

Contents lists available at [ScienceDirect](#)

Journal of Hand Surgery Global Online

journal homepage: [www.JHSGO.org](http://www.JHSGO.org)

## Surgical Technique

## A Simple Technique Ensuring Adequate Exposure During Primary Repair of Complex Thumb Injuries



Koji Moriya, MD, \* Yutaka Maki, MD, \* Naoto Tsubokawa, MD \*

\* Niigata Hand Surgery Foundation, Niigata, Japan

## ARTICLE INFO

## Article history:

Received for publication January 15, 2024

Accepted in revised form January 18, 2024

Available online February 16, 2024

## Key words:

Complex injury

Flexor tendon repair

Replantation

Surgical exposure

Thumb

As the thumb is pronated, primary repair of complex injuries may be more difficult than the repair of other digits. We describe a simple technique that facilitates thumb repair. We insert a Kirschner wire perpendicular to the bone axis in the middle of the proximal phalanx, which ensures adequate exposure of the palmar aspect without the need for thumb position adjustment by an assistant. This technique is particularly useful when inexperienced surgeons perform thumb replantation and primary flexor tendon repair using a multistrand suture technique.

Copyright © 2024, THE AUTHORS. Published by Elsevier Inc. on behalf of The American Society for Surgery of the Hand. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The thumb is responsible for 40% of the overall hand function, and it is essential for grasping and pinching.<sup>1</sup> Impairment of thumb function seriously compromises hand functionality; adequate primary repair of thumb trauma is essential, regardless of the type of injury. Although adequate digit exposure and correct orientation are of paramount importance during any hand surgery, the thumb is unique in that primary repair of complex injuries (eg, amputation and flexor pollicis longus [FPL] tendon injuries) may be challenging because the thumb is pronated relative to the other digits. It is thus difficult to correctly orientate the thumb to create ideal operating conditions for the palmar aspect.

We describe a simple technique that ensures adequate exposure of the palmar aspect of the thumb during primary repair of complex injuries. This technique is particularly useful for inexperienced surgeons who perform thumb replantation and primary flexor tendon repair using a multistrand suture technique. Written informed consent was obtained from all patients for publication of this technical report and accompanying images.

## Indications and Contraindications

The main indication for the technique is a complex thumb injury that requires primary repair or secondary reconstruction of a

structure on the palmar aspect. Thumb amputation and FPL tendon injuries are highly relevant indications. The contraindications include active infection, poor proximal phalanx bone quality, and severe stiffness caused by arthritic changes in the thumb metacarpophalangeal and carpometacarpal joints.

## Surgical Anatomy

The topographic anatomy of the thumb digital nerves is remarkably constant.<sup>2,3</sup> Two palmar digital nerves (PDNs) derived from the median nerve pass distal to the pulp on the radial and ulnar side of the thumb in a position palmar to the digital artery. The dorsal digital nerves (DDNs) of the thumb (the number of branches that enter the digit ranges from two to five) all arise from the radial nerve.<sup>3</sup> There is no connection between the thumb PDN and DDN. However, a dorsal branch from the PDN lies distal to the A1 pulley in 11% of thumbs.<sup>3</sup> In these cases, there is no interconnection between the DDN and the dorsal branch of the PDN; the dorsal area of the thumb is dually innervated by both nerves.

The mean diameter of the thumb PDN in the middle of the proximal phalanx is 1.15 (SD: 0.13) mm and that of the dorsal branch of the PDN is 0.55 mm (approximately half the size of the PDN).<sup>3,4</sup>

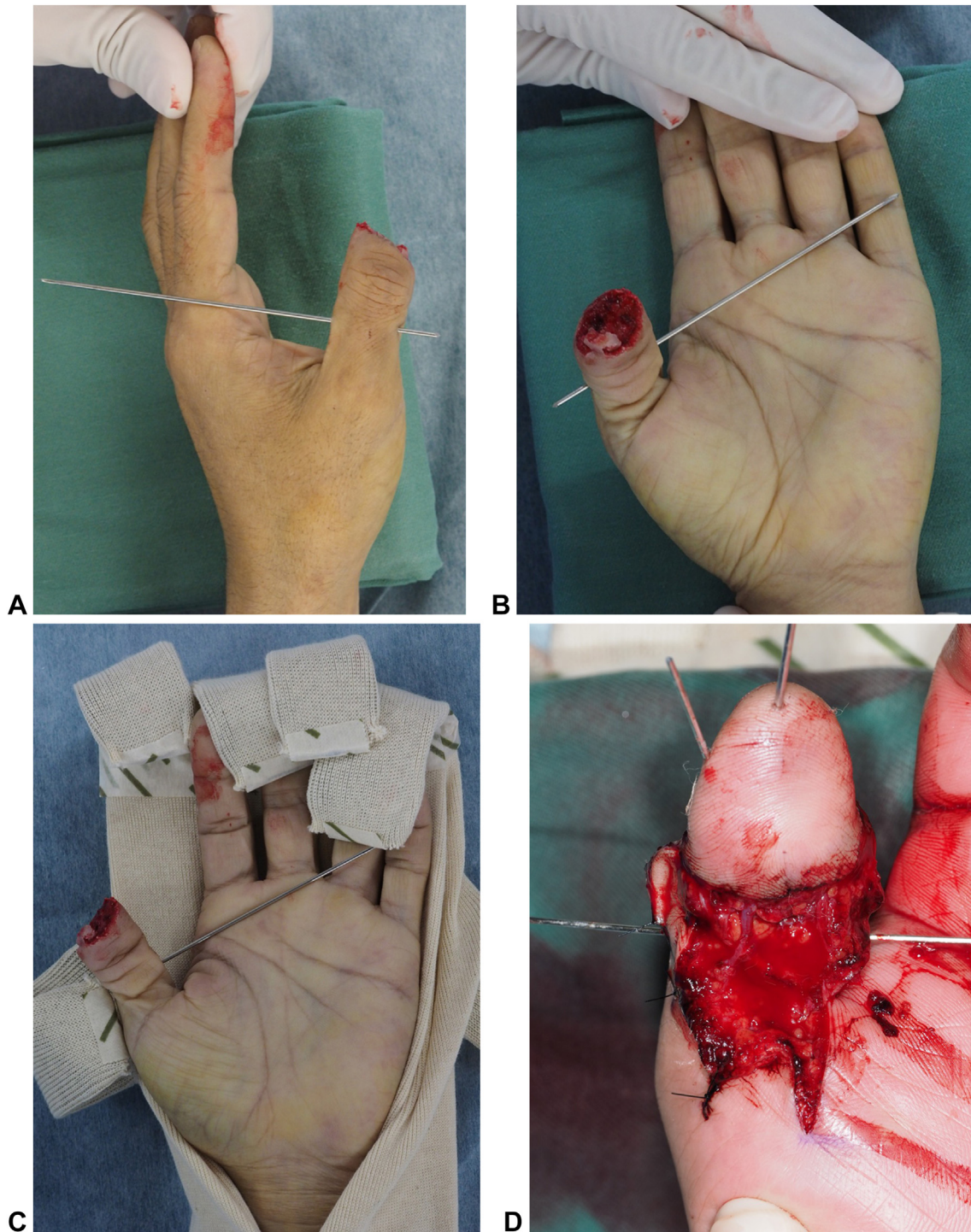
## Surgical Technique

After thorough debridement of any wound contamination, the digital artery, nerve, and tendon are exposed via a midlateral

**Corresponding author:** Koji Moriya, MD, Niigata Hand Surgery Foundation, Suwayama 997, Seiro-machi, Niigata 957-0117, Japan.  
E-mail address: [kmoriya@k8.dion.ne.jp](mailto:kmoriya@k8.dion.ne.jp) (K. Moriya).

<https://doi.org/10.1016/j.jhsg.2024.01.003>

2589-5141/Copyright © 2024, THE AUTHORS. Published by Elsevier Inc. on behalf of The American Society for Surgery of the Hand. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



**Figure 1.** Surgical technique ensuring adequate exposure of the palmar aspect of the thumb. **A** A 1.5-mm K-wire is inserted in the middle of the proximal phalanx. **B** The thumb is supinated to obtain adequate exposure of the palmar aspect by rotating the K-wire. **C** One end of the K-wire is placed on the palm, and the other end is held by a hand fixation device. **D** Primary repair can then be performed without the need for thumb position adjustment by an assistant.

or a Bruner incision. Then, a 1.5-mm Kirschner (K) wire is inserted perpendicular to the bone axis in the middle of the proximal phalanx. The thumb is then supinated to ensure adequate exposure of the palmar aspect by rotating the K-wire. After rotation, one end of the K-wire is placed on the palm, and the other is held in position by a device such as a lead hand. The palmar digital artery on either side, and the FPL tendon, can

thus be adequately repaired without the need for thumb position adjustment by an assistant (Fig. 1). After all procedures are completed, the K-wire is removed.

If thumb replantation is required, the technique is usually used after completion of all procedures on the dorsal side (eg, skeletal fixation, extensor tendon repair, and venous anastomosis).



**Figure 2.** An FPL tendon laceration in zone T1.

### Postoperative Management

This technique does not affect the commencement or nature of postoperative management. The initial hand therapy varies by the type of injury and the surgical procedure used.

### Pearl and Pitfalls

It is important to insert the K-wire perpendicular to the bone axis at the midpoint between the palmar and dorsal aspects of the proximal phalanx. Also, an insertion point slightly distal to the middle of the proximal phalanx potentially avoids injuries to the PDN, the dorsal nerve branch from the PDN, and the DDN. However, the risk of nerve injury cannot be completely eliminated. Especially, patients must be warned of the possibility of injury to the dorsal branch of the PDN.

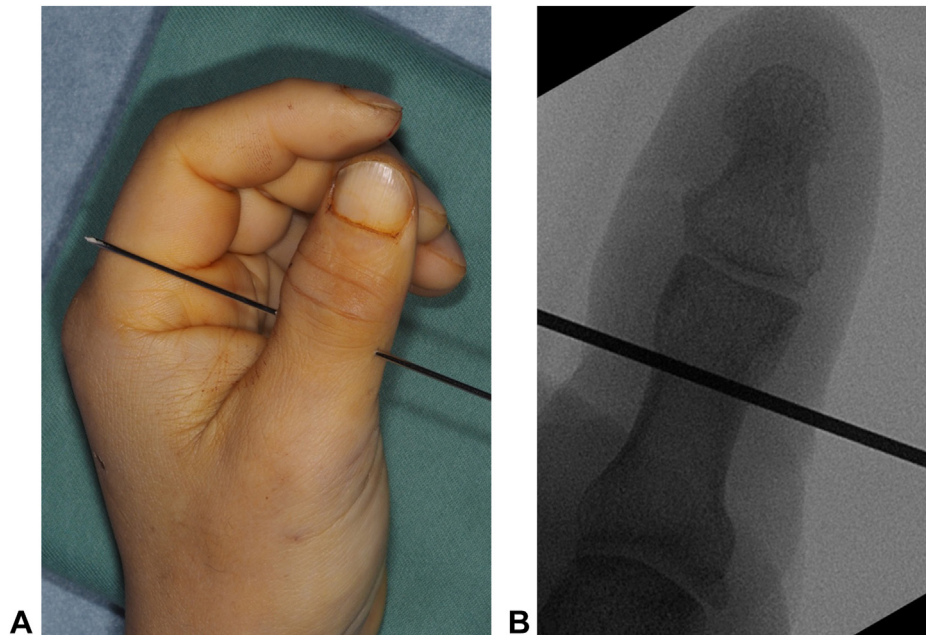
Sometimes, the K-wire bends and is then somewhat difficult to remove. When removing the K-wire, the section extending outward from the ulnar side of the thumb should be cut close to the skin first; K-wire removal is then easy.

### Complications

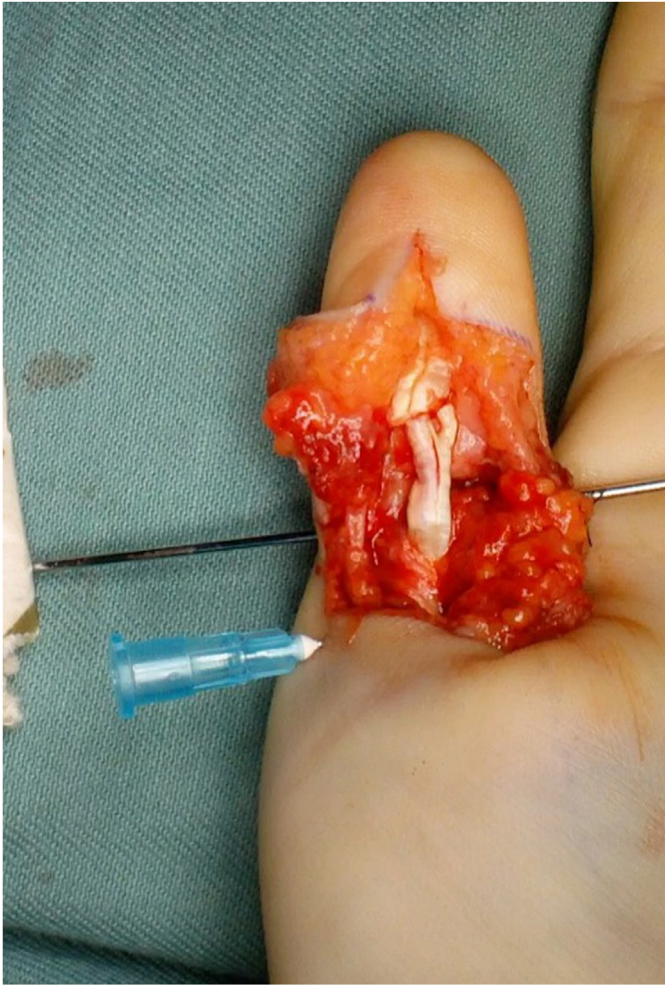
Although we have not encountered any complications, potential complications include infection, proximal phalanx fracture, thumb metacarpophalangeal or carpometacarpal joint sprain, and digital nerve injury.

### Case Illustration

A 23-year-old man sustained lacerations of the FPL tendon and ulnar digital nerve of the left thumb when operating machinery (Fig. 2). The wound margin was relatively clean. After thorough debridement, a 1.5-mm K-wire was inserted slightly distal to the middle of the proximal phalanx; this ensured adequate exposure of



**Figure 3.** Insertion of the K-wire. An intraoperative photograph **A** and a posteroanterior x-ray **B** show that the K-wire was inserted slightly distal to the middle of the proximal phalanx.



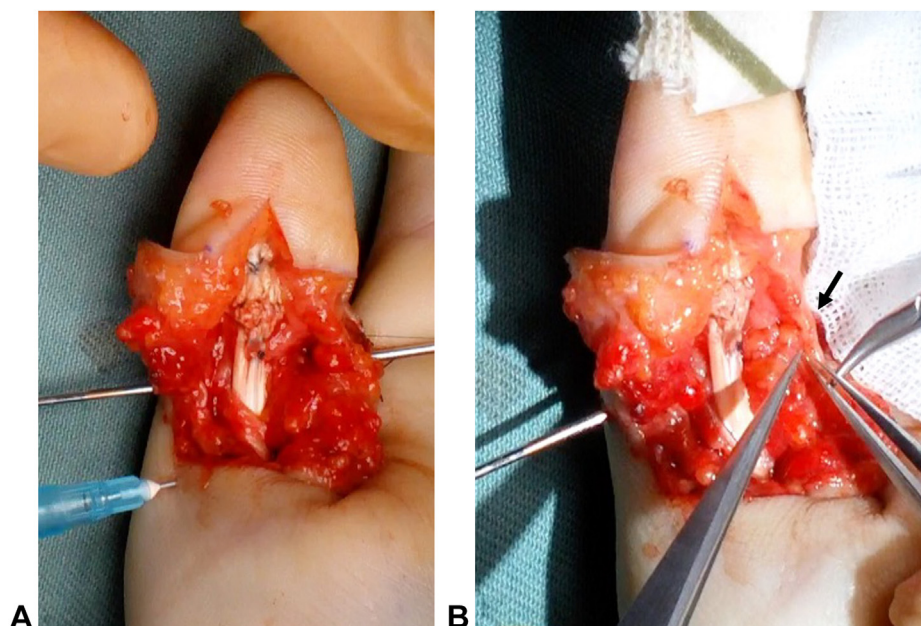
**Figure 4.** Exposure of both the distal and proximal stumps of the FPL tendon and the ulnar digital nerve within the Bruner incision.

the palmar aspect (Fig. 3). Both the distal and proximal stumps of the FPL tendon and the ulnar digital nerve were visible through the Bruner incision (Fig. 4). The FPL tendon was repaired using the six-strand suture technique; the ulnar digital nerve was repaired under an operating microscope with a 9-0 nylon (Fig. 5). Digit rehabilitation (controlled active mobilization) commenced on the first postoperative day (Fig. 6). At 9 months after surgery, the active range of motion and sensory recovery were good; there was no pain or clinically evident FPL tendon bowstringing (Fig. 7).

### Discussion

The diameter of the thumb ulnar digital artery is generally larger than that of the radial digital artery.<sup>5</sup> However, direct repair of the ulnar digital artery may be difficult given the pronated position of the thumb; a long venous graft is a useful alternative.<sup>6</sup> If possible, direct repair of the digital artery is ideal and is easier than venous grafting. There are fewer anastomosis points and, of course, there is no need to harvest a donor vein. Our new and simple technique facilitates direct and rapid arterial repair. Ohi et al<sup>7</sup> used a similar technique to ensure adequate exposure during thumb replantation, but the clinical outcomes were not reported. From 2012 to 2020, we used this technique for replantation on a total of seven thumbs in seven patients. In terms of arterial repair, end-to-end methods were used for six thumbs, and a venous graft was anastomosed in an end-to-end manner to the proximal stump of the ulnar digital artery at the level of the proximal phalanx in one thumb. The palmar veins of six thumbs were repaired. The average replantation time was 3.6 hours. All seven thumbs survived without any need for revision surgery, and there were no complications associated with additional K-wire insertion.

The rupture rate of repaired primary flexor tendons after early active mobilization is much higher in the thumb than in other fingers.<sup>8,9</sup> Moriya et al<sup>10</sup> reported that all ruptures occurred in thumbs treated by inexperienced surgeons who found it difficult to perform multistrand repair and secure an adequate operative field during FPL tendon repair because the thumb was opposed to the other fingers. We believe that primary FPL tendon repair might have been inadequate; poor exposure notably compromises



**Figure 5.** Primary repair. **A** The FPL tendon was repaired using the Yoshizu #1 technique. **B** The ulnar digital nerve was sutured under an operating microscope with a 9-0 nylon (arrow).

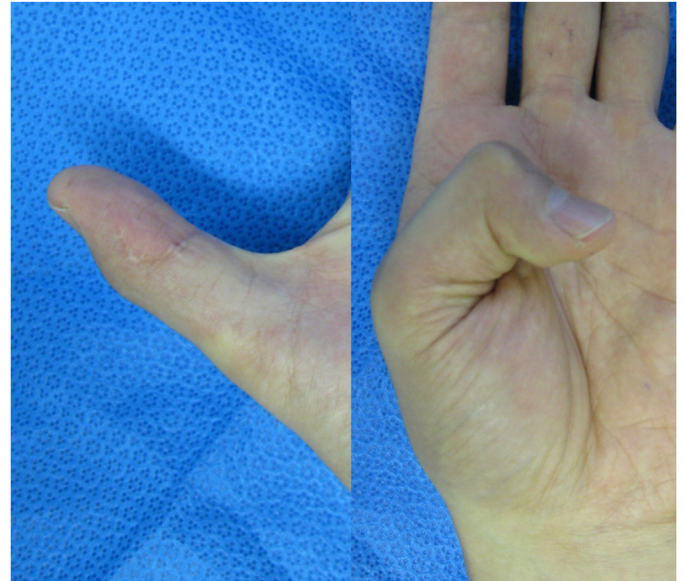


**Figure 6.** Active extension and flexion during hand therapy at 1 week after surgery.

multistrand repair, especially if the surgeon is inexperienced. Our new technique is particularly useful when repairing an ulnar digital nerve injury associated with FPL tendon laceration.

#### Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article.



**Figure 7.** Active extension and flexion at 9 months after surgery.

#### References

1. Moran SL, Berger RA. Biomechanics and hand trauma: what you need. *Hand Clin.* 2003;19(1):17–31.
2. Wallace WA, Coupland RE. Variations in the nerves of the thumb and index finger. *J Bone Joint Surg Br.* 1975;57(4):491–494.
3. Bas H, Kleinert JM. Anatomic variations in sensory innervation of the hand and digits. *J Hand Surg Am.* 1999;24(6):1171–1184.
4. Amador RO, Westenberg RF, Langhammer CG, Knaus WJ, Chen NC, Eberlin KR. Nerve diameter in the hand: a cadaveric study. *Plast Reconstr Surg Glob Open.* 2019;7(3):e2155.
5. Edwards EA. Organization of the small arteries of the hand and digits. *Am J Surg.* 1960;99:837–846.
6. Wagner ER, Bishop AT, Shin AY. Venous bridge arterial grafting for thumb replantation. *Hand (N Y).* 2017;12(3):272–276.
7. Ohi H, Saito H, Takahashi Y, Moriya K. Tips for thumb replantation surgery. In Japanese. *J Jpn Soc Surg Hand.* 2001;17(6):756.
8. Elliot D, Moiemmen NS, Flemming AF, Harris SB, Foster AJ. The rupture rate of acute flexor tendon repairs mobilized by the controlled active motion regimen. *J Hand Surg Br.* 1994;19(5):607–612.
9. Sirotkova M, Elliot D. Early active mobilization of primary repairs of the flexor pollicis longus tendon. *J Hand Surg Br.* 1999;24(6):647–653.
10. Moriya K, Yoshizu T, Maki Y. Early active mobilization after primary repair of the flexor pollicis longus tendon. *J Orthop Sci.* 2021;26(5):792–797.