPJ. Treatment is aimed at restoring the stabilizing cup-shaped geometry of the base of the middle phalanx by reconstructing its palmar deficiency, which is responsible for the instability of these fractures. Treatment options include open reduction and internal fixation, palmar plate arthroplasty, and hamate osteochondral autograft arthroplasty. Traction or dynamic external fixation may also be used alone or in conjunction with any of the earlier-mentioned methods.

When fracture fragments are of sufficient size to accommodate fixation with screws, Kirschner wires, tension band wires, cerclage wires, or pull-out wires, open reduction and internal fixation\textsuperscript{20} should be used to restore the palmar buttress. Frequently, however, one finds small, comminuted, and impacted fragments that require alternative techniques. In cases with one relatively large fragment volarly and comminution of the middle aspect of the joint, cerclage wiring, as described by Weiss, can provide a stable construct providing interfragmentary compression and allowing early range of motion\textsuperscript{22} (Fig 8).

If traction across the PIPJ is able to effect both fracture alignment by ligamentotaxis and concentric joint reduction, traction or dynamic external fixation may be used to maintain concentric joint reduction while the fracture heals. When this is unsuccessful, restoration of stable geometry to the base of the middle phalanx requires a reconstructive procedure such as palmar plate arthroplasty or hamate osteochondral autograft arthroplasty. Immediately after restoration or reconstruction of the palmar base of the middle phalanx, dynamic external fixation may be

---

**FIGURE 7.** When using an extension block splint, the proximal phalanx must be firmly affixed to the splint with tape to prevent loss of extension blocking by pulling away of the finger from the splint.
used to maintain joint reduction, protect the healing bone and soft tissues, and institute early active and passive range of motion exercises.

**TREATMENT OF CHRONIC DORSAL FRACTURE DISLOCATIONS**

Palmar lip fractures with associated dorsal PIPJ dislocations that are missed, neglected, or incorrectly treated lead to chronic dorsal fracture dislocations. In such cases, joint flexion is limited to that allowed by hinging or pivoting of the middle phalangeal base about the dorsal margin of the fracture resulting in articular erosion and joint stiffness. In deciding treatment for a chronic PIPJ fracture dislocation, it is first necessary to determine whether or not the remaining articular surfaces have undergone significant degenerative changes based on radiographic assessment. With significant post-traumatic arthrosis, silicone implant arthroplasty\(^3\) or arthrodesis\(^3\) may be better options. If the remaining articular surface quality is good, the goals of treatment are, once again, to obtain and to maintain concentric PIPJ reduction to restore functional motion. Donaldson and Millender\(^3\) performed open reduction through a lateral approach by clearing the palmar retrocondylar space of proximal phalanx of scar and adhesions, dorsal capsulotomy, and extensor tenolysis. Stability was maintained by a transarticular pin placed with the joint at 90° of flexion for less than 2 weeks. Then, a dorsal extension block splint at 60° was initiated allowing active flexion; the angle was gradually decreased over a 4-week period after which immobilization was discontinued. Others have used corrective osteotomy\(^3\) or palmar plate arthroplasty\(^3\) to reestablish the cup-shaped geometry of the base of the middle phalanx to restore stability to the joint. Zemel et al\(^3\) proposed corrective osteotomy in which the palmar articular surface and the central depressed articular fragments are levered back into position and supported by distal radius bone graft. Our preferred method is palmar plate arthroplasty because it simultaneously resurfaces the palmar articular surface of the middle phalanx, restores the palmar buttress, and tightens the palmar plate. Though current experience is limited, we have also successfully used hamate osteochondral autograft arthroplasty for chronic dorsal fracture dislocations of the PIPJ.

**TREATMENT OF DORSAL LIP FRACTURES**

As with palmar lip fractures, the goals of treatment of dorsal lip fractures are to obtain and maintain concentric reduction of the joint to reestablish joint

---

**FIGURE 8.** In highly comminuted fractures of the base of the middle phalanx, a 22-gauge steel cerclage wire can be used to stabilize the fragments by providing circumferential compression with wire tightening.
stability. In addition, continuity of the central slip of the extensor apparatus must be reestablished.

**Stable Fractures**

The PIPJ does not show palmar subluxation with stable dorsal lip fractures. Therefore, the primary treatment goal is to reestablish continuity of the central slip. Though the fracture fragment may vary in size, most are not significantly comminuted and will heal with osseous or stable fibrous union. At issue, however, is the amount of fragment separation acceptable with respect to compromise of central slip function.

In our experience, stable dorsal lip fractures with less than 2 mm of fragment separation may be treated by immobilization of the PIPJ in extension by splint or transarticular Kirschner wire with acceptable results. Duration of immobilization should be 3 to 4 weeks, after which a dynamic extension splint should be placed to permit active flexion. At 6 weeks, passive flexion and strengthening exercises should be initiated. It should be noted that immobilization must not include the distal interphalangeal joint, which should be started immediately on active and passive range-of-motion exercises.

In dorsal lip fractures with fragment displacement greater than 2 mm, unacceptable extensor lag may result unless treated with open reduction and internal fixation. Fixation options include Kirschner wires with or without a tension band wire, loop wire, pull-out suture, suture anchor, or lag screws; with stable fixation, immediate postoperative motion is initiated.

**Unstable Fractures**

If the PIPJ is subluxated or dislocated anteriorly after closed reduction, it is by definition unstable. Treatment is directed at obtaining and maintaining concentric joint reduction to restore integrity of the central slip. If the fracture fragments are large enough, this is achieved by open reduction and internal fixation. Highly comminuted fractures may be treated by closed reduction and percutaneous pinning with the PIPJ in full extension to allow consolidation of the fracture fragments and the insertion of the central slip if the dorsal buttress of the base of the middle phalanx is restored by reduction of the joint. When this is not the case, some investigators have proposed fragment elevation with bone grafting, or central slip suture into the fracture bed. These methods have been associated with considerable postoperative stiffness; use of a dynamic external fixator has been advocated to limit stiffness and PIPJ contracture. Alternatively, in cases in which the fracture fragment is displaced less than 2 mm and moves with the base of the middle phalanx, traction and immediate motion have been used successfully to correct joint subluxation and restore joint stability with minimal extensor lag.

**TREATMENT OF Pilon Fractures**

Pilon fractures involve both palmar and dorsal lip fractures with extensive central depression and comminution and are unstable. The goal of treatment is to reestablish a concentric gliding arc of motion of the base of the middle phalanx about the head of the proximal phalanx. To achieve this goal, the proximal and middle phalanges must be collinear and the palmar and dorsal fracture fragments must realign to reapproximate the cup-shaped geometry of the base of the middle phalanx. Exact anatomic reduction of the joint surface is far less important than the institution of early motion. Traction accomplishes these prerequisites and has been shown to be effective in treating pilon fractures.

Although any of the traction methods described may be used successfully to treat pilon fractures, certain principles apply to all. Splint immobilization is to be discouraged; Traction is a reasonable alternative and is our treatment of choice. It should effect collinear alignment of the proximal and middle phalanges with no angulation in the coronal plane as well as good overall alignment of the fracture fragments in the sagittal plane as shown by radiographs. The traction method chosen should permit immediate mobilization of the joint. Traction is discontinued at 6 weeks when the fracture fragments have consolidated; aggressive range-of-motion exercises are continued. Treated as such, these fractures frequently remodel, resulting in an acceptable arc of motion with minimal pain.

Although not contraindicated, we have found open reduction and internal fixation risky, and complications such as loss of reduction, stiffness, and infection can arise.

**ACKNOWLEDGMENT**

The authors thank T. R. Kiefhaber, MD, for sharing his photographs and illustrations.
REFERENCES


