

Hypodermic Needle Osteosynthesis: A Pragmatic Solution for Manual Workers and Vulnerable Populations in Resource-Constrained Settings

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Abstract- Background: Fingertip injuries, particularly unstable distal phalanx fractures and open mallet-type extensor tendon injuries, impose a significant socioeconomic burden, especially on working-age adults in precarious employment. While internal fixation is often required to preserve alignment and function, the gold standard—Kirschner wire (K-wire) fixation under fluoroscopic guidance—is frequently inaccessible in emergency settings or for patients with limited financial resources. This study evaluates the efficacy of hypodermic needle osteosynthesis as a cost-effective, “damage-control” alternative for immediate stabilization in vulnerable populations.

Methods: We present two patients presenting to the emergency department with unstable distal phalanx injuries. In the absence of intraoperative fluoroscopy and orthopedic power drills, stabilization was achieved using standard sterile hypodermic needles (18–21 gauge) as intramedullary or transarticular fixation devices. The technique prioritized rapid stabilization, soft-tissue preservation, and pain control to facilitate early return to function. Patients were followed for a minimum of 12 weeks to assess fracture healing, infection rates, and functional recovery.

Results: Successful immediate stabilization was achieved in both cases. The needle fixation technique effectively reduced fracture displacement and, in the tendon injury case, restored the continuity of the extensor mechanism. At the final follow-up, all patients demonstrated maintained alignment and clinical fracture union. Notably, no cases of infection, pin-site complications, or implant failure occurred, and no patient required secondary surgical intervention. Functional outcomes were favorable, with patients regaining a pain-free range of motion at the distal interphalangeal joint and returning to daily manual labor without significant delay.

Conclusion: Hypodermic needle osteosynthesis is a safe, accessible, and highly cost-effective technique for damage-control fixation of selected fingertip injuries. While not intended to replace standard K-wire fixation in well-resourced centers, it offers a critical option for preserving hand function in austere emergency settings and for patients of low socioeconomic status where conventional surgical infrastructure is limited.

Keywords—fingertip injuries, distal phalanx fracture, damage-control orthopedics, low socioeconomic status, frugal innovation, emergency hand trauma.

1 Introduction

Fingertip injuries represent a substantial proportion of hand trauma cases presenting to emergency departments worldwide¹. These injuries disproportionately affect working-age adults, particularly those engaged in manual labor, construction, and industrial occupations². For this demographic, hand function is not merely a matter of quality of life but is directly linked to professional activity, economic productivity, and socioeconomic stability². Among these injuries, distal phalanx fractures are the most frequently encountered fractures of the hand, largely due to the exposed anatomical position of the fingertip and its critical role in occupational activities^{1,3}.

Despite often being perceived as minor injuries, distal phalanx fractures are rarely isolated or simple. They are frequently associated with nail-bed lacerations, significant soft-tissue disruption, and varying degrees of contamination, particularly in occupational settings involving heavy machinery or crush mechanisms³. Furthermore, acute extensor tendon injuries at the level of the distal interphalangeal joint (DIPJ), including open lacerations and bony mallet deformities, commonly coexist with these fractures⁴. When inadequately treated, this combination of osseous, tendinous, and soft-tissue injury may result in chronic pain, deformity, extensor lag, and long-term functional impairment⁴.

The management of these injuries is significantly complicated when treating patients of low socioeconomic status or those in resource-limited environments. For manual laborers without robust social safety nets ("bad social status"), prolonged immobilization or staged reconstructive surgeries can lead to devastating loss of income⁵. While standard operative fixation using percutaneous Kirschner wires (K-wires) under fluoroscopic guidance is effective, it is associated with recognized complications such as pin-tract infection, joint stiffness, and hardware irritation^{6,7}. Moreover, in emergency settings or smaller hospitals, immediate access to fluoroscopic imaging, operating theaters, and specialized surgical equipment may be unavailable or significantly delayed⁷.

In such circumstances, the principles of Damage-Control Orthopaedics (DCO) become particularly relevant. Originally developed for the management of life-threatening polytrauma, DCO strategies emphasize rapid stabilization, minimization of additional tissue injury, and deferral of definitive reconstruction until optimal conditions are achieved^{8,9}. Although traditionally applied to major skeletal trauma, we propose that these principles can be meaningfully adapted to localized hand trauma using a "frugal innovation" approach. In this report, we introduce a pragmatic technique for damage-control fixation of fingertip injuries using universally available hypodermic needles. By repurposing low-cost, sterile medical equipment, this technique aims to provide immediate mechanical stability, protect injured structures, and facilitate early healing for vulnerable patients in the emergency setting.

2. Case report

We conducted a retrospective analysis of two patients treated for acute fingertip injuries in the emergency department of our institution. Both patients were young adult

males employed in construction trades, representing a demographic with high physical demands and high risk of occupational trauma.

Case 1: A 29-year-old man presented with a deep laceration to the dorso-radial aspect of the right fifth finger at the DIPJ due to a crush injury from a falling metal object. Radiographic study presented a fracture of the distal phalanx (*Figure 1-4*). The removal of the needle was after 1 month. No complications and full range of motion of the DIPJ was detected.

Case 2: A 19-year-old man presented by a wound caused by a utility knife, resulting in an extensor tendon injury at the level of DIPJ of the left middle finger (*Figure 5*). Following removal of the transarticular needle at 45th day after operation, the patient regained full active extension (no extensor lag) and a functional flexion arc of 0–60° at the DIPJ (*Figure 6*).

In these cases, the injuries were deemed unsuitable for simple splinting due to clinical instability or associated tendon disruption^{3,4}. However, immediate formal operative fixation was not feasible due to the unavailability of fluoroscopy and financial/logistical constraints at the time of presentation.

Indications for Needle Osteosynthesis

Hypodermic needle fixation was employed as an emergency stabilization technique for injuries meeting specific criteria:

1. Unstable distal phalanx fractures unable to be maintained by external splinting alone.
2. Open fractures associated with soft-tissue injury or nail-bed lacerations where internal stability facilitates wound care.
3. Acute extensor tendon lacerations at the DIPJ requiring immobilization of the joint in extension⁴.
4. Emergency situations where standard fixation implants (K-wires) or fluoroscopic guidance were unavailable⁷.

Injuries characterized by extensive comminution, segmental bone loss, gross contamination, or signs of neurovascular compromise were excluded from this technique and managed with definitive surgical intervention^{3,6}.

Surgical Technique

The procedures were performed in the emergency department under sterile conditions. Digital nerve block anesthesia was administered to achieve adequate analgesia¹⁰. No tourniquet was used to simplify the procedural setup.

Needle Selection: Standard disposable hypodermic syringe needles were selected based on the size of the distal phalanx and the desired balance between rigidity and ease of insertion. For larger digits (e.g., thumb) or unstable patterns requiring greater rigidity 18-gauge needles were preferred, while for smaller digits or transarticular fixation a 20-gauge needles could be used. The guiding principle was to select the thickest needle that could be inserted safely without causing iatrogenic bone damage.

Fixation Procedure:

1. Reduction: Following wound preparation, closed manual reduction of the fracture was performed to restore length and correct angular deformity.
2. Insertion: The hypodermic needle was inserted percutaneously. For fractures, the entry point was typically slightly off-center on the volar aspect of the fingertip pulp (or through an existing wound), advancing longitudinally into the medullary canal to span the fracture site. For tendon injuries, the needle was driven transarticularly across the DIPJ to lock it in extension, consistent with principles of mallet injury management⁴.
3. Assessment: In the absence of fluoroscopy, reduction quality and needle trajectory were assessed by tactile feedback and direct visual inspection of finger alignment.
4. Finalization: Once stability was achieved, the excessively protruding portion of the needle was trimmed and gently bent to reduce the risk of migration, leaving a small external segment to facilitate later removal. A sterile dressing was applied.

Post-Procedure Management: No rigid external splints were applied. Each treated finger was protected with a soft, bulky dressing. Patients were instructed to perform gentle range-of-motion exercises of the unaffected joints. Prophylactic oral antibiotics were prescribed for five days due to the open nature of the injuries.

Two patients were followed for a minimum of 12 weeks. Immediate stabilization was achieved in all cases, with procedure times under 20 minutes.



Figure 1. Preoperative roentgenography (Case 1).



Figure 2. Postoperative roentgenography (Case 1).

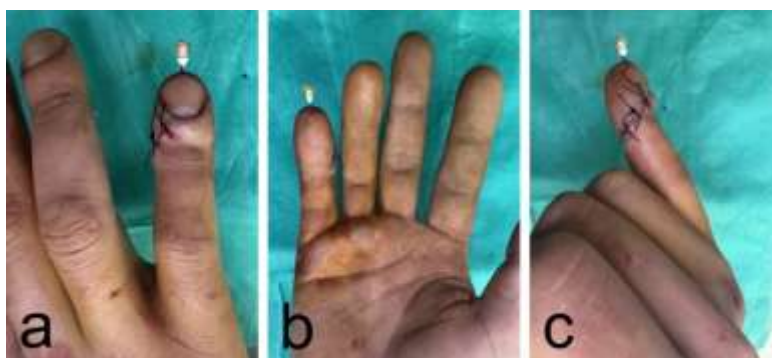


Figure 3. Postoperative photographs (Case 1).



Figure 4. Postoperative roentgenography presenting bone healing (Case 1).

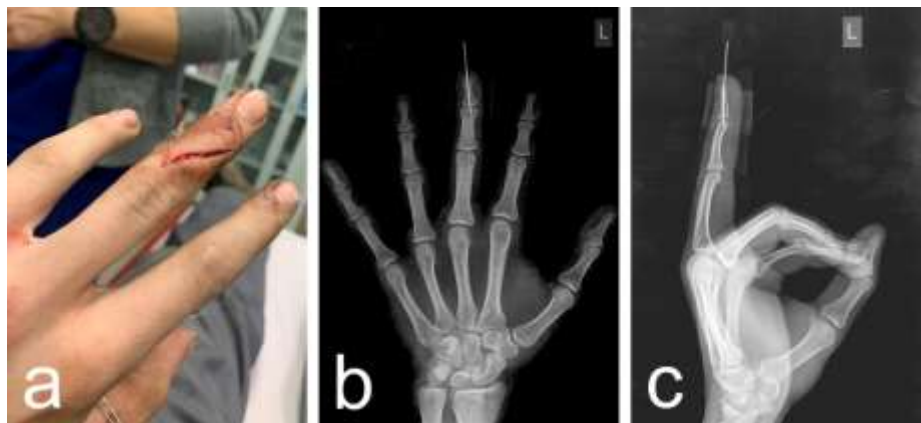


Figure 5. Preoperative photography and postoperative roentgenography (Case 2).

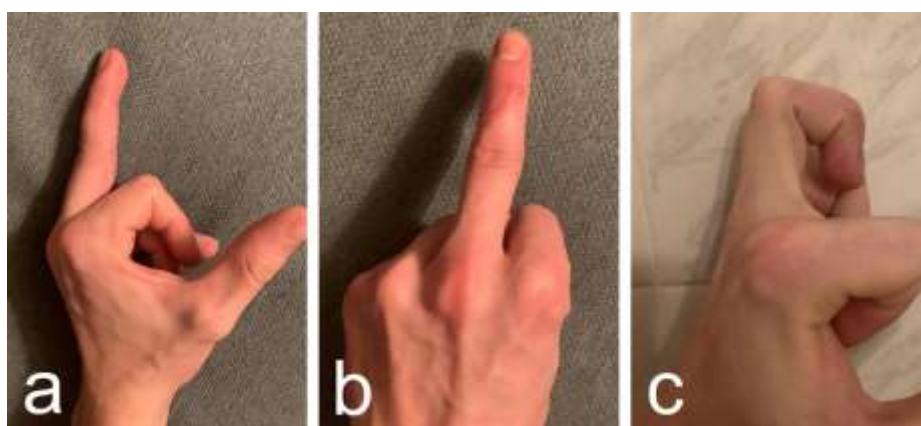


Figure 6. Postoperative follow up photographs on the fourth month after injury (Case 2).

Clinical Outcomes

- **Pain Relief:** Patients reported a marked decrease in pain within 1–2 weeks once mechanical stability was achieved.
- **Functional Recovery:** Patients resumed light activities of daily living within days. By 8 weeks, all patients had returned to their construction jobs, indicating successful restoration of occupational capacity.
- **Healing:** Clinical and radiographic union was evident by 6–8 weeks in the fracture cases. The soft tissue wounds and tendon repairs healed without complication.

Complications

There were no complications observed in this series during the follow-up period.

- Infection: No pin-tract infections, cellulitis, or deep infections were noted^{6,7}.
- Hardware failure: There was no evidence of needle migration or breakage, despite the relatively small diameter of the fixation devices.
- Secondary displacement: Fracture alignment was maintained until union in all cases.

4. Discussion

Fingertip injuries are among the most common forms of hand trauma encountered in emergency departments, accounting for a substantial proportion of upper extremity injuries across all age groups¹. Epidemiological studies consistently demonstrate a predominance among young male patients, a pattern largely attributed to increased exposure to occupational hazards in manual labor, construction, and industrial settings^{1,2}. Common mechanisms of fingertip injury include crush and blunt trauma, sharp lacerations from tools, and direct axial loading of the fingertip².

Beyond the immediate clinical presentation, these injuries impose a heavy socioeconomic burden. Patients of lower socioeconomic status often lack comprehensive health insurance, paid sick leave, or the financial reserves to withstand periods of unemployment⁵. For these individuals, the "indirect costs" of injury—such as lost workdays, reduced productivity, and the potential loss of employment—can be financially catastrophic. Consequently, there is immense pressure on these patients to return to work quickly, often making conservative treatment with cumbersome external splints impractical or prone to non-compliance.

Furthermore, smaller or resource-constrained hospitals that serve these populations may lack on-call hand surgeons or bedside fluoroscopy¹¹. This creates a significant barrier to care, as transferring patients to tertiary centers incurs additional costs, transportation challenges, and treatment delays. Therefore, an ideal emergency treatment strategy must be not only clinically effective but also economically viable and logistically simple. It should provide rapid stabilization to maintain alignment and length, protect tendon repairs, and minimize resource utilization, aligning with global surgery initiatives to improve access to care in low-income settings¹¹. The management of hand trauma in patients of low socioeconomic status requires a delicate balance between cost, efficacy, and recovery time. Conservative management with splints, while avoiding surgical risks, relies heavily on prolonged immobilization and patient adherence³. In occupational settings, poor compliance—often driven by the economic necessity to return to work—can lead to malunion, deformity, and chronic pain³. Conversely, formal operative fixation is resource-intensive and often unavailable in the austere settings where these injuries frequently occur⁷.

Hypodermic needle osteosynthesis offers a "middle path." It provides the internal stability of surgery without the costs, delays, or logistical barriers of the formal operating theater. For a daily-wage worker, the ability to forgo a cumbersome splint (which may mark them as "disabled" to an employer) and return to light function quickly is a

significant socioeconomic advantage. This technique aligns with global health initiatives advocating for **frugal innovation**—simple, low-cost solutions that expand access to effective surgical care^{5,11}.

Hypodermic needles vs. K-wires

While K-wires are widely regarded as the biomechanical gold standard¹², hypodermic needles possess distinct advantages in the damage-control context:

Availability: They are ubiquitous in virtually every medical center, regardless of resource level.

Beveled Tip: The sharp beveled tip permits controlled manual advancement through bone without the need for power drills, providing excellent tactile feedback for the surgeon.

Hollow Structure: Although mechanically inferior to solid wires, 18G and 20G needles provided sufficient rigidity to counteract the predominantly axial forces acting on the distal phalanx during the healing phase.

Limitations

This study is limited by its small sample size (n=2) and retrospective design. The relatively short follow-up period (12 weeks) prevents assessment of potential late sequelae such as cold intolerance, nail growth disturbances, or degenerative changes³. Additionally, the technique relies on surgeon experience for "blind" placement without fluoroscopy, which may affect reproducibility. Despite these limitations, the absence of complications suggests that in selected patients, this is a viable and safe alternative to referral or neglect.

5. Conclusion

Hypodermic needle osteosynthesis represents a simple, accessible, and cost-effective damage-control fixation technique for selected fingertip injuries involving distal phalanx fractures and acute extensor tendon disruptions. This technique is particularly valuable for patients of "bad social status" or in resource-limited settings, where it eliminates the need for expensive technology and facilitates early return to work. While not intended to replace conventional K-wire fixation in well-resourced centers, it serves as a pragmatic, definitive solution for preserving hand function in the vulnerable populations who need it most.

6. References

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