

Reconstruction of Total Hand Degloving Injury with Combined Free and Pedicled Flaps and Ilizarov Minifixator

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Summary: Total hand degloving injuries present a significant challenge in treatment, with no consensus yet on the optimal choice of flap for coverage. Functional reconstruction necessitates careful consideration of syndactyly release, particularly after flap coverage. A 64-year-old woman sustained a total hand degloving injury and underwent extensive reconstructive surgery. Initially, a free superficial circumflex iliac perforator flap was applied to the thumb, whereas pedicled groin and superficial inferior epigastric artery flaps were used for the remaining fingers. However, partial necrosis at the edges of the pedicled flaps necessitated the adduction of the fingers, followed by suturing the skin flaps closed. This led to the formation of adduction contractures, requiring careful release and skin flap extension for effective syndactyly release. Subsequently, the innovative use of an Ilizarov minifixator was used for the dual purpose of interdigital widening and elongation of the flap. At the 27-month follow-up, the patient demonstrated significant functional recovery of the hand and fingers, showing the effectiveness of this multifaceted surgical approach. Despite some residual flexion contractures, the patient regained the ability to write and perform pinching motions with the thumb and middle finger, expressing satisfaction with the surgical outcome. In conclusion, for a functional reconstruction of the thumb and fingers, the thumb and other fingers should be covered separately. When the fingers are in adduction and there is insufficient skin stock for syndactyly release, using an external fixator to expand the interdigital spaces before the syndactyly release proved to be effective. (*Plast Reconstr Surg Glob Open* 2024; 12:e5976; doi: 10.1097/GOX.0000000000005976; Published online 15 July 2024.)

INTRODUCTION

Wound coverage after total hand degloving injury remains one of the greatest predicaments for a hand surgeon. Although there are reports of replantation¹ or flap coverage approaches for such injuries, the optimal reconstructive technique is yet to be unequivocally established.²⁻⁵

Furthermore, for a functional and aesthetic reconstruction of the hand after covering the fingers with a flap, syndactyly release becomes essential.⁴ However, performing syndactyly release becomes challenging when there is a limited skin stock in the flap. Although external fixation is used

to increase soft tissue before syndactyly release in pediatric cases,^{6,7} its application in adult total degloving injuries is rare.

We present a case of total hand degloving injury. The thumb was covered by a free superficial circumflex iliac perforator (SCIP) flap. The middle to the little fingers were covered with pedicled groin and superficial inferior epigastric artery (SIEA) flaps. After this, we used an Ilizarov minifixator (Arata; Tokyo, Japan) to expand the spaces between the fingers before executing a syndactyly release, which demonstrated favorable outcomes.

CASE REPORT

A 64-year-old woman sustained a right-hand degloving injury from a noodle-making machine. [See Video (online), which demonstrates the details of the case report.] The only medical complication was hypertension.

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The skin of the thumb was completely degloved, but metacarpophalangeal (MP) joint motion was preserved. For the other fingers, only distal phalangeal skin remained without blood flow, yet their proximal interphalangeal and MP joints were preserved.

On the day of the injury, wound debridement was performed. The arteries were damaged at multiple sites, making replantation or revascularization challenging to perform. The second digital ray was amputated at the neck of the metacarpus to widen the first webspace. The distal phalanges of the third to fifth fingers were amputated (Fig. 1). The middle and proximal phalanges were stabilized with Kirschner wires (K-wires) in an extended position.

Three days postinjury, the thumb was covered using an SCIP flap, whereas the third to fifth fingers were covered with a pedicled groin and SIEA flaps. (See figure, Supplemental Digital Content 1, which displays the hand after flap coverage. <http://links.lww.com/PRSGO/D341>.) The donor site of the SCIP and SIEA flaps permitted primary closure, but the donor site of the groin flap necessitated a skin graft.

Five weeks later, the hand was divided from the pedicled groin and SIEA flaps. Range of motion (ROM) exercises for the thumb and the MP joints of the fingers were



Fig. 1. Anterior view after the debridement and K-wire fixation.

Takeaways

Question: How to perform aesthetic and functional reconstruction of total hand degloving injury.

Findings: Our study on a 64-year-old woman with a total hand degloving injury showed successful functional recovery using a free superficial circumflex iliac perforator flap for the thumb, pedicled groin and superficial inferior epigastric artery flaps for the remaining fingers, and an Ilizarov minifixator for interdigital widening and flap elongation, demonstrating a multifaceted surgical approach's effectiveness.

Meaning: In total hand degloving injuries, a combination of microsurgery and external fixation techniques proves to be extremely useful.

initiated before the detachment of the pedicled flaps, preventing significant contractures at this point. Although the SCIP flap fully survived, the pedicled flaps showed partial necrosis at their edges, which were excised; the fingers were positioned in adduction, and flap edges were approximated and sutured (Fig. 2).

Four months post flap division, after complete healing of the wound edges and extensive rehabilitation, an



Fig. 2. After the wound healing of the pedicled flaps.

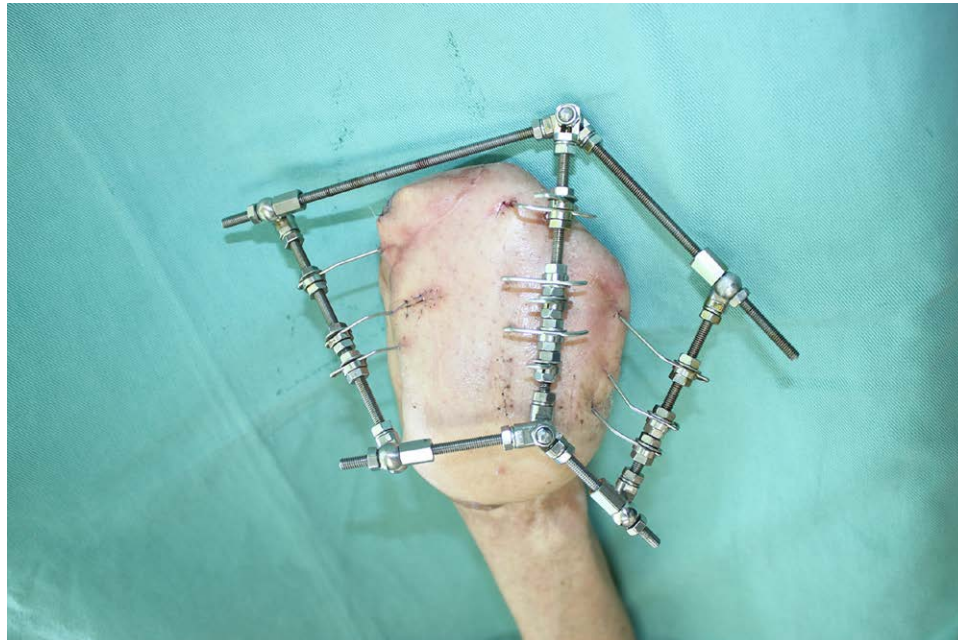


Fig. 3. Posterior view of the right hand, 2 months postinitiation of interdigital expansion.

Ilizarov minifixator was applied to expand the soft tissue in interdigital spaces. Initially, six 1.5 mm wires were placed at 45 degrees into the ring finger, with four in the proximal phalanx and two in the middle phalanx. After bending the K-wires just beyond the skin level, they were connected to rods with nuts and washers. Prebent, sterilized 1.2-mm corkscrew-like K-wires were percutaneously inserted into the middle and little fingers from the volar side, direction confirmed by fluoroscopy, hooked onto the cortex, and pulled outward. Three K-wires were applied to each of the middle and little fingers, each set connected to a rod, similar to the ring finger. A transposition flap was also performed for the first web space. ROM exercises continued even after applying the Ilizarov minifixator, with no pin-related complications.

Two months after initiation of interdigital expansion, the space between the middle and ring fingers was separated (Fig. 3). (See figure, Supplemental Digital Content 2, which displays the x-ray of the right hand. <http://links.lww.com/PRSGO/D342>.) Simultaneously, the K-wires used for initial fixation were removed. Five months after commencing interdigital expansion, the ring and little fingers were eventually separated. Although proximal skin grafts were still essential, they were not required around the middle phalanx (Fig. 4). One-year postinjury, defatting of the flap and linear scar formation procedures were executed.

RESULTS

Twenty-seven months postinjury, the thumb's ROM showed 25 degrees radial abduction, 30 degrees volar abduction, and -10 to 20 degrees MP joint motion. The fingers exhibited flexion contractures at the MP joints: middle finger, -68 to 82 degrees; ring finger,

-62 to 72 degrees; and little finger, -68 to 70 degrees. Sensory perception-wise, superficial sensation was lost, but deep sensation was intact. Slight bone absorption was observed at the distal ends of the middle phalanges of the middle, ring, and little fingers on x-ray. The Disabilities of the Arm, Shoulder and Hand disability score was 23.2. In terms of daily life activities, the patient could write with the affected hand and was able to pinch using the thumb and middle fingers, expressing satisfaction with the outcome.

DISCUSSION

Functional reconstruction requires adequate first web space and preventing thumb adduction contracture, advocating for separate coverage of the thumb and other digits.^{3,4} In this case, more than two free flaps complicated procedures; thus, the thumb was covered with an SCIP flap, and the other fingers with pedicled groin and SIEA flaps. The development of adduction contracture in the fingers and the limited skin stock of the flap necessitated the release of the contracture and the extension of the skin flap for syndactyly release.

We used the Ilizarov minifixator, inserting corkscrew-like bent wires into the middle and little fingers for proposed widening, as reported by Ilizarov⁶ and Shevtsov and Danilkin.⁷ This device is specialized for phalangeal applications such as osteosynthesis, bone lengthening,⁸ syndactyly release, and releasing joint contractures during joint distraction.

The case had several limitations: first, repeated ulcer formation at the fingertip during interdigital widening necessitated phalangeal shortening, delaying finger separation and causing MP joint flexion contracture. Prior amputation of the distal two phalanges might have been



Fig. 4. Anterior view of the right hand after separating between the middle and ring fingers, and between the ring and little fingers, and achieving wound healing.

preferable due to inadequate vascularity. Second, the patient retained only deep sensation because no sensory reconstruction was performed. For better functionality, using a sensate flap or staged sensory reconstruction could be more effective. Third, although the corkscrew-like bent wires of the Ilizarov minifixator facilitated traction of the middle and little fingers, their insertion was complex. A simpler palmar to dorsal wire insertion could have sufficed^{9,10} because proximal interphalangeal joint flexion-extension was unnecessary.

In mangled hand injuries, including total hand degloving injuries, a combination of microsurgery and external fixation techniques sometimes proves to be extremely useful. Surgeons well-versed in both techniques can widen the range of therapeutic options and, thus, the ultimate aim to achieve the most elusive result for a reconstructive surgeon—an acceptable equilibrium between form and function.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

1. Zhang G, Ju J, Jin G, et al. Replantation or revascularization for the treatment of hand degloving injuries. *J Plast Reconstr Aesthet Surg.* 2016;69:1669–1675.
2. Pshenisnov K, Minachenko V, Sidorov V, et al. The use of island and free flaps in crush avulsion and degloving hand injuries. *J Hand Surg Am.* 1994;19:1032–1037.
3. Kleinman WB, Dustman JA. Preservation of function following complete degloving injuries to the hand: use of simultaneous groin flap, random abdominal flap, and partial-thickness skin graft. *J Hand Surg Am.* 1981;6:82–89.
4. Kim KS, Kim ES, Kim DY, et al. Resurfacing of a totally degloved hand using thin perforator-based cutaneous free flaps. *Ann Plast Surg.* 2003;50:77–81.
5. Doctor AM, Mathew J, Ellur S, et al. Three-flap cover for total hand degloving. *J Plast Reconstr Aesthet Surg.* 2010;63:e402–e405.
6. Ilizarov GA. Syndactyly. In Green SA (ed.), *Transosseous Osteosynthesis.* Berlin, Heidelberg, New York: Springer; 1990:658–668.
7. Shevtsov VI, Danilkin MY. Application of external fixation for management of hand syndactyly. *Int Orthop.* 2008;32:535–539.
8. Kanchanathepsak T, Gotani H, Hamada Y, et al. The effectiveness of distraction lengthening in traumatic hand amputation with Ilizarov mini fixator. *Injury.* 2020;51:2966–2969.
9. Mei H, Zhu G, He R, et al. The preliminary outcome of syndactyly management in children with a new external separation device. *J Pediatr Orthop B.* 2015;24:56–62.
10. Lohmeyer JA, Hülsemann W, Mann M, et al. Transverse soft tissue distraction preceding separation of complex syndactylies. *J Hand Surg Eur Vol.* 2016;41:308–314.