

Metatarsal Reconstruction with a Fibular Osteocutaneous Flap: A Novel Approach Utilizing Virtual Surgical Planning

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Summary: Craniofacial reconstruction remains the main application for virtual surgical planning (VSP). We present a case in which this technology was applied to reconstruct a bony defect of the first metatarsal bone from a gunshot injury. VSP was used to facilitate a 1-stage reconstruction with a fibular osteocutaneous flap. A template of the reconstructed bone was designed based on the virtual mirror-image, noninjured bone. Prefabricated cutting guides facilitated precise shaping of the vascularized bone accounting for location of perforators. Successful reconstruction of the metatarsal bone was achieved with excellent functional outcomes. We believe that VSP can be a valuable tool in reconstruction of metatarsal bones by facilitating precise intraoperative shaping and anatomic orientation of the vascularized flap and reducing flap ischemia and operative time. (*Plast Reconstr Surg Glob Open* 2014;2:e258; doi: 10.1097/GOX.0000000000000223; Published online 21 October 2014)

CASE REPORT

A 32-year-old man presented to clinic 6 weeks following an accidental self-inflicted gunshot wound to the medial aspect of the right foot. He suffered a comminuted fracture to the right distal first metatarsal bone with a significant bony defect (Fig. 1) (**Supplemental Digital Content 1**, <http://links.lww.com/PRSGO/A61>). A free fibular osteocutaneous flap was planned to reconstruct the injured bone. Appropriate computed tomographic scans of bilateral lower extremities were obtained. Virtual surgical planning (VSP) using VSP Reconstruction software (Medical Modeling Inc.,

Golden, Colo.) was then undertaken by the reconstructive surgeon. The patient's preinjury metatarsal bone anatomy was restored virtually using the mirror-imaged contralateral foot. The fibular osteocutaneous flap was also virtually inset into the proximal segment of the injured bone and rotated to position the posterior/medial fibular surface and associated vessels toward the medial side of the foot to accommodate the dorsal plate (Fig. 2). Cutting guides were also developed for both the donor and recipient sites.

Intraoperatively, the prefabricated cutting guide facilitated the preparation of the metatarsal bone recipient site and allowed precise osteotomy of the residual distal bone (**Supplemental Digital Content 2**, <http://links.lww.com/PRSGO/A62>). A prefabricated surgical plate and plastic fibula template was fitted into the resulting defect in preparation for the fibula flap (Fig. 3). A fibular osteocutaneous flap was then raised from the contralateral leg with a skin paddle measuring 17 cm × 4 cm. Prefabricated cutting guides

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Fig. 1. Virtual image of comminuted fracture of the first metatarsal bone with significant bony defect.

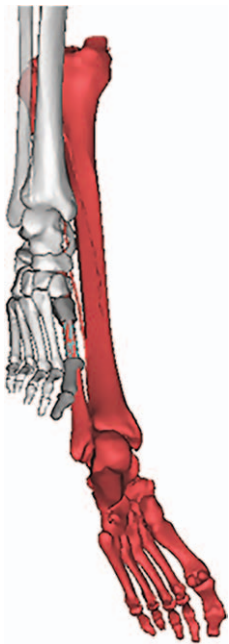


Fig. 2. The fibula osteocutaneous flap was virtually inset into the proximal segment of the injured bone and rotated to position the posterior/medial fibular surface and associated vessels toward the medial side of the foot to accommodate a dorsal plate.

were placed on the fibula to facilitate the osteotomies with the exact dimensions of the metatarsal bony defect (**Supplemental Digital Content 3**, <http://links.lww.com/PRSGO/A63>). Prefabricated dorsal plate was used for fixation of the flap to the proximal phalanx and base of the metatarsal bone. Microsurgical



Fig. 3. Prefabricated dorsal plate and plastic fibula template in position.

anastomosis of the peroneal artery and vein to the anterior tibial artery and a branch of the greater saphenous, respectively, was performed. The skin paddle was then inset on the dorsum of the foot and closed over a penrose drain. The patient tolerated the procedure well and was discharged postoperative day 3. Three-month follow-up demonstrates restoration of function and stability of the right foot (Fig. 4).



Fig. 4. Three months postoperative after reconstruction of the first metatarsal bone.

DISCUSSION

Metatarsal defects can be problematic for reasons beyond aesthetic shortcomings, including complications from acquired brachymetatarsia (abnormal shortening of the metatarsal that alters the biomechanics of the foot), metatarsalgia, and malposition of the intermetatarsal angle.^{1,2} Although there are a variety of interventions to treat bony defects of the foot,^{3,4} Lykoudis et al⁵ documented the benefits of 1-stage reconstruction relative to multistage procedures, such as simultaneous bone reconstruction and soft tissue coverage, accelerated bone union, prevention of postoperative bone resorption and collapse, and increased resistance to infection. Thus, indications in this case led to the fibular osteocutaneous flap being the best choice for the bone graft donor site.

Since the use of the fibular free flap in mandibular reconstruction was first described in 1989 by Hidalgo,⁶ it has come to be considered the gold standard for functional and esthetic rehabilitation after oncological surgery in maxillofacial reconstruction.⁷ Furthermore, as medical technology has advanced, the popularization and utilization of VSP software in complex craniofacial reconstructions has provided both intraoperative and postoperative benefits.^{8,9} As reported by Rodby et al,¹⁰ up to 80% of VSP procedures involved the fibular osteocutaneous flap, and benefits include increased accuracy of reconstruction, ease of use, decreased flap ischemia time and intraoperative time, and overall improved surgical outcomes.

By combining VSP technology and its associated benefits along with the utilization of a 1-stage reconstruction involving the fibular free flap, we believe that functional and structural stability of the reconstructed foot has been achieved along with optimal aesthetic results.

CONCLUSION

We believe that the use of the fibular osteocutaneous free flap in combination with VSP technology for reconstruction of complex midfoot defects provides

improved functional and aesthetic outcomes while reducing the possibility of surgical error, flap ischemia time, flap rejection, and postoperative infection. To the best of our knowledge, our case is the first report to utilize VSP in a reconstruction of this scope.

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