

Reconstruction of a soft tissue defect of the big toe by pedicled perforator flap



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The distal area is most frequently affected when the big toe is injured, however the plantar and dorsum can also be damaged. The management of soft tissue defects of the big toe still poses a lot of difficulties because local flaps are unreliable. We present an original technique that has been used to cover the injured big toes of a number of our patients. A perforator flap created from direct cutaneous arteries of the superficial branches of the medial plantar artery is used to cover the damaged area. This is a simple and effective technique with good end results.

Treatment of soft tissue defect on the distal of the big toe is challenging due to the lack of reliable options that can be used to create a local flap to cover the injured area. Following injury, soft tissue defects expose the structures, joints, tendons and bone. Even a small defect will become problematic if it is not managed appropriately.

Conventional reconstructive options include:

- Split-thickness skin grafting
- Adipofascial turnover flap
- Distal flaps based on the dorsalis pedis and microvascular free tissue transfer.

All of these procedures come with risks including morbidity at the donor site, incomplete functional recovery, infection and poor cosmetic outcome. In this article, we outline an original technique for reconstruction the distal of the big toe following soft tissue injury. The defect is covered with perforator flaps created from superficial branches of the medial plantar artery. This article describes the position of the flap and presents a technique that can be used to create the flap. A case series is also presented in which this technique has been applied.

Relevant arterial anatomy

The medial plantar artery is a continuation of the posterior tibial artery. It mainly supplies the muscles of the big toe and branches off into the plantar digital arteries. Its superficial branch gives rise to three or four perforators, which are direct cutaneous arteries that supply the skin on the medial side of the sole. The direct cutaneous arteries are linked together by direct

and indirect vessels. Macroscopic direct linking vessels form “bridges” between branches of the adjacent perforator vessels.

Preparation for surgery

Indications for flap reconstruction following soft tissue injury are the exposure of vital tissue, such as tendons and bone joints, and the defect being a suitable size for local flap coverage. A 4 MHz and 8 MHz hand-held Doppler is used to identify potential recipient vessels and trace the perforators of the flap. Prior to surgery, the limb to be operated on is immobilised by a splint for 7 days. The area is warmed up by light exposure before surgery.

Surgical technique

A skin incision 3–4 cm long is made on the medial aspect of the foot, from the proximal first metatarsophalangeal joint to the first metatarsal shaft. The dorsal and ventral flaps are then raised. Watch for the medial branch of the dorsal cutaneous nerve (superficial peroneal nerve) and the medial marginal vein when the dorsal flap is raised. The plantar fascia is incised along the length of the incision to expose the perforator vessels of the superficial branches of the medial plantar artery [Figure 1]. This artery enters the membrane of the flexor hallucis brevis muscle and is 1.5–2.0 cm from the first metatarsophalangeal joint. The flap is designed around the skin of the medial side of the foot. The width of the flap should equal the width of the defect. The length of the flap needs to be equal to the length of the defect plus the distance from the proximal wound edge

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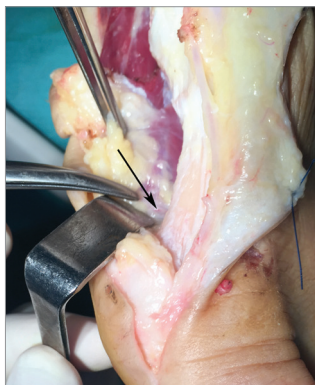


Figure 1. The pedicle of the flap is isolated (see black arrow).

to the perforator pedicle in order to create a propeller-type flap. We always harvest from the proximal flap edge to the perforator, creating a flap that is 1.5 cm wide. The flap is rotated 180 degrees to cover the soft tissue defect of the big toe.

The donor site is closed using the primary intention method following flap harvest.

Post surgery

Patients are not routinely prescribed aspirin or heparin following surgery. The success of the procedure is assessed by flap survival and healing of the margins. The donor site closed and healed about 2 weeks after surgery. The foot healed well about 6 weeks after surgery.

Case series

Between March 2016 and February 2017, three patients with a soft tissue defect on their big toe were treated by our team.

Patient 1, 36-year-old male, presented with a distal defect covering an area 2.5 cm × 3.0 cm [Figure 2a]. The proposed flap was marked prior to surgery, with markings being guided by Doppler [Figure 2b]. The 2.5 cm × 4.0 cm flap was then harvested [Figure 2c], rotated and attached to the side of the big toe [Figure 2d]. We created a pedicle that was 4 cm in length. The donor site immediately closed by primary intent to ensure a good cosmetic outcome. The foot healed well after surgery, with minimal scarring [Figure 2e and 2f].

Patient 2 was a 44-year-old male with soft tissue defect of the plantar region that measured 2.5 cm × 3.0 cm in diameter [Figure 3b]. He was referred for surgery and a flap 2.5 cm × 4.0 cm was marked and harvested

from his foot [Figure 3b and 3c]. The defect was covered with a perforator flap created from the direct cutaneous arteries of the superficial branches of the medial plantar artery [Figure 3d], the donor site was closed, and Patient 2's foot was found to be healing well 7 days postoperatively [Figure 3e and 3f].

Patient 3 was a 21-year-old woman who had a 5.0 cm × 5.0 cm injury to the dorsum that was closed with a 2.5 cm × 5.0 cm flap with a pedicle that was 3 cm long. The donor site was successfully closed following flap creation.

All of the flaps survived without any complications related to the flap or donor site. The patients are comfortable when wearing shoes and have regained normal function of the big toe.

Discussion

Covering big toe tissue defects is a challenge because the soft tissue in this area is thin. Skin grafting is a poor option because the recipient bed is inadequate. Local random flaps are often unreliable due to local trauma or chronic scarring (Attinger, 1995).

The problem is more complicated when important structures, such as joints, tendons and bones, are exposed or injury is associated with fractures, osteomyelitis and acute infection (Attinger et al, 2002).

The adipofascial turnover flap offers the advantages that:

- It can be created during a relatively simple operative procedure
- It involves a shorter operation time than other reconstructive options
- It is reliable
- It results in minimal donor site injury.



Figure 2. Patient 1: Flap markings [a] for repair of the soft tissue defect of the distal region [b]. Creation of the perforator flap [c] and rotating it to cover the defect [d]. Post operative view from the side [e] and the top [f].



Figure 3. Patient 2: [a] Soft tissue defect of the plantar region; [b] flap markings; [c] flap harvest, [d] covering the defect with perforator flaps; [e] and [f] the foot a week after surgery.

The durability of the skin graft over an adipofascial flap is questionable, however, as it must be subjected to the daily trauma of ambulation.

The dorsalis pedis flap was first described by McGraw and Furlow in 1975. It was not until 1987 that it was utilised as a distally-based pedicled flap to cover defects of the distal foot (Ishikawa et al, 1987). The use of the dorsalis pedis flap is limited as it leaves an aesthetically unpleasing scar at the donor site and damages the dorsalis pedis artery, which is the main source of blood supply to the toes.

Free flaps are effective for the repair of a wide range of skin defects. They do, however, require the use of special instruments and microsurgical techniques that are not always available (Karp et al, 1994). This limits their use in some countries.

To our knowledge, this is the first time the creation of a perforator flap from the direct cutaneous arteries of the superficial branches of the medial plantar artery has been reported. The blood supply for this flap is obtained from the vascular network between branches of the adjacent perforator vessels. We think that this method is simpler than the creation of a free flap because it does not necessitate microsurgery, shortens the operative time and avoids the risk of thrombosis. Other points in its favour are that we do not need to sacrifice the main artery supply to the foot, as occurs during the creation of a distally-based pedicled flap, and the scar at the donor site is located at the medial aspect of the foot resulting in a wonderful aesthetic result, as can be seen in *Figure 2e* and *2f*.

Conclusion

We feel that the creation of perforator flaps from direct cutaneous arteries of the superficial branches of the medial plantar artery to cover soft tissue defects of the big toe is safe and provides a good aesthetic result. We therefore propose that this is a simple and effective technique for patients with soft tissue defect of the big toe.

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