

Don't Shoot Yourself in the Foot: Reconstruction of a Through-and-Through Gunshot Wound of the Foot

Brittany Georgia Kay*
Nanda Kandamany, MBChB,
MRCS, FRCS (Plast)*

Summary: A 69-year-old man presented with an accidental, self-inflicted, through-and-through left foot gunshot wound. An entry wound on the dorsum of the foot was noted, with a larger exit wound on the plantar aspect. X-ray revealed comminuted fractures of the second, third, fourth, and fifth metatarsals with numerous foreign bodies. Immediate excisional debridement was performed, and negative-pressure wound therapy was applied. A second look was performed 48 hours later. Five days after initial debridement, a Kirschner wire was utilized for fixation of the second metatarsal fracture, and an external fixator applied to the fifth metatarsal due to extensive bone loss. A free gracilis muscle flap was used to fill the defect, with plans for a vascularized bone graft at a later date. The flap was tunneled through the wound to the plantar aspect of the foot, with an overlying split-thickness skin graft. The patient's postoperative course was uncomplicated, and secondary bone grafting was not required. The gracilis flap was used to reconstruct the bony and soft tissue defects, and secondary muscle fibrosis appeared to provide adequate skeletal support. The patient was full weight-bearing by 4 months and has since returned to his preoperative activities, baseline gait, and regular footwear. The free gracilis muscle flap may serve as a valuable reconstructive option for through-and-through gunshot wounds to the foot, restoring both contour and function, while eliminating the need for secondary bone grafting. (*Plast Reconstr Surg Glob Open* 2019;7:e2314; doi: 10.1097/GOX.0000000000002314; Published online 24 July 2019.)

The foot is a challenging area to reconstruct due to its complex anatomy and unique functional demands.^{1,2} Local tissues are limited, thus it can be difficult to concurrently optimize soft tissue coverage, contour, and weight-bearing.^{3,4}

Gunshot wounds to the foot can cause significant soft tissue damage, particularly at close range and high velocity.⁴ With timely surgical intervention and careful reconstructive planning, good functional and aesthetic outcomes are achievable. Very limited free flap options allow for restoration of baseline gait, limited pain on ambulation, and a return to regular footwear.¹

There are very few descriptions of the free gracilis flap being used for through-and-through gunshot injuries to

the foot. Due to the severity of soft tissue and bony destruction, below-knee amputation is often a preferable option,² allowing quicker healing time and early ambulation with a prosthesis. Pu et al.³ describe four patients with similar injuries who were treated with debridement and metatarsal stabilization, before a free gracilis transfer and split-thickness skin graft. In one patient, secondary iliac bone grafting for the first metatarsal was required. Our case management and outcomes are comparable to those of Pu et al.³ but differ in terms of specific pattern of injury.

CASE PRESENTATION

A 69-year-old man presented with a through-and-through left foot gunshot wound (Fig. 1). The patient was kangaroo hunting when he accidentally shot himself with a 0.222 caliber rifle and hollow point bullet. The patient drove himself home before presenting to the emergency department. A 1 cm entry wound on the dorsum of the foot was noted, with a 5 cm exit wound on the plantar aspect. There was gross contamination, poor perfusion of the fourth and fifth toes, and reduced plantar sensation. His medical history included atrial fibrillation, treated with dabigatran, digoxin, and verapamil. His baseline gait was mildly abnormal, secondary to a right femur fracture over 40 years ago.

Disclosure: The authors have no financial interest to declare in relation to the content of this case report.

From the *Department of Plastic & Reconstructive Surgery, Royal Hobart Hospital, Hobart, Tasmania, Australia.

Received for publication January 30, 2019; accepted April 30, 2019.

Statement of Conformity: This case report was conducted in accordance with the Declaration of Helsinki.

Copyright © 2019 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000002314



Fig. 1. Shotgun injury of the left foot, pre-debridement.



Fig. 3. Shotgun injury of the left foot, post-debridement with external fixator in situ.



Fig. 2. Preoperative radiographs of the left foot showing comminuted fractures of the third, fourth, and fifth metatarsals, with bone loss and foreign bodies.

X-ray and computed tomography revealed comminuted fractures of the third, fourth, and fifth metatarsals, with bone loss and multiple foreign bodies (Fig. 2a, 2b). Immediate excisional debridement was performed, with a second look 48 hours later. Negative-pressure wound therapy was applied after the first and second debridement.

Five days later, a retrograde 1.6mm Kirschner wire was used for fixation of the second metatarsal fracture, pre-

serving the medial plantar arch (Fig. 3). Due to extensive bone loss, an external fixator (Hoffman II-Compact; Stryker, Michigan, USA) was utilized for the fifth metatarsal fracture, preserving the lateral plantar arch, with plans for a secondary vascularized bone graft once adequate soft tissue coverage was achieved. An ipsilateral free gracilis muscle flap was harvested and tunneled through the wound. A split-thickness skin graft was applied to the dorsal and



Fig. 4. Views of the left foot at 6 months postoperatively. X-ray of the left foot at this time.

plantar areas of muscle. End-to-end microanastomosis was performed to the anterior tibial artery and vena comitans.

The patient's postoperative course was uncomplicated. The flap remained well-perfused, and there was 100% take of the dorsal and plantar split-thickness grafts. The external fixator was removed after 10 weeks.

Although initially planned, secondary bone grafting was eventually not required. The gracilis flap, presumably through secondary muscle fibrosis, provided adequate skeletal support. Partial weight-bearing was commenced at 11 weeks, and by 4 months, the patient had returned to his baseline gait. The flap continued to shrink, achieving excellent contour (Fig. 4a, 4b, 4c). X-ray at 7 months revealed osteopenia of the third, fourth, and fifth metatarsals

and no new bone formation Fig. 4d. His has since returned to activities of daily living and is able to fit into normal footwear (See Video, [online], in which, nine months postoperatively, the patient was able to return to use of regular footwear, as well as normal ambulation and baseline gait).

DISCUSSION

The foot serves as a dynamic platform on which posture is maintained. Although advances in microsurgery have allowed for foot reconstruction utilizing free tissue transfer, a through-and-through gunshot wound remains a challenge for the reconstructive surgeon. The severity of injury is influenced by the target distance, firearm, and

type of ammunition.⁵ This injury, involving a 0.222 caliber rifle with a hollow point bullet, created a high-velocity, blast-type injury with significant bone and soft tissue destruction.

Free flap selection is based on several factors, including wound surface area, type and volume of tissue deficiency, donor site morbidity, vascular pedicle length, and anticipated cosmetic outcomes.⁶ The rectus abdominis and latissimus dorsi muscles, with their long and prominent pedicle vessels, are common sources of free tissue transfer for lower limb salvage⁷; however, debulking is often required to allow for footwear and efficient ambulation.⁴ Furthermore, these donor sites are commonly associated with delayed healing, seroma, suboptimal scarring, and reduced function.⁶

It can be challenging to simultaneously optimize soft tissue coverage along with foot contour and weight-bearing,^{3,8} and the use of the free gracilis muscle appears to circumvent this. The gracilis muscle, with its long, slender shape, makes an excellent choice for soft tissue reconstruction of small- to medium-size areas,⁹ especially where flap tunneling is required. Furthermore, it can be harvested with minimal donor site morbidity,³ allowing early ambulation.

A through-and-through gunshot wound to the foot can have devastating effects for the patient. Below-knee amputation is often a preferable option to achieve quicker wound healing, ambulation, and return to work.² Rigid skeletal support is thought to be essential prior to full weight-bearing, and bone grafting is often utilized. This case suggests that the gracilis free flap can fill the typically deep but narrow wound, offering skeletal support, thus eliminating the need for secondary bone grafting.³

SUMMARY

This case suggests that a free gracilis muscle transfer serves as a valuable reconstructive option, especially for through-and-through gunshot wounds to the foot. The free gracilis flap may also eliminate the need for secondary bone grafting, while providing a satisfactory reconstructive outcome, with restoration of contour, skeletal support, and function.

Brittany Georgia Kay

Department of Plastic & Reconstructive Surgery
Royal Hobart Hospital
48 Liverpool St
Hobart, Tasmania, 7000, Australia
E-mail: brittany.kay@utas.edu.au

REFERENCES

1. Struckmann V, Hirche C, Struckmann F, et al. Free and pedicled flaps for reconstruction of the weightbearing sole of the foot: a comparative analysis of functional results. *J Foot Ankle Surg.* 2014;53:727–734.
2. Cho EH, Garcia R, Pien I, et al. An algorithmic approach for managing orthopaedic surgical wounds of the foot and ankle. *Clin Orthop Relat Res.* 2014;472:1921–1929.
3. Pu LL, Medalie DA, Lawrence SJ, et al. Reconstruction of through-and-through gunshot wounds to the feet with free gracilis muscle flaps. *Ann Plast Surg.* 2003;50:286–291.
4. Hollenbeck ST, Woo S, Komatsu I, et al. Longitudinal outcomes and application of the subunit principle to 165 foot and ankle free tissue transfers. *Plast Reconstr Surg.* 2010;125:924–934.
5. Bartlett CS. Clinical update: gunshot wound ballistics. *Clin Orthop Relat Res.* 2003;408:28–57.
6. Heller L, Levin LS. Lower extremity microsurgical reconstruction. *Plast Reconstr Surg.* 2001;108:1029–1041; quiz 1042.
7. Langstein HN, Chang DW, Miller MJ, et al. Limb salvage for soft-tissue malignancies of the foot: an evaluation of free-tissue transfer. *Plast Reconstr Surg.* 2002;109:152–159.
8. Li X, Cui J, Maharjan S, et al. Reconstruction of the foot and ankle using pedicled or free flaps: perioperative flap survival analysis. *PLoS One.* 2016;11:e0167827.
9. Calotta NA, Pedreira R, Deune EG. The gracilis free flap is a viable option for large extremity wounds. *Ann Plast Surg.* 2018;81:322–326.