

Contents lists available at [ScienceDirect](#)

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Case Report

Resurfacing of a Degloved Finger With a Reverse Radial Adipofascial Forearm Flap



Yi Xie, MD, * Lipi Shukla, MBBS *

* Plastic and Reconstructive Surgery Department, The Alfred Hospital, Melbourne, Victoria, Australia

ARTICLE INFO

Article history:

Received for publication November 22, 2021

Accepted in revised form March 16, 2022

Available online April 28, 2022

Key words:

Forearm flap

Hand reconstruction

Radial adipofascial forearm flap

Complex upper-limb trauma, in particular crush and avulsion injuries, present an ongoing challenge for the reconstructive hand surgeon given the extensive zone of injury, particularly involving the neurovascular structures. When replantation is deemed unsuitable, the reconstruction must be both robust and flexible enough to meet the functional needs of the patient. The authors present a case of a ring avulsion amputation of the middle digit of a young patient's dominant hand. Due to the distal extent of avulsion, the amputated digit was determined to be nonreplantable, and the patient's medical comorbidities precluded traditional delayed pedicle flap options. Therefore, a reverse radial adipofascial flap was used as a single-stage reconstruction to resurface the entirety of the circumferential digital defect. At 8 months of follow up, the patient demonstrated exceptional passive and active range of motion with excellent contour and cosmesis, illustrating the utility of this reconstructive option.

Copyright © 2022, 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/>).

Complex upper-limb trauma, in particular crush and avulsion injuries, present an ongoing challenge for reconstructive hand surgeons despite increasing innovation in the field of hand surgery and improved microsurgical techniques. Ring avulsion amputations, categorized by Urbaniak,¹ involve severely compromised degloved skin, often with a lengthy zone of injury involving the tendons and neurovascular structures with variable bony amputation. Even if replantation is successful, full functional restoration is difficult. Due to the extensive degloving and distal neurovascular injury, alternative reconstruction is required when replantation is deemed unsuitable. Traditionally described staged, buried flaps, such as of the chest wall or groin, often result in bulky, stiff digits which are of limited use for patients' day to day requirements.

The pedicled radial forearm flap is known for its versatility in composition and use for reconstruction around the elbow and the hand.^{2,3} It is not often used in finger defects, due to the availability of more suitable local and free flap options. We

present a case report of a ring avulsion amputation which was resurfaced with a reverse radial adipofascial forearm flap (RRAFF). At 8 months of follow up, it was demonstrated to be both robust and flexible, allowing the patient to undertake both vocational activities and hobbies with minimal donor site morbidity.

Case Report

A 36-year-old male, right-hand dominant schoolteacher presented with a traumatic ring avulsion amputation of his right middle finger after his digit was caught on the rear tray of a utility vehicle as it pulled away. This resulted in bony amputation through the distal interphalangeal joint, avulsion of his flexor digitorum profundus from the musculotendinous junction, digital neurovascular structures avulsed distal to the distal interphalangeal joint, and soft tissue degloving from the base of the metacarpal bone and proximal phalanx (Fig. 1).

The patient's medical history was important for severe chronic kidney disease secondary to immunoglobulin A nephropathy, awaiting renal transplant. He neither presented with preexisting arteriovenous fistulas nor the need for any as a bridge to transplant.

Declaration of interests: No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Yi Xie, MD, 107/77 Hawthorn Road, Caulfield North, Melbourne, VIC 3161, Australia.

E-mail address: Philip.y.xie@gmail.com (Y. Xie).

<https://doi.org/10.1016/j.jhsg.2022.03.004>

2589-5141/Copyright © 2022, 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/>).

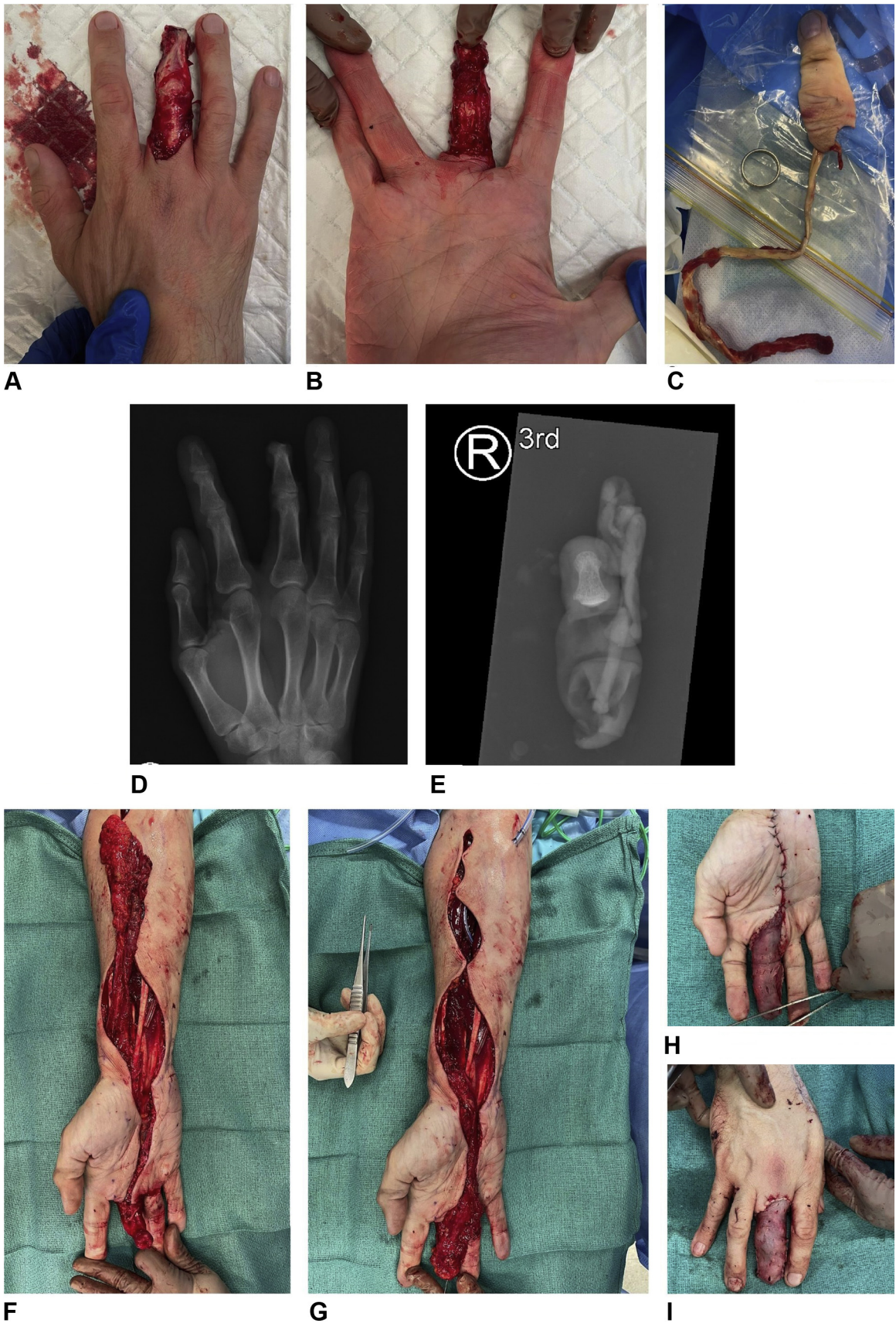


Figure 1. A–E. Degloved middle finger with remnant proximal and middle phalanx. F–G. Reverse radial adipofascial forearm flap. H–I. Flap covered with split skin graft from upper thigh.

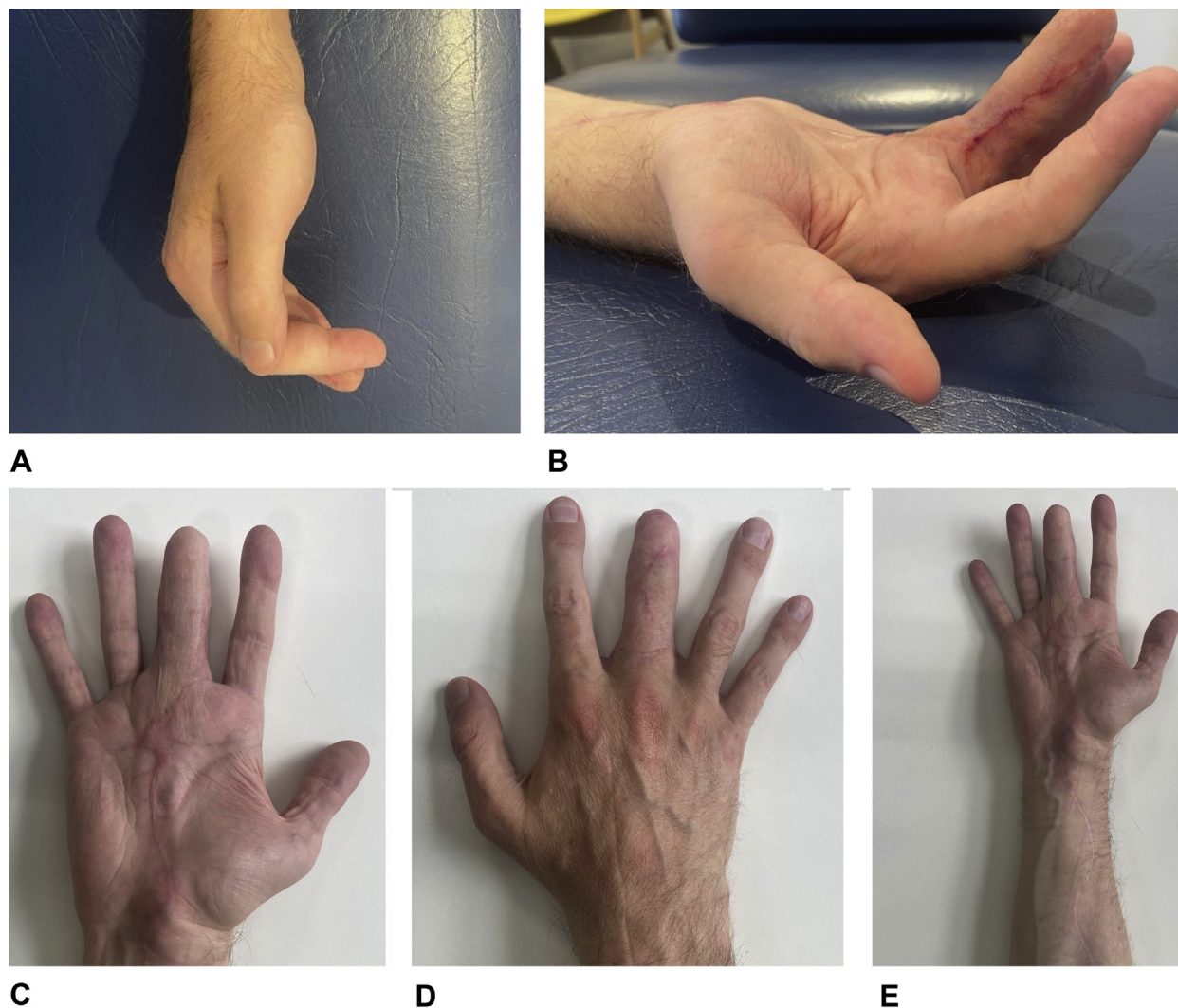


Figure 2. A, B. Two month of follow up showing healed flap with early palmar contracture. C–E. Six month of follow up post tenolysis and palmar scar release with Z-plasty.

Management

The patient was taken to the operating room within 5 hours of the injury, and examination of the amputated digit determined it nonreplantable given the distal extent of avulsion of the digital vessels. Preoperative discussion with his nephrologist highlighted that his immunosuppression notably increased the morbidity associated with buried pedicled flaps from the groin or abdominal region due to the increased risks of infection and subsequent sepsis. After establishing intact collateral circulation with Allen's test, the decision was made to reconstruct with a RRAFF.

Following the preoperative template, a curvilinear incision was made from palm to volar forearm. An 8 cm by 6 cm segment of fascia was raised, islanded on proximal perforators. The radial artery was ligated proximally, while the cephalic vein was ligated and kept in the flap for a supercharge option. The carpal tunnel was released, and a palmar incision was made over the middle finger ray. The radial and ulnar digital arteries were ligated, while the radial and ulnar digital nerves were neurolyzed and coapted at the level of midway on the middle phalanx to prevent symptomatic neuroma. The flap was inset circumferentially over the middle finger stump and surfaced with a fenestrated split thickness skin graft. The donor was closed directly.

Postoperative Course

The patient recovered well after surgery and was discharged on the fourth day after presentation.

At 2 months of follow up, his wounds had healed, with excellent contour and cosmesis. However, functionally he demonstrated restricted passive flexion and no demonstrable active flexion at his proximal interphalangeal (PIP) joint. He retained good finger movement from the metacarpophalangeal joint, including laterally; however, he was unable to fully extend his metacarpophalangeal joint due to contracture. A functional ultrasound determined PIP joint dorsal capsule thickening with intrinsic tightness with an intact and gliding flexor digitorum superficialis tendon (Fig. 2).

At 6 months of follow up, after maximizing hand therapy and passive range of motion, he underwent a dorsal PIP joint capsule and intrinsic release in conjunction with a Z-plasty scar revision of his longitudinal palmar scar and tenolysis of his flexor digitorum superficialis tendon in the palm (Fig. 2). This intervention resulted in nearly full passive range of motion in his middle finger and notably improved active PIP joint flexion to 36° (42° composite), aided by use of his ring finger to guide middle finger flexion (see video, available online on the *Journal's* website at www.jhandsurg.org/).

The patient returned to work with reduced hours approximately 2 months after the initial operation. After the revision procedure at 6 months after surgery, the patient was able to return to work full time; however, he was unable to perform some tasks requiring advanced dexterity such as manipulating network infrastructure and cabling. At 10 months after surgery, the patient completed the Disabilities of the Arm, Shoulder, and Hand questionnaire with a score of 43.3. He was able to perform most regular daily activities with mild to moderate limitation, experiencing greater difficulty with tasks requiring a prolonged grip such as carrying a heavy bag or using a knife.

Discussion

The patient's age, hand dominance, occupation, and medical comorbidities were major considerations in the reconstructive decision. Although advances in hand surgery have improved long-term functional outcomes and cosmetic results for primary ray amputation in traumatic finger injuries, we decided against this approach in the first instance. We wanted to preserve as much as possible the patient's ability to type accurately for his work in information technology, as well as his ability to manipulate fine objects such as computer cabling and wiring. Secondly, we wanted to avoid injuring intact metacarpal and carpal bones in a patient with an already increased risk of infection in the trauma setting. Once the decision was made to retain the middle metacarpal, the primary aim was to maintain length of the digit and resurface it with durable soft tissue to facilitate middle finger function. A RRAFF was chosen as a single-stage operation with advantages of using regional tissue of both adequate dimension and pliability for circumferential coverage. Previous cases have reported the success of adipofascial-only flaps in reducing donor site morbidity associated with skin grafts for wound closure, an often-cited drawback of forearm flaps.^{4,5} In these cases, as in ours, a skin graft was applied over the flap instead, and the donor site closed primarily.

First described over 30 years ago, the radial forearm flap is well regarded for its versatility, ability to supply soft tissue and bone with a long, predictable pedicle that facilitates microvascular anastomosis, and sufficiently large tissue coverage.^{6,7} While often used as a free flap, the radial forearm flap and the reverse variant are also used in the reconstruction of locoregional injuries of the upper-limb. Other options for hand wounds include delayed pedicled groin and abdominal flaps (options deemed unsuitable for this patient given the high risk of infection and sepsis), as well as other locoregional flaps of the forearm such as the ulnar artery and lateral arm flaps.^{3,8}

While free flaps are also used for soft tissue coverage of the fingers, nonfree flap options have predominantly been locally based, such as the cross finger or dorsal metacarpal artery flaps, which in this case would fail to resurface a circumferential defect. Additional consideration is given to the specific amputated digit and stumps, particularly of the thumb, as coverage should ideally provide sufficient soft tissue for further reconstructive procedures

without compromising microvascular recipients such as the radial artery and branches for toe transfers.³ Less commonly, a circumferential loss of soft tissue, caused by distal finger or thumb degloving injuries, may require the use of multiple flaps for reconstruction, which again is not ideal as it leaves multiple donor sites in an already injured hand.⁹

Following the principle of replacing like with like, we selected a RRAFF to circumferentially resurface a degloved middle and proximal phalanx. This case is distinguished by the fact that reconstruction required more soft tissue than could be adequately provided by other local options. The staged groin or chest flap and other free flap options carried an unacceptably high morbidity due to the patient's immunosuppression. We needed a single-stage, robust option that was simultaneously thin and pliable, while allowing glide without adhesions. An additional benefit of this procedure is the protection of other hand and finger structures during the reconstructive process, facilitating the patient's rehabilitation while maintaining the dexterity required for his occupation.

We demonstrate one of the first reported cases of a RRAFF circumferentially resurfacing a partially amputated, degloved finger. As surgical techniques become more refined, we demonstrate with this case that the reconstructive hand surgeon should consider the utility of less conventional flaps, such as the RRAFF, to achieve the goal of digital resurfacing with thin, pliable tissue in a single-stage operation.

Acknowledgments

Patient consent was obtained for the publication of images and data relating to the patient. The authors received no financial support for the authorship and/or publication of the manuscript.

References

1. Urbaniak JR, Evans JP, Bright DS. Microvascular management of ring avulsion injuries. *J Hand Surg Am.* 1981;6(1):25–30.
2. Benanti E, De Santis G, Leti Acciaro A, Colzani G, Baccarani A, Starnoni M. Soft tissue coverage of the upper limb: a flap reconstruction overview. *Ann Med Surg.* 2020;60:338–343.
3. Naalla R, Chauhan S, Dave A, Singhal M. Reconstruction of post-traumatic upper extremity soft tissue defects with pedicled flaps: an algorithmic approach to clinical decision making. *Chin J Traumatol.* 2018;21(6):338–351.
4. Akdag O, Karamese M, NebilSelimoglu M, et al. Reverse adipofascial radial forearm flap surgery for soft-tissue reconstruction of hand defects. *EPlasty.* 2016;16:e35–e35.
5. Jin YT, Guan WX, Shi TM, Quian YL, Xu LG, Chang TS. Reversed island forearm fascial flap in hand surgery. *Ann Plast Surg.* 1985;15(4):340–347.
6. Song R, Song Y, Yu Y, Song Y. The upper arm free flap. *Clin Plast Surg.* 1982;9(1):27–35.
7. Hentz VR, Pearl RM, Grossman JA, Wood MB, Cooney WP. The radial forearm flap: a versatile source of composite tissue. *Ann Plast Surg.* 1987;19(6):485–498.
8. Neumeister M, Hegge T, Amalfi A, Sauerbier M. The reconstruction of the mutilated hand. *Semin Plast Surg.* 2010;24(1):77–102.
9. Hao R, Wang B, Wang H, Yang H, Huo Y. Repair of distal thumb degloving injury using combination of reverse dorsoradial flap of the thumb and middle finger proper digital arterial island flap. *J Orthop Surg Res.* 2020;15(1). 417–417.