



Reconstruction of Complete Circumferential Degloving Injury of a Digit with a Sensate Medial Sural Artery Perforator Flap

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Complete circumferential degloving injury of the digits usually results in a large cutaneous defect with tendinous structures, bone and joint exposure. When revascularization is not possible, a thin and adequately sized flap is required to resurface the defect, restore finger function, and prevent amputation. This report presents our experience with reconstruction of the entire circumferential degloving injury of the digit using a free sensate medial sural artery (MSA) perforator flap. The donor site was covered with split-thickness skin graft (STSG) and healed without complications. Furthermore, the MSA flap was thin and did not interfere with finger movements. The patients could attain smooth finger contours, acceptable function results, and adequate protective sensation after reconstruction. Patient satisfaction for the resurfaced digit scored 9 on a 10-point visual analogic pain intensity scale. This method may provide a valuable alternative for reconstruction of entire circumferential avulsion injury of the digit.

Key words: degloving injury, free medial sural flap, sensate flap, digit

INTRODUCTION

Complete degloving injury of the finger, which is a class III injury according to the Urbaniak classification,¹ can be difficult to manage due to the lack of appropriate tissues that can be employed to cover denuded tendons, pulleys, phalangeal bones, and structurally intact joint capsules. Defects of smaller size can be treated by simpler procedures, such as secondary intention healing, delayed closure, or skin grafting.^{2,3} Larger soft-tissue defects are treated with a pedicle or free flap, especially when poorly vascularized structures are exposed.⁴ With developments in microsurgical procedures, free flaps have been introduced for large defect reconstruction of complete circumferential degloving injury of the digits. Although there are several methods for managing this type of injury in order to preserve function and prevent

deformities,⁵⁻¹⁸ none provide an ideal solution to the problem due to the unique prehensile finger skin, which has loops and whorls on the fingerprint. The purpose of this paper is to present our experience with reconstruction of entire circumferential degloving injuries of the digit using a free sensate MSA perforator flap.

CASE REPORT

A 30-year-old man presented with a degloving injury of his right index finger, with complete loss of the skin envelope at the level of the proximal interphalangeal joint (Figure 1A) because of an accident with a roller machine. The degloved skin envelope could not be replanted and the patient did not want to use the cutaneous part from the second toe fashioned as a wraparound flap. Thus, a thin free MSA perforator flap, 8×6 cm in size, was raised from his right medial calf to cover the exposed bones and tendons of his index finger (Figure 1B, C, D). The proximal major perforators of the MSA emerged in an area between 6 and 10 cm from the popliteal crease and approximately 5 cm from the posterior midline of the leg, correlating with the axis of the MSA.¹⁹ The perforator, sprouting from the medial gastrocnemius muscle to the overlying deep fascia ran in an oblique course 2 to 4 cm to the main trunk of the MSA.¹⁹ The medial sural artery, approximately 2.0 mm in diameter, was accompanied by two venae comitantes, one of which tended to be larger than the other and measured up to 4 mm in diam-

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Fig. 1 A 30-year-old man presented with a complete degloving injury of his right index finger (A). A thin free medial sural artery perforator flap, 8×6 cm in size, was raised from his right calf, and the pedicle length was 10 cm (B, C). Intraoperative view of the resurfaced digit (D).

eter.¹⁹ The arterial pedicle was 10 cm in length and was anastomosed end-to-side to the radial artery at the anatomical snuffbox, and the venous pedicle was end-to-end anastomosed to the venae comitantes of the radial artery. The medial sural nerve was included in the flap and was sutured to a branch of the radial nerve. The donor site was covered with split-thickness skin graft (STSG) and healed without complications. The postoperative course was uneventful, and the patient was discharged on Day 10. Six months after the operation, the flap survived well and the contour of the index finger was restored aesthetically (Figure 2A, B). The patients could also attain adequate protective sensation after reconstruction. The static 2-point discrimination value was 9 mm in this patient.

DISCUSSION

In 1981, Urbaniak *et al.*¹ classified ring avulsion injuries into three categories depending on the magnitude of structural involvement. Although the avulsed skin should be used for wound coverage wherever possible,²⁰ the tissues and vascular structures are usually so traumatized that replantation is not feasible. Class III injury, with complete loss of the skin and exposed intact functional bone and tendon, is the most difficult injury to manage because of the scarcity of muscle and skin in this region. The general consensus among hand surgeons is that



Fig. 2 At 6-month follow-up, the flap survived well and the contour of the index finger was restored (A, B).

prompt coverage of raw areas and early motion exercise are the keys to successful treatment of avulsed fingers.

Therapeutic options include skin grafting, local flaps, and free tissue transfer. Circumferentially stripped fingers with circulatory disturbance constitute an unfavorable bed for skin grafts. In addition, skin grafting is not usually considered because of problems associated with wound contraction, non-gliding of tendons directly under skin grafts, and avascular necrosis of the distal bones. Although local flaps, such as palmar advancement flaps, homo- or hetero-digital flaps, cross-finger flaps, or distally based dorsal-hand flaps offer the main advantage of “replacing like with like,” their use is limited by the size and location of the defect.²¹⁻²³

Reconstruction of digital defects can be performed using distant pedicled flaps from the groin, trunk, or contralateral arm.²⁴⁻²⁶ Such approach requires the hand to be attached to the distant body part for at least 2 weeks, which usually causes joint stiffness after prolonged immobilization. The other disadvantage of this technique is that the flaps are very thick and bulky and require multiple, staged defatting procedures. Free flaps offer flexibility in size, shape, and positioning and do not add donor-site morbidity to the injured hand. Although free flaps are technically more demanding, they offer a favorable cosmetic result and are arguably superior to local options.

With the introduction of the concept of the perforator flap,^{27,28} muscle as a carrier for skin flap vascularity is no longer needed. According to the report of Chen *et al.*²⁹, the advantages of the perforator flap are as follows.

1. All of the medial gastrocnemius muscle and its motor nerve supply can be preserved.
2. The thin skin flap can be used for resurfacing shallow

defects of distal limbs.

3. A long donor vessel can reach the recipient vessel distant to traumatized or irradiated defects.
4. There is no need to sacrifice major arteries of the leg. Therefore, this flap can be harvested even from a traumatized leg with damaged major arteries.
5. For foot and lower leg reconstruction, both the donor and recipient sites lie within one operating field, which may offer economic use of time and personnel. Thus, only one microsurgical team is required for the entire free flap transfer.
6. This flap potentially provides protective sensation.
7. A medium-sized flap can be safely raised with a single perforator.

This flap dissection avoids unnecessary bulk and maintains donor-site muscle function. A free sensate MSA perforator flap was performed in the present case because the cutaneous part of the MSA perforator flap, including the deep fascia on the medial calf, is usually very thin. Furthermore, the major perforator of the MSA is easier to identify than the perforators of other flaps, thus enabling a rather safe and rapid dissection between the deep fascia and the medial gastrocnemius muscle.³⁰

In conclusion, the main advantage of the medial sural artery perforator flap is that it requires only cutaneous tissue to achieve better accuracy in reconstructive site, and it preserves the medial gastrocnemius muscle and motor nerve to minimize donor-site morbidity. Although the tedious dissection of perforators of varying diameters and locations, thus necessitating prolonged surgery, is another disadvantage of the flap, this may be overcome by training, experience, and a good assistant. In this case, our experience showed that free sensate MSA perforator flaps can be used for resurfacing defects, restoring acceptable finger function, and preventing amputation in the treatment of complete circumferential degloving injury of the digits.

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FINANCIAL DISCLOSURE

None of the contributing authors have any conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript.

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REFERENCES

1. Urbaniak JR, Evans JP, Bright DS. Microvascular management of ring avulsion injuries. *J Hand Surg* 1981;6:25-30.
2. Beasley RW. Principles of soft tissue replacement for the hand. *J Hand Surg* 1983;8:781-784.
3. Martin C, Gonzales del Pino J. Controversies in the treatment of fingertip amputations. *Clin Orthop* 1998;63-73.
4. Foucher G, Koury RK. Digital reconstruction with hand flaps. *Clin Plast Surg* 1997;24:1-32.
5. Ishiko T, Nakaima N, Suzuki S. Free posterior interosseous artery perforator flap for finger reconstruction. *J Plast Reconstr Aesthet Surg* 2009;62:e211-215, doi: 10.1016/j.bjps.2009.01.065.
6. Chen SL, Chou GH, Chen TM, Wang HJ. Salvage of completely degloved finger with a posterior interosseous free flap. *Br J Plast Surg* 2001;54:69-71.
7. Adani R, Castagnetti C, Landi A. Degloving injuries of the hand and fingers. *Clin Orthop Relat Res* 1995;314:19-25.
8. Yamauchi T, Yajima H, Kizaki K, Kobata Y, Fukui A, Tamai S. Sensory reconstruction in sensate radial forearm flap transfer. *J Reconstr Microsurg* 2000;16:593-595.
9. Yu P, Selber J. Perforator patterns of the anteromedial thigh flap. *Plast Reconstr Surg* 2011;128:151e-157e.
10. Lin CH, Lin CH, Lin YT, Hsu CC, Ng TW, Wei FC. The medial sural artery perforator flap: a versatile donor site for hand reconstruction. *J Trauma* 2011;70:736-743, doi: 10.1097/TA.0b013e318203179e.
11. Inigo F, Gargollo C. Secondary coverage of the hand using a dorsalis pedis plus first web space free flap. *J Reconstr Microsurg* 1992;8:461-465.
12. Woo SH, Choi BC, Oh SJ, Seul JH. Classification of the first web space free flap of the foot and its applications in reconstruction of the hand. *Plast Reconstr Surg* 1999;103:508-517.
13. Javaid M, Cormack GC. Anterolateral thigh free flap for complex soft tissue hand reconstructions. *J Hand Surg* 2003;28B:21-27.
14. Ulrich D, Pallua N. Treatment of avulsion injury of three fingers with a compound thoracodorsal artery perforator flap including serratus anterior fascia. *Microsurgery*. 2009;29:556-559, doi: 10.1002/mi-

- cr.20650.
15. Atzei A, Pignatti M, Udali G, Cugola L, Maranzano M. The distal lateral arm flap for resurfacing of extensive defects of the digits. *Microsurgery* 2007;27:8-16.
16. Logan A, Elliot D, Foucher G. Free toe pulp transfer to restore traumatic digital pulp loss. *Br J Plast Surg* 1985;38:497-500.
17. Morrison WA. Thumb and fingertip reconstruction by composite microvascular tissue from the toes. *Hand Clin* 1992;8:537-550.
18. Rui Y, Mi J, Shi H, Zhang Z, Yan H. Free great toe wrap-around flap combined with second toe medial flap for reconstruction of completely degloved fingers. *Microsurgery* 2010;30:449-456, doi: 10.1002/micr.20777.
19. Wang X, Mei J, Pan J, Chen H, Zhang W, Tang M. Reconstruction of distal limb defects with the free medial sural artery perforator flap. *Plast Reconstr Surg* 2013;131:95-105, doi: 10.1097/PRS.0b013e3182729e3c.
20. Adani R, Busa R, Castagnetti C, Castagnini L, Caroli A. Replantation of degloved skin of the hand. *Plast Reconstr Surg* 1998;101:1544-1551.
21. Tremolada C, Ponzielli P, Candiani P, Donati L. The subcutaneous laterodigital reverse flap. *Plast Reconstr Surg* 1998;101:1070-1074.
22. Adani R, Marcoccio I, Tarallo L, Fregni U. The reverse heterodigital neurovascular island flap for digital pulp reconstruction. *Tech Hand Up Extrem Surg* 2005;9:91-95.
23. Vuppalapati G, Oberlin C, Balakrishnan G. Distally based dorsal hand flaps: Clinical experience, cadaveric studies and an update. *BJPS* 2004;57:653-667.
24. Yamada N, Ui K, Uchinuma E. The use of a thin abdominal flap in degloving finger injuries. *Br J Plast Surg* 2001;54:434-438.
25. Lee WPA, Salyapongse AN. Thumb reconstruction. In: Green DP, Hotchkiss RN, Pederson WC, Wolfe SW, editors. *Green's Operative Hand Surgery*, 5th ed. New York: Churchill Livingstone; 2005. pp 1865-1912.
26. Inigo F, Gargollo C. Secondary coverage of the hand using a dorsalis pedis plus first web space free flap. *J Reconstr Microsurg* 1992;8:461-465.
27. Koshima I, Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. *Br J Plast Surg* 1989;42:645-648.
28. Koshima I, Fukuda H, Utunomiya R, Soeda S. The anterolateral thigh flap: variations in its vascular pedicle. *Br J Plast Surg* 1989; 42:260-262.
29. Chen SL, Yu CC, Chang MC, Deng SC, Wu YS, Chen TM. Medial sural artery perforator flap for intraoral reconstruction following cancer ablation. *Ann Plast Surg* 2008;61:274-279, doi: 10.1097/SAP.0b013e318157a1a0.
30. Cavadas PC, Sanz-Gimenez-Rico JR, Gutierrez-de la Camara A, Navarro-Monzonis A, Soler-Nomdedeu S, Martínez-Soriano F. The medial sural artery perforator free flap. *Plast Reconstr Surg* 2001;108:1609-1615.