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## Case Report

## Bridge Plating of a First Proximal Phalanx Intra-articular Base Fracture—Benefits Over External Fixation

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A 62-year-old right-handed man presented with an intra-articular fracture of the proximal phalanx base of the right thumb after a motor vehicle accident. Computed tomography revealed severe comminution, apex volar angulation, and minimal bone stock at the proximal phalanx base. The patient consented to open reduction internal fixation with a locking plate to bridge the fracture and cancellous bone grafting of the distal radius. The hardware was removed at 8 weeks, without complications. The patient began therapy, and at 19 weeks following the surgery, the patient's thumb metacarpophalangeal joint motion was 10° to 30° and the interphalangeal motion was 30° to 50°. Radiographs showed fracture union and proper alignment, with modest shortening. The patient was satisfied with this result. Bridge plating may be an alternative to external fixation for certain thumb fractures, with the potential to maintain alignment and articular congruity while permitting earlier return to activities of daily living and avoiding the risk of pin-track infections.

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Phalanx fractures are the second most common fracture of the upper extremities.<sup>1</sup> Proximal phalanx fractures often result in more substantial deformities than middle and distal phalanx fractures. Surgical treatment is considered in cases with significant coronal or sagittal plane angulation, malrotation, shortening, or intra-articular displacement.<sup>2</sup>

Bridge plate fixation is an effective surgical treatment option for other upper-extremity injuries such as unstable, comminuted distal radius fractures.<sup>3</sup> Bridge plates provide relative stability, length, and alignment while preserving blood supply to the fracture site and spanning comminuted fragments. The bridge plate is typically removed after fracture healing is confirmed, and rehabilitation is initiated to restore range of motion (ROM) and strength.

Although external fixation could be an option for proximal phalanx fractures such as the one presented here, we questioned its ability to maintain alignment in this setting and saw a role instead

for bridge plate fixation. The thumb is unique compared with the other digits for what may be theoretically increased tolerance for bridge plate fixation for reasons elucidated below. This case report describes a comminuted intra-articular base fracture of the first proximal phalanx treated with bridge plating.

### Case Report

#### Consent

Written informed consent was obtained from the patient to publish this case report and accompanying images.

A 62-year-old right-handed man with a medical history of diabetes mellitus presented to the clinic with pain and swelling in the right thumb 2 weeks after a motor vehicle accident. He observed a deformity in his right thumb immediately; however, there was a delay in presentation by 14 days. The patient had diffuse swelling, pain with all activities, and guarding at presentation.

On examination, the patient had a healed superficial laceration over the right first dorsal web space but no sign of open fracture. There was an obvious deformity, with minimal tolerable ROM throughout the thumb; however, the flexion and extension of the interphalangeal (IP) joint were intact. The proximal phalanx was

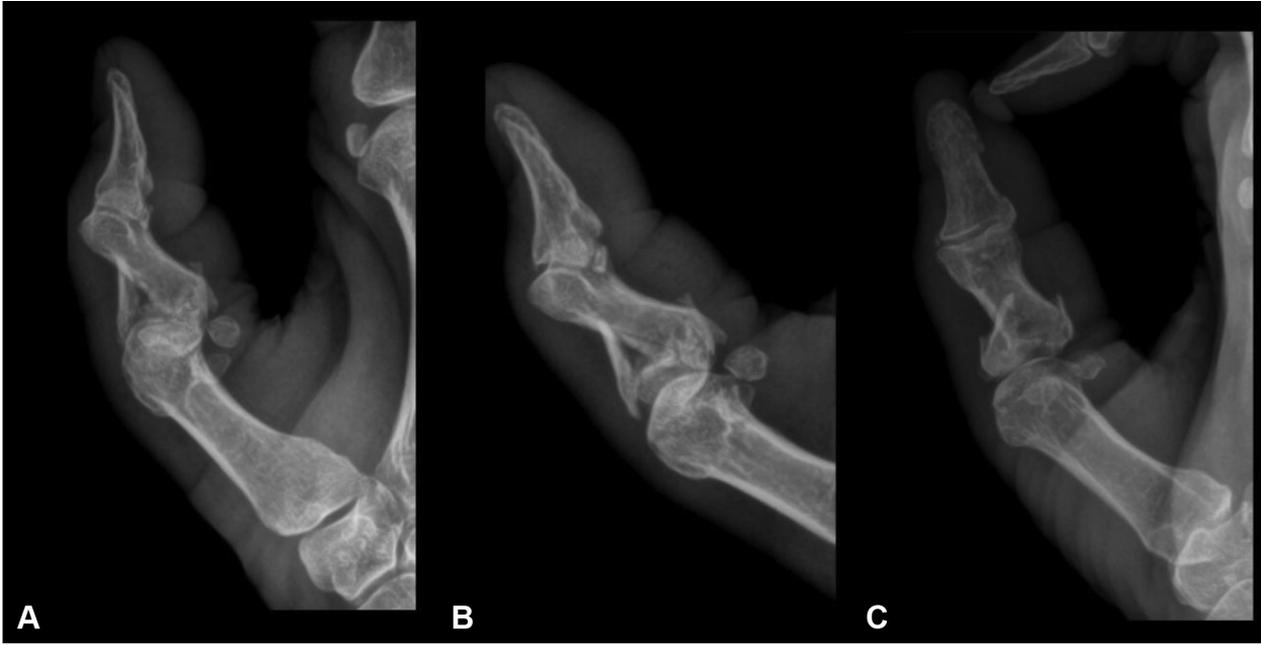
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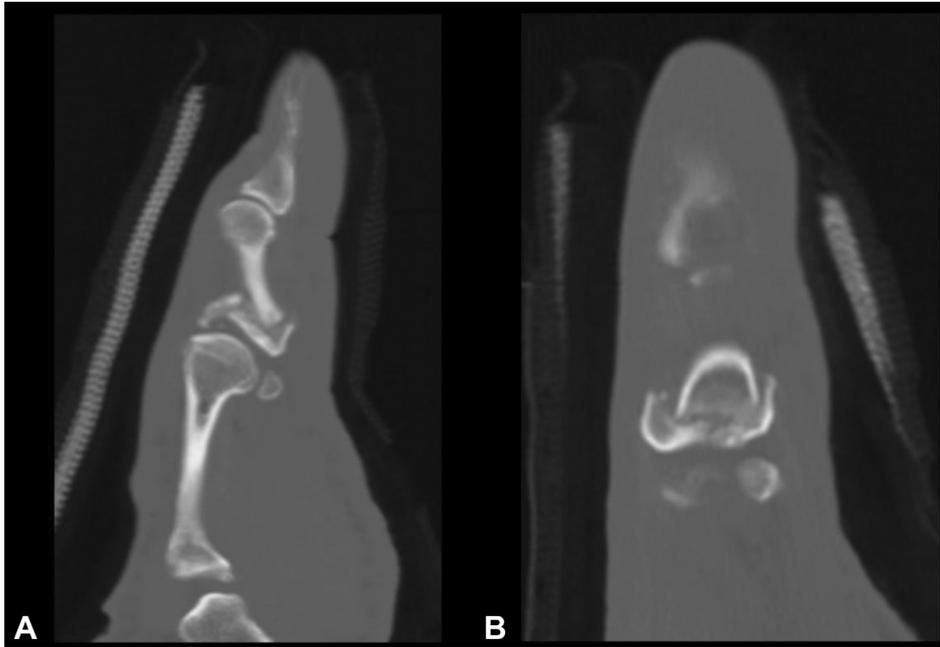
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**Figure 1.** Preoperative hand x-rays—**A** posteroanterior, **B** oblique, and **C** lateral views—demonstrated a first proximal phalanx base fracture with comminution.



**Figure 2.** Preoperative hand computed tomographic scans—**A** sagittal and **B** coronal views—demonstrated comminution with minimal bone stock at the base of the first proximal phalanx.

tender to palpation, and a neurovascular examination yielded normal results.

Radiographs (Fig. 1) and computed tomography scans (Figs. 2, 3) revealed an acute, severely comminuted fracture of the proximal phalanx, with impaction, apex volar angulation, and intra-articular extension into the metacarpophalangeal (MCP) joint. An articular displacement of 2–3 mm was present, without significant depression.

Because of the subacute presentation, comminution, and the risk of malunion, open reduction internal fixation (ORIF) was

pursued. Insufficient bone stock at the proximal phalanx base obviated plate and screw fixation. The anticipation of prolonged bony consolidation and significant force required to maintain reduction in the subacute setting precluded an open reduction with external fixation or pin fixation and bone grafting. Therefore, ORIF with bridge plating and bone grafting was selected, and the patient consented appropriately. The patient was operated on 25 days after injury because of scheduling conflicts.

During the surgery, the extensor tendon splitting approach was used. Subperiosteal dissection was necessary based on the time



**Figure 3. A and B** Preoperative 3-dimensional computed tomographic reconstruction of the first proximal phalanx further demonstrated extension into the MCP joint, comminution, and lack of proximal bone stock.

from injury to presentation. After mobilizing and aligning the fracture fragments, a 2.0-mm locking plate (Synthes) was applied to the distal aspect of the proximal phalanx using fluoroscopy (Fig. 4). With the plate clamped to the distal metacarpal, gentle traction and subtle correction achieved appropriate plate alignment, at which point 3 fixation screws were applied proximally and 4 distally. The proximal articular fragments were too comminuted for plate or pin fixation; so, a cancellous bone graft harvested from the distal radius backfilled and supported the reduced articular segments.

At 2 weeks of follow-up, the skin envelope was healthy, and the patient generated 60° of radial abduction at the thumb carpometacarpal joint, and the IP joint motion ranged from 10° to 40°. Anteroposterior, lateral, and oblique radiographs of the thumb demonstrated stable fracture alignment, and the bridge plate was situated with no interval changes.

At 6 weeks of follow-up, the fracture was appropriately consolidating, ROM at the IP joint was 10° to 40°, and thumb radial abduction was 60° bilaterally. The decision was to proceed with hardware removal and extensor tenolysis 8 weeks after ORIF.

The patient was seen again 1 week after hardware removal (9 weeks after ORIF). Hand therapy was then initiated thrice weekly, in addition to a home exercise program for unrestricted active and passive ROM and a hand-based static thermoplastic orthosis for protection starting the day after hardware removal. Orthosis fabrication continued until the final postoperative visit. The ROM at the thumb MCP joint was 0° to 35°, ROM at the IP joint was 30°–50°, and thumb radial abduction was 60°. Radiographs of the right thumb demonstrated a healing fracture of the proximal phalanx base, with no loss of reduction, and good MCP joint articular congruity (Fig. 5).

At the final postoperative visit, 6 weeks after hardware removal (14 weeks after ORIF), the patient was doing well clinically, with subjective thumb stiffness but no pain. The patient completed hand therapy and was pleased with his functional level. The ROM at the thumb MCP joint was 10°–30°, and the ROM at the IP joint was 30°–50°. An anteroposterior radiograph demonstrated some interval collapse (Fig. 6).

## Discussion

Bridge plate fixation has gained popularity in the treatment of certain distal radius fractures and complex wrist injuries and, more recently, hand fractures, with promising benefits in large patient

cohorts. For example, in a meta-analysis of 895 patients, Wang and Ilyas<sup>4</sup> found that bridge plating was comparable with external fixation for distal radius fractures and had a lower complication profile.

Bridge plating confers advantages over traditional external fixation, namely, it avoids pin-track infections and the inconvenience of prominent hardware and can maintain fracture alignment longer. From the patient's perspective, bridge plating may permit earlier weight bearing and return to work given the increased rigidity compared with external fixation. However, the main disadvantages of bridge plates are the need for a secondary operation for plate removal and potential scarring to adjacent soft tissues, including tendons. Additionally, bridge plating requires more open exposure than external fixation, thereby contraindicated in compromised soft tissues.

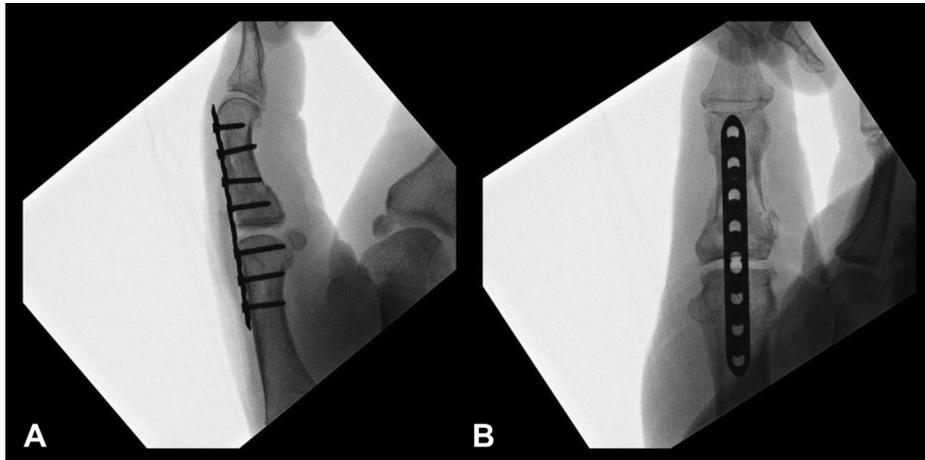
When external fixation is performed for proximal phalanx fractures of the thumb, the most common complications are loss of motion, followed by malunion (secondary to angulation or shortening).<sup>5</sup> These fractures are subject to deforming forces that contribute to apex volar angulation. Specifically, the proximal fragment is flexed by intrinsic insertion into the base of the proximal phalanx, and the distal fragment is often hyperextended by the extensor pollicis longus.<sup>6</sup>

From an anatomic and biomechanics stand point, of all the digits, the thumb is most amenable to spanning bridge plate fixation. Motion about the MCP joint is comparably less crucial for thumb function, and the extensor mechanism may have a greater tolerance for hardware. For example, dorsal thumb MCP arthrodesis with plate and screw fixation is well tolerated and retains adequate ROM and extensor tendon excursion at the IP joint. As opposed to the thumb—where a bridge plate across the MCP joint can be placed in neutral extension, providing ease of obtaining length and alignment correction—a bridge plate would need to ideally be contoured into deliberate flexion for the lesser digits to avoid MCP extension contracture. Doing so would likely make fracture reduction and length restoration challenging. Moreover, the extensor mechanisms of the lesser digits are less tolerant to hardware in general and often lead to tendon adhesions even with plate and screw fixation. For these reasons, the thumb may tolerate and benefit from bridge plating compared with the other digits.

Bridge plating has been previously reported in the management of other hand fractures. Jung et al<sup>7</sup> reported 16 patients with hamatometacarpal fracture dislocations, which were treated with bridge plating. There were no cases of residual dorsal subluxation using this technique in their report. All the patients returned to work within 5 weeks, their grip strength recovered to 90% of the uninjured hand, and no patients complained of finger or wrist joint stiffness.

Selverian and Jones<sup>8</sup> also recently reported a case of an unstable proximal IP fracture dislocation of the ring finger. Specifically, the fracture pattern was a comminuted, impacted middle phalanx volar base with dorsal subluxation. Although this report was limited by lack of follow-up after 2 weeks after surgery, the patient returned to work and had no complaints. The authors' primary reason for using a bridge plate over the typical hemihamate reconstruction was their patient's refusal to have exposed wires and significant postoperative motion restrictions. At 9 months of follow-up, the patient had a usable finger, without pain.

Ozer<sup>9</sup> reported a case of a pilon fracture of the third proximal IP joint, which was managed with bridge plating. The patient's preoperative radiographs were consistent with pilon fracture, displaying comminution and depression of the articular surface of the base of the middle phalanx. At 1 year of follow-up, the patient had no pain, maintained a 90% arc of active motion at the proximal IP joint, and was satisfied with the outcome.



**Figure 4.** Intraoperative fluoroscopy, **A** posteroanterior and **B** lateral views, demonstrated successful application of bridge plates.



**Figure 5.** **A** Posteroanterior and **B** lateral hand x-rays after plate removal, 9 weeks after the initial operation, demonstrated preservation of joint congruity, fracture stability, and bony geometry.

Of note, our patient experienced a loss of reduction from the 9- and 14-week visits after ORIF. However, the patient did not have pain and retained motion and function. Although surprising, this collapse exemplifies the slow pace of bony union, even with autografting, and further supports the value of bridge plate fixation, with its ability to maintain prolonged stability. Likewise, we used a nonvascularized, cancellous bone graft, which may have contributed to shortening because these are typically resorbed over time. In retrospect, the patient may have benefited from prolonged bridge plating and an additional computed tomography scan for the assessment of union before hardware removal.

The success of case reports, including ours, supports the use of bridge plates over traditional external fixators in the management of certain hand fractures. Future studies should compare the outcomes between these methods in a randomized and controlled fashion.



**Figure 6.** **A** Posteroanterior and **B** lateral x-rays 14 weeks after surgery demonstrated healing fracture union, with some fracture collapse, compared with the previous set of images.

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