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Journal of Plastic, Reconstructive & Aesthetic Surgery

Volume 91, April 2024, Pages 3-5

Correspondence and Communications

Reconstruction of plantar forefoot in diabetic foot ulcers with microvascular tissue transfer using tunneled pedicle with dorsal anastomosis

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https://doi.org/10.1016/j.bjps.2024.02.039

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Traditionally, the free flaps to the plantar forefoot region were based on the donor vessels of the posterior tibial artery and its branches around the ankle. To access the posterior tibial artery, the whole of the sole needs to be dissected, and this adds to the morbidity of the procedure. Herein, we describe the use of the dorsalis pedis artery as a recipient vessel through trans-metatarsal pedicle route for the microvascular reconstruction of plantar forefoot defects in diabetic foot ulcers. This technique has been mentioned earlier,[1] but the use of this technique in a large series of patients has not been described. We describe the various nuances in performing this technique for reconstructing plantar forefoot defects.

The ulcer on the plantar forefoot region is debrided, and continuous dressings are done for the patient (Figure 1). Once the infection is under control, a free flap cover is planned. Through a dorsal exploratory incision, the dorsalis pedis artery is dissected (Supplementary Material Figure 2). At this level, the venae comitantes along the dorsalis pedis artery are usually not of sufficient caliber for microvascular anastomosis. The great saphenous vein and its tributaries are dissected for venous drainage. Care is taken here to ensure that there is significant subcutaneous tissue in the raised skin flaps, and the dissection is kept minimal to prevent skin flap necrosis.

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Figure 1. The intraoperative photograph showing the plantar forefoot defect in a patient with diabetes mellitus exposing the second, third, and fourth metatarsophalangeal joint.

Once the vessel dissection is completed and the vessels are satisfactory for microvascular anastomosis, the tunnel from the dorsum to the plantar forefoot region in the defect is created in the first intermetatarsal space. This tunnel is created just distal to the point where the dorsalis pedis artery dips from the dorsal side to the plantar aspect. Once the tunnel is made, the tunnel is widened using a cervical Hegar dilator, starting from the smallest size till 16 size Hegar dilator can be easily passed (Supplementary Material Figure 3). Once the tunnel is made, the free flap is harvested based on the size of the defect. The authors usually prefer a suprafacial ALT flap along with a long skeletonized pedicle (Supplementary Material Figure 4). Once the flap is harvested, the pedicle is tunneled from the plantar to the dorsal aspect through the pre-dilated tunnel, taking care to avoid twists (Supplementary Material Figure 5) (Video 1). Once the pedicle is brought into the dorsum of the foot, the anastomosis of the artery to the dorsalis pedis artery and venae comitantes to the saphenous vein and its tributaries are done. The authors prefer an end-to-side arterial anastomosis (Supplementary Material Figure 6). Once the anastomosis is completed, the dorsal incision is closed primarily after giving a few minutes of traction using a skin hook. This stretches the skin flap sufficiently to avoid compression on the anastomotic site. Later, the flap inset is given on the plantar aspect.

The following is the Supplementary material related to this article Video S1.

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Video S1. - Demonstration of the pedicle of the suprafacial ALT flap being tunneled from plantar to dorsal aspect taking care to avoid twists in the pedicle.

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Authors, in their experience between June 2022 and October 2023, have done nine such free flaps for the plantar foot defect using the intermetatarsal tunneled pedicle technique with the anastomosis in the dorsum of the foot (Figure 7). Eight free flaps were successful. One case had a delayed venous thrombosis, and the flap could not be salvaged despite prompt re-exploration and redo venous anastomosis. This patient also had high-grade perivenous fibrosis around the recipient vein. Two other cases required re-exploration, and in both cases, venous congestion was present at the time of re-exploration. In one case, the tunnel that was made for the pedicle to pass was not of sufficient size, and the anastomosis was taken down; the tunnel was further dilated, and then a redo anastomosis was done. In another case, there was a hematoma at 48 hours, which compressed the veins in the dorsal sutured wound, requiring evacuation. Once evacuated, the wounds could not be sutured again due to edema, and the dorsum of the foot was covered with a skin graft. In three cases, superficial discoloration and epidermolysis of the skin flap in the dorsum of the foot were noted. However, they settled well with dressings (Supplementary Material Figure 8).

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Figure 7. Six months follow-up photograph showing well-healed scar in the dorsum of the foot over the anastomotic site and the flap on the plantar aspect having good contour.

In this technique, it would be pertinent to look for a palpable pulse or ascertain good flow in the dorsalis pedis artery using non-invasive duplex arteriograms. The dorsal dissection should be minimal with the raising of skin flaps with sufficient subcutaneous tissue to avoid necrosis of skin flaps. A wide tunnel should be made, considering the postoperative edema and the chances of the pedicle getting compressed in a small tunnel. A thin free flap with a long pedicle, sometimes even a muscle flap with a long pedicle, such as a rectus muscle based on the descending branch of the lateral circumflex femoral artery, can be used in this technique. Care must be taken to avoid twisting of the pedicle while tunneling the pedicle.

In conclusion, the authors describe a microvascular reconstruction technique of plantar forefoot defects using intermetatarsal pedicle route and dorsal anastomosis. By this technique, the deformity of the forefoot is significantly reduced. No additional plantar scars or dissections are traditionally required to access the posterior tibial vessels. Furthermore, secondary offloading procedures may be required once the flap settles well to prevent the breakdown of the flap under the metatarsal heads.

Ethical approval

Not required.

Funding

None.

Declaration of Competing Interest

None declared.

Appendix A. Supplementary material

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Supplementary Material Figure 2. The intraoperative photograph shows the dorsal exploratory incision with an explored Dorsalis pedis artery and dissected saphenous vein and its tributaries. The orange color rubber band shows the tunnel created in the first intermetatarsal space.

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Supplementary Material Figure 3. The created tunnel has been dilated using Heger's cervical dilator.

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Supplementary Material Figure 4. Intraoperative photograph showing the harvested suprafacial ALT flap with its perforator dissected and long pedicle harvested.

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Supplementary Material Figure 5. Intraoperative photograph showing the tendon tunneller in the first intermetatarsal tunnel ready for the pedicle to be tunneled from the plantar to the dorsal aspect.

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Supplementary Material Figure 6. Shows the completed anastomosis in the dorsum of the foot.

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Supplementary Material Figure 8. Postoperative photograph showing the discoloration of the suture line in the dorsum of the foot which eventually healed with regular dressings.

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J Reconstr Microsurg, 32 (5) (2016), pp. 402-410, 10.1055/s-0036-1579536

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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