

Needle-in-needle Pinning Technique Using Disposable Hypodermic Needles for Fractures of Distal Phalanx With Dorsal Disruption

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Abstract: Fingertip injuries are frequently encountered by the hand surgeon, and often present with a combination of the following: avulsed or broken nail plate, nail bed disruption, and/or distal phalangeal fracture. Recommended management of these injuries consists of reduction of the fracture followed by repair of soft tissues. To achieve an anatomic reduction and sufficient stability of the fracture, current management consists of temporary Kirschner-wire stabilization. Hypodermic needles can be substituted to secure temporary transosseous fixation. We describe a technique for stabilizing open distal phalangeal fracture using hypodermic needles which are readily available. Eight patients over 12 months have been treated with this technique which has proven to be successful. We would advocate that providers consider this technique when Kirschner-wires or other necessary instruments are unavailable.

Key Words: nail disruption, nail bed injury, distal phalangeal fracture, hypodermic needle, pinning

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The fingertip is one of the most important structures for prehension. Fingertip injuries often present with a combination of avulsed or broken nail plate, nail bed disruption, and/or distal phalangeal fracture. In a previous study, 51% of nail bed injuries are accompanied by an underlying distal phalangeal fracture,¹ owing to the vicinity of those structures. Fractures are frequently open.² Most common mechanisms of injuries include in descending order: crush injury, laceration, or a penetrating injury—frequently related to occupational activities.³

Fingertip stability is important for prehension, and appropriate and timely treatment may help to prevent nonunion and minimize nail plate deformities.⁴ Current management is often performed in the operating room to debride the open fracture site, obtain anatomic reduction and stable fixation with Kirschner (K)-wires and repair the nail bed. We suggest an alternative technique, in which hypodermic needles can be utilized as a substitute for K-wires to secure temporary transosseous fixation and allow bony stability for healing. The hypodermic needles are

inexpensive and invariably available. This technique can be completed immediately in the emergency department or even in the office setting without the use of fluoroscopy.

ANATOMY

Fingertips injuries with nail disruptions are often accompanied by various degrees of fractures of the distal phalanx and potentially can be open injuries. As part of a thorough evaluation of these injuries, radiographs are of paramount importance to assess for associated fractures as well as rule out retained foreign bodies.

To describe the injury, we propose that all injuries are classified into 3 stages according to a depth of injury in the sagittal plane (Fig. 1).

Stage 1 (Superficial)

An injury confined to dorsal soft tissue including nail bed (sterile matrix and/or germinal matrix). The distal phalangeal fracture may include nondisplaced fracture or partial bone loss of the dorsal cortex, which maintain the alignment and continuity of the distal phalangeal bone.

Stage 2 (Deep)

The injury goes deeper onto the level of volar soft tissue and through the distal phalangeal open fracture. The distal phalangeal bone and dorsal soft tissue were involved remaining attached by unscathed or little injured volar soft tissue. The fracture in this stage includes small segmental bone loss which can cause skeletal shortening of the digit.

Stage 3 (Near-amputation)

The more extensive injury involves volar soft tissue, remaining attached by only a narrow bridge of palmar soft tissue.⁵ Associated soft tissue injury on palmar aspect, especially neurovascular injury, which would be predisposed to distal part nonunion or necrosis in the distal phalanx.⁶ This stage should be considered for other intervention such as replantation when

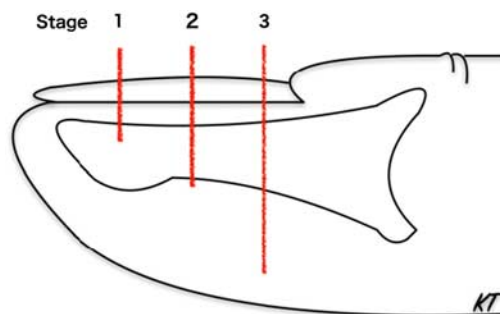


FIGURE 1. Schematic diagram of 3 stages for dorsal injury on a sagittal section of the fingertip. These stages refer only to the depth of injury and not to the proximal-distal extent.

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appropriate, composite grafting, local flap advancement, or revision amputation.

INDICATIONS AND CONTRAINDICATIONS

Our indications for this technique were patients with a stage 2 injury. The following presentations are not suitable for the described technique: distal tuft fracture, comminuted fracture, longitudinal fracture, substantial bone loss, and/or significant tissue loss. In addition, contraindications for this procedure are nonunion, severely mangled digits, and digits with active infection or severe contamination—in these instances, we would recommend alternative treatment strategies.

TECHNIQUE

Before proceeding with the described technique, the affected digit is thoroughly cleansed and irrigated copiously with normal saline. As with any invasive procedure, sterile preparation and technique must be considered to reduce the risk for potential infection. Appropriate analgesia is performed utilizing a digital block. A finger tourniquet is applied and the physician should be cognizant of application and its timely removal at the conclusion of the procedure. If there is a disrupted or avulsed nail plate, it is gently removed from its eponychium and paronychia for nail bed repair. If any foreign bodies or tiny fracture fragments were seen, they were removed under direct vision with careful handling of remaining volar soft tissue.

Readily available hypodermic needles are prepared for this technique. The 18 gauge (G) needles (inner diameter, 0.8 mm⁷) are most suitable for the following procedure. Considering outer and inner diameters of general hypodermic needles, 18 and 22 G (outer diameter, 0.70 mm) or 23 G (outer diameter, 0.65 mm) needles are the best combinations to perform the following procedure. The thicker 22 G needle may be less likely to bend during the procedure than a 23 G needle.

A smaller needle is then driven antegrade into a distal fragment of distal phalangeal fracture from the injured cut surface (Fig. 2). During insertion of the needle, if resistance is encountered, it is important not to apply an excessive force

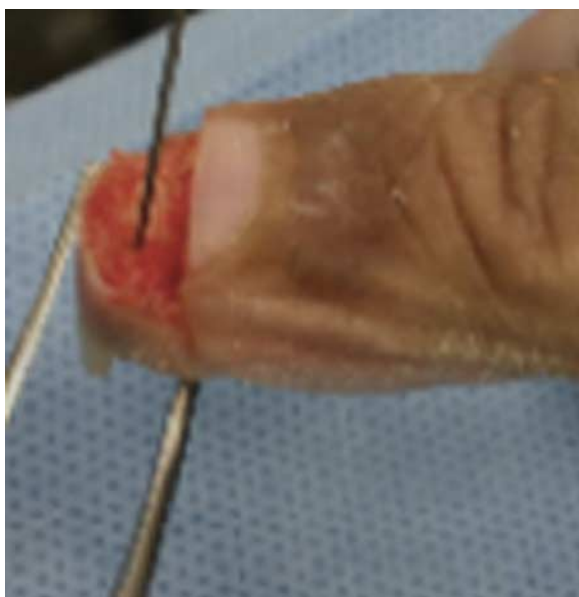


FIGURE 2. A smaller needle is driven into the distal fragment from the injured cut surface.



FIGURE 3. The needle is advanced carefully through the distal fragment.

which may lead to needle breakage. The authors recommend rotation of the needle to help facilitate insertion during this critical portion. The needle is advanced through the distal fragment carefully and penetrated out of the skin (Fig. 3). If the fracture requires 2 needles for stabilization, at this step the second needle should be inserted in the same fashion.

Subsequently, a larger needle is inserted over the smaller needle from the fingertip (Figs. 4A, B). The use of the inner followed by outer needles function as a trocar with “stylet and cannula” where the initially placed smaller needle provides the track to guide the larger needle as the fracture is reduced and the larger needle maintained for stabilization. A key point to prevent needle stick injury for physicians while guiding the needles is the plastic hub located at the base of each needle. While pushing the larger needle through the smaller needle, the sharp tip of the smaller needle is always safely covered with the hub of the larger needle unless significant discrepancy of the lengths between smaller and larger needles. Thus, similar or same length of the needles (usually 38 mm) are recommended.

After the larger needle was inserted through the distal fragment, the smaller needle is removed (Fig. 5). The larger needle is passed across the fracture site while holding the reduction and inserted into the proximal fragment, engaging subchondral bone but not crossing the adjacent joint (Figs. 6A, B). The plastic hub is then removed cutting with a wire cutter or wiggling and breaking

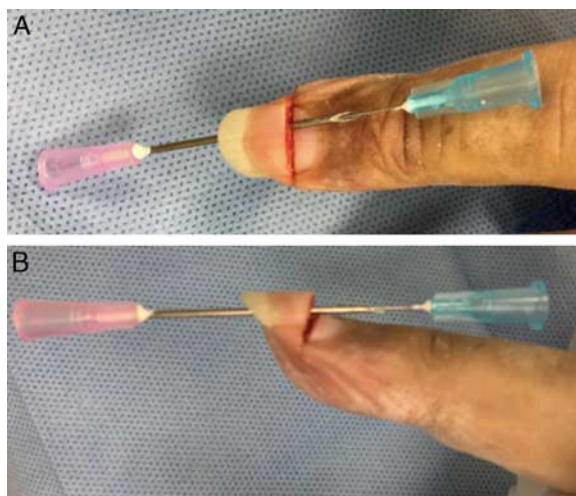


FIGURE 4. A larger needle is inserted over the smaller needle from the fingertip (A: dorsal view, B: lateral view).

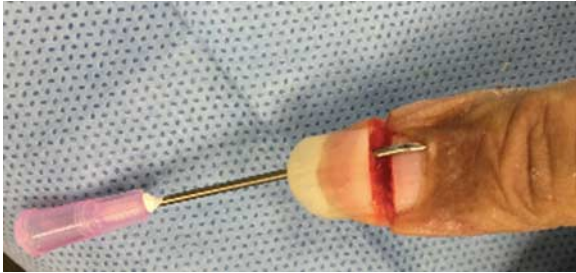


FIGURE 5. The smaller needle is removed.

its connection with the needle while holding the needle part just out of the skin of the fingertip. The importance of gentle handling of the fragile connecting volar soft tissue throughout the procedure should be emphasized.

This technique can be performed manually without the use of fluoroscopy. Only a 22 G needle and an 18 G needle are usually needed for the whole procedure. However, if great resistance is felt while advancing the needle, one should change it to a new needle which has a sharp point tip.

Nail bed lacerations are then repaired meticulously with small absorbable sutures. The skin lacerations are approximated. Replacing the nail plate underneath the eponychium is generally recommended, to cover the exposed nail bed and to keep the nail fold open.⁸ The nail plate has a role as the natural splint⁸ if it is intact. If the nail is broken or detached, it can be repaired with tissue adhesive glue after cleansing,⁹ or only the proximal part of the broken nail is replaced. Nonadherent gauze, part of a sterile glove or silicone sheet can be used as a substitute for the nail plate for a few weeks.¹

Finally, the wound is covered with a sterile dressing. The retained needle can also function as a drain following wound closure. Following completion of the procedure, radiography should be obtained to confirm proper needle placement and adequate reduction of the fracture. We recommend postoperative immobilization with a dorsal aluminum splint at the distal interphalangeal joint with the proximal interphalangeal joint free. The splint is applied beyond the tip so as to protect the fingertip

and the needle end. Range of motion exercises are generally recommended within 48 hours following the procedure.

OUTCOMES

Between January 2018 and December 2018, 8 fingers (4 thumbs, 3 ring fingers, 1 index finger) of 8 patients with an open fracture of the distal phalanx with dorsal disruption (stage 2 injuries) who presented acutely following injury.

They underwent treatment with the described technique at the time of the first visit. There were 6 men and 2 women with an average age of 45.0 years (range, 32 to 60 y). None had undergone previous surgery or trauma of the involved digit. Two needles for a fracture were placed in 1 case with thumb injury (Figs. 7A–D).

No needle breakage occurred throughout the procedure except in 1 case, a 23 G stylet trocar needle was bent at its connection while driving through the distal fragment. The whole needle was removed and discarded and changed to a fresh 22 G needle and the procedure was successfully completed. It is imperative during needle insertion to exchange bent or dull needles to prevent breakage.

All procedures were performed by a single surgeon under digital block and patients were followed up for a minimum of 3 months. Following informed consent was obtained for each patient, postoperative outcomes were retrospectively evaluated.

Criteria for needle removal was determined either clinically when the patient no longer exhibited tenderness to palpation at the injury, and callus formation was noted radiographically or after a period of 8 weeks following insertion. The needles were removed at 4.8 weeks on average (range, 3 to 8 wk). In 2 cases, the needles got loose and fell out at 4 and 8 weeks respectively.

All patients were given oral antibiotics for 3 days. Minimal dressing with the bandage was applied with the aluminum splint. The dressings were changed regularly and the aluminum splint was removed 2 weeks after the procedure. They were advised to keep the fingertip clean, dry, and covered with bandage or adhesive tape until the needle removal. There was no evidence of infection clinically or radiographically in all cases.



FIGURE 6. The larger needle is then inserted into the proximal fragment. Note a good coaptation of the lacerated nail plate (A: dorsal view, B: lateral view). Radiograph showing lateral view (C) of the reduced distal phalangeal bone with an 18 G needle.

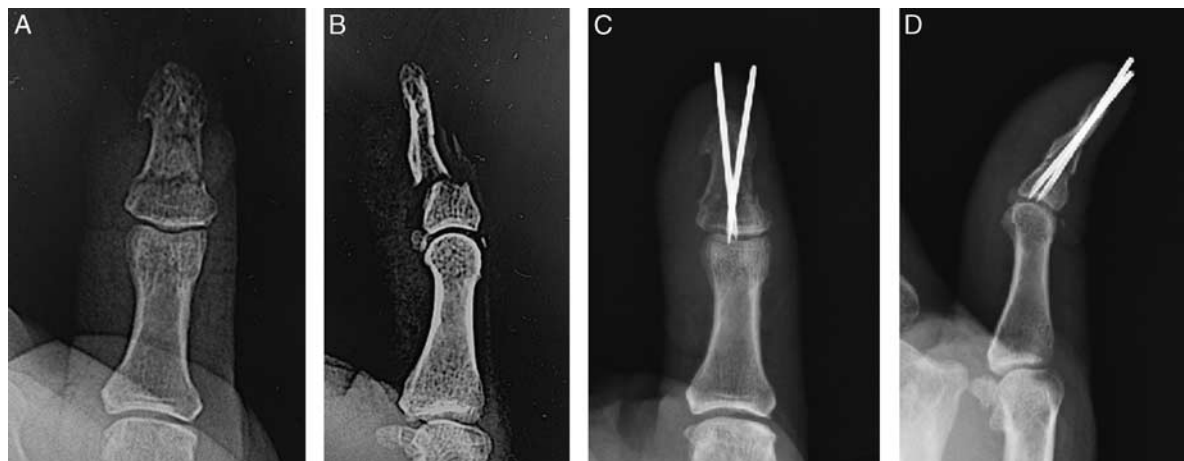


FIGURE 7. A 59-year-old male sustained a left thumb injury and the distal phalangeal open fracture (stage 2) was reduced and fixed using 2 needles followed by nail bed repair. X-ray showing anteroposterior (A) and lateral (B) view of the thumb before the procedure and anteroposterior (C) and lateral (D) view after reduction and pinning.

The average time to radiographic fracture consolidation with bridging callus was 7.3 weeks (range, 4 to 20 wk). The uneventful union was achieved within 8 weeks in 7 cases. One patient had a small gap in the fracture site initially and delayed union occurred. The needle was removed at 8 weeks and a complete radiographic osseous union was achieved at 20 weeks.

All patients demonstrated fully sensate, pain-free digits at the latest follow-up, and no patient needed further intervention.

COMPLICATIONS

Possible complications include delayed or nonunion of fractures, and therefore adequate reduction and stability is necessary to prevent these complications. Close monitoring is paramount in determining healing. Another possible complication is an infection, and it is critical to thoroughly clean the wound and consider judicious use of antibiotics as necessary. A potential complication related to our technique is damage to remained volar soft tissue or breakage of the needles, and we advocate for cautious manipulation and handling of the needles throughout the entire technique. Stiffness of the digit is another known complication and we suggest only a brief period of immobilization with early motion to minimize this risk.

DISCUSSION

The fracture of the distal phalanx is the most common fractures of the hand.¹⁰ The distal phalangeal fracture can be healed without symptoms even without the presence of a radiologic union. It is thought that the fractures are stabilized by the stable fibrous union.

However, some patients develop symptomatic nonunion because of a lack of bone viability and stability at the fracture site.¹¹ Most nonunions in the hand are atrophic,¹² and therefore it is inherently difficult to distinguish nonunion from fibrous union through the sole use of radiography. Pain, instability, and dynamic deformity are important clinical signs of nonunion.¹³ It is important to monitor for nonunion of distal phalangeal fractures as the progression could make precise and powerful pinch difficult.¹⁴ Because of its anatomic structure, the middle part or waist could be the most vulnerable site for symptomatic nonunion.¹⁴

Currently, it is difficult to determine which distal phalangeal fractures will progress to symptomatic nonunion at the

time of injury. Therefore, performing temporary fixation of the distal phalangeal fracture is deemed necessary to reduce the risk of this sequelae. In addition, temporary stabilization of the fracture will potentially provide a better environment for the anatomic repair of the nail bed and surrounding soft tissue. It may also contribute to better esthetics with preventing future nail plate abnormalities such as hook nail deformity, which may result from loss of support for the nail.¹⁵ The fixed distal phalangeal bone can act as stable support under the nail bed and minimize abnormal nail growth.^{4,16}

The technique described in this study has several advantages. The hypodermic needles are the sterile and readily available product. The smaller caliber needle functions as a stylet. It navigates the larger needle more precisely and smoothly, compared with simple 18 G needle penetration from the fingertip. This needle-in-needle technique might need less power to penetrate the bone than doing without the stylet needle. The gentle manipulation would also be of benefit to atraumatic handling of soft tissues.

In summary, the open distal phalangeal fracture with dorsal injury could be treated with needle-in-needle pinning technique using disposable hypodermic needles. This straightforward method is reproducible in an emergency room or the office without the use of fluoroscopy. It is beneficial to practicing hand surgeons and trainees, who may be without necessary tools such as power drills and K-wires or in an environment with limited operating room availability due to pandemic-related restrictions, hospital cost, patient condition, etc. It secures the accuracy of insertion of a needle into the bone and provides safer manipulation. We would advocate this method as an equally effective alternative when fixation with K-wire is not available for treating fractures of the distal phalanx with dorsal disruptions.

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