DORSALIS PEDIS CUTANEOUS PERFORATOR FLAP

The Dorsalis pedis cutaneous flap is one of the earliest neurovascular flaps to be described; as its origins can be traced as far back as 1897 and 1900 when the Austrian surgeon Carl Nicoladoni described his procedure to transfer a toe to the hand to reconstruct a lost thumb[117,118]. Handicaps and complications derived from attempting to immobilize the hand attached to the foot caused the procedure to be abandoned.

In 1973 O'Brien and Shanmugan[121] suggested the possibility of raising a free flap based on the Dorsalis pedis artery. In 1975, McGraw and Furlow[106] described the Dorsalis pedis arterialized flap. Further studies about macro and microcirculation of the Dorsalis pedis artery[90,94] aided the description of the dorsalis pedis artery angiosome that includes the entire dorsal aspect of the foot with tendons, muscle (extensor digitorum brevis) and bone (metatarsal bones) supplied by the medial tarsal, lateral tarsal, arcuate and dorsal metatarsal arteries. This angiosome facilitated the development of a panoply of flaps and thumb reconstruction by means of toe transplants based on the Dorsalis pedis artery. This flap has the advantage of being capable of transferring thin pliable skin and subcutaneous tissue, even in overweight patients.

Since its description, this flap has been widely used as a proximal pedicled flap, distally based flap, free flap or composite flap containing tendons, muscle or bone.

This is a difficult flap to elevate and potential problems at the donor site should be taken into consideration, as they are not insignificant. Specifically, failure to preserve the paratenon layer will lead to poor healing of the donor site.

Indications

Indications for this type of flap are multiple and mainly depend on whether the flap is elevated as a pedicled flap or free flap. As a pure cutaneous flap or muscular (extensor digitorum brevis) flap[85, 89], the flap has been described to repair dorsum defects of the foot (Lai)[87], heel defects or distal foot defects[53,68]. As a free flap it has been extensively used to repair soft tissue defects on the head and neck area[11,36,166] as well as to repair bone defects of the mandible[167], the hand, and digits[69,104].

Vascularization and anatomy

The Tibialis anterior artery, at the level of the ankle, takes the name of the Dorsalis pedis artery. It courses distally lateral to the extensor hallucis longus and medially to the tendon of the extensor digitorum longus and the medial terminal branch of the deep peroneal nerve. Above the tarsus it gives off a lateral branch: the lateral tarsal artery, which passes deep to the extensor digitorum brevis and supplies this muscle, and the arcuate artery from where the second, third and fourth metatarsal arteries emerge. Finally, the Dorsalis pedis artery reaches the first intermetatarsal space and divides into two terminal branches, the first dorsal metatarsal artery and the deep plantar artery. The first dorsal metatarsal artery courses forward towards the first web space above the deep transverse metatarsal ligament to give three terminal branches. One branch courses on the dorso-lateral aspect of the great toe, another on the dorsal aspect of the medial side of the second toe and the third acts as a communicating branch with the first plantar metatarsal artery.

Markings

Routine angiography and/or Doppler examination are not necessary if adequate independent dorsalis pedis and posterior tibial pulse are present. The flap is outlined centered on the second metatarsal. The proximal boundary is over the extensor retinaculum while the distal one is proximal to the interdigital web spaces. Laterally it can be extended up to 1 cm from the extensor digiti quinti and medially up to 1 cm from the extensor longus tendon. Proximal to the skin paddle a longitudinal incision is made over the axis of the flap to facilitate access to the vascular, nerves and tendinous structures supplying or traversing the flap. When a superficial dorsal intermetatarsal artery is present (Doppler assistance is then necessary) the cutaneous island of the flap can be extended distally to the base of the toes.

The Dorsalis pedis cutaneous perforator flap can be raised proximally or distally based, depending on where the defect is. If it is intended to cover medial or lateral ankle defects, the flap is best harvested proximally based. The flap can also be raised as a free flap to repair distal

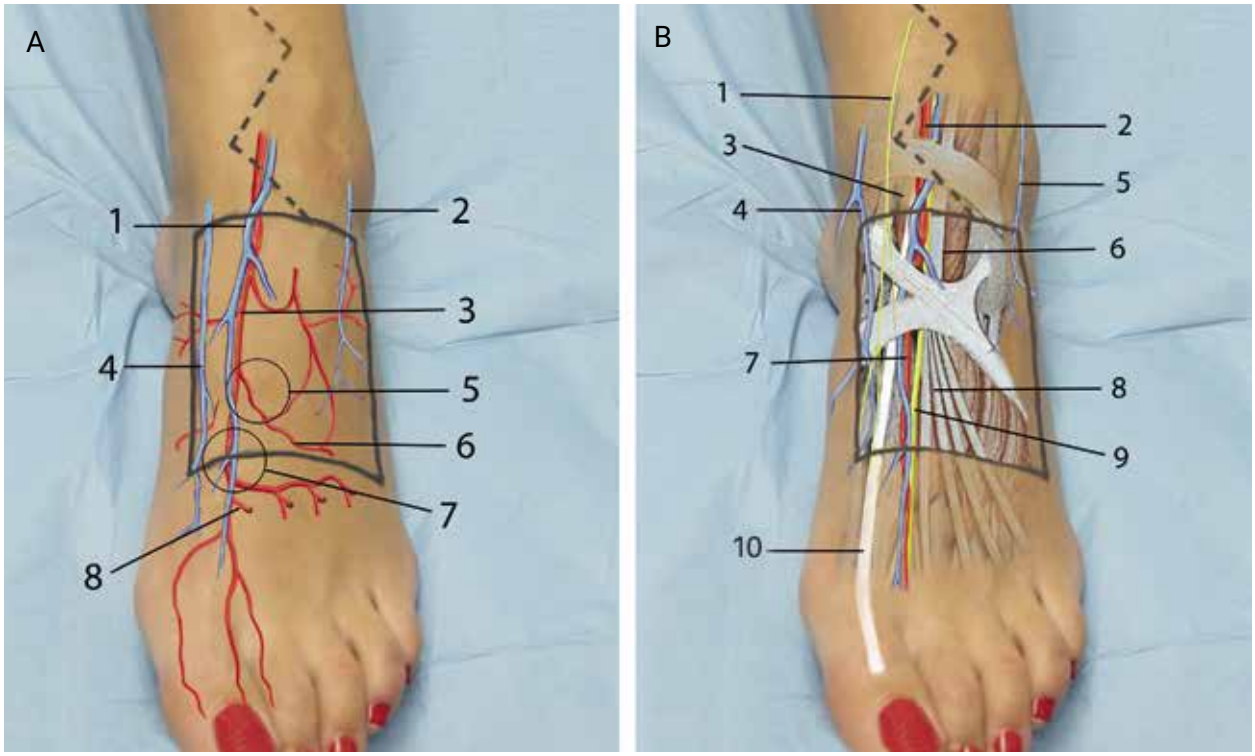

Figure 7.164. Dorsalis pedis skin flap main vascular and anatomical references.
A) 1: Dorsalis pedis vessels. 2: Lateral vein. 3: Dorsalis pedis artery. 4: Medial vein. 5: Area of skin perforators from the lateral tarsal artery and first muscular head of the extensor digitorum brevis. 6: Lateral tarsal artery. 7: Area of skin perforators from the first dorsal metatarsal artery. 8: Plunging branch of the Dorsalis pedis artery.
B) Anatomy of the DPCP flap: 1: Superficial peroneal nerve. 2: Anterior tibial artery. 3: Extensor hallucis longus muscle. 4: Distal branch from the Saphenous vein. 5: Lateral vein. 6: Extensor digitorum longus. 7: Dorsalis pedis vessels. 8: Tendons of the extensor digitorum longus. 9: Deep peroneal nerve. 10: Tendon of the extensor hallucis longus.

defects. In this case, selection of the left or right foot as a donor site is done depending on the recipient area and recipient vessels. It seems that for hypopharyngeal, mandibular or floor of the mouth defects, it is better to select the contralateral foot[167].

Elevation

Elevation starts by doing a small incision proximal to the cutaneous island to identify and preserve the vascular pedicle, the internal saphenous vein and the superficial peroneal nerve. Only after all these important structures have been identified, can the skin paddle be elevated from medial to lateral. To keep the vascular pedicle properly connected with the skin paddle it is usually necessary to divide the tendon of the extensor hallucis brevis muscle. It is extremely important to preserve the paratenon of all exposed tendons, as well as all areolar tissue exposed, to leave a reliable layer to the skin grafts.

It is a thin, sensitive and pliable flap, which is easy to adapt to proximal defects of the foot and distal third of the leg, as well as for defects around the mouth and neck.

However, it is also a difficult flap to elevate because the tissue connecting the artery with the skin is very thin, even in overweight patients. And the resulting defect at the donor area may be aesthetic and functionally limited.

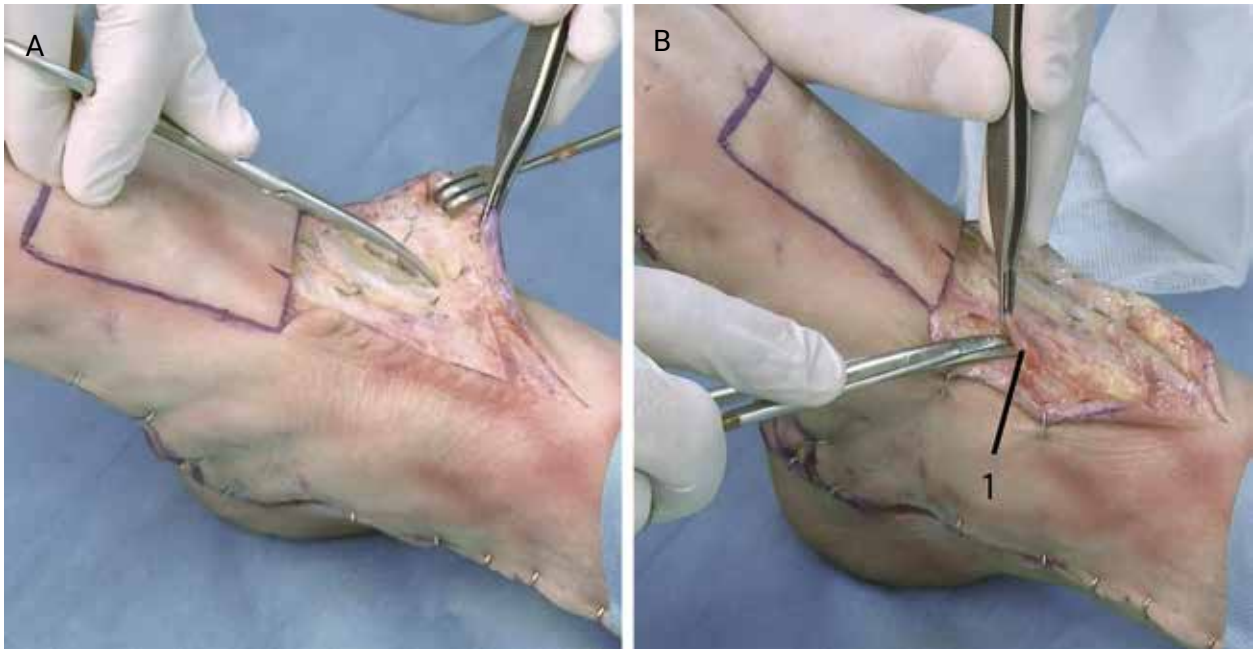

Figure 7.165. A) The incision begins proximally to the skin paddle exposing all subcutaneous structures and the skin edges reflected on top to expose the superficial peroneal nerve and the great saphenous vein. B) Great saphenous vein (1) is isolated from deeper structures and is left attached to the subcutaneous pedicle.

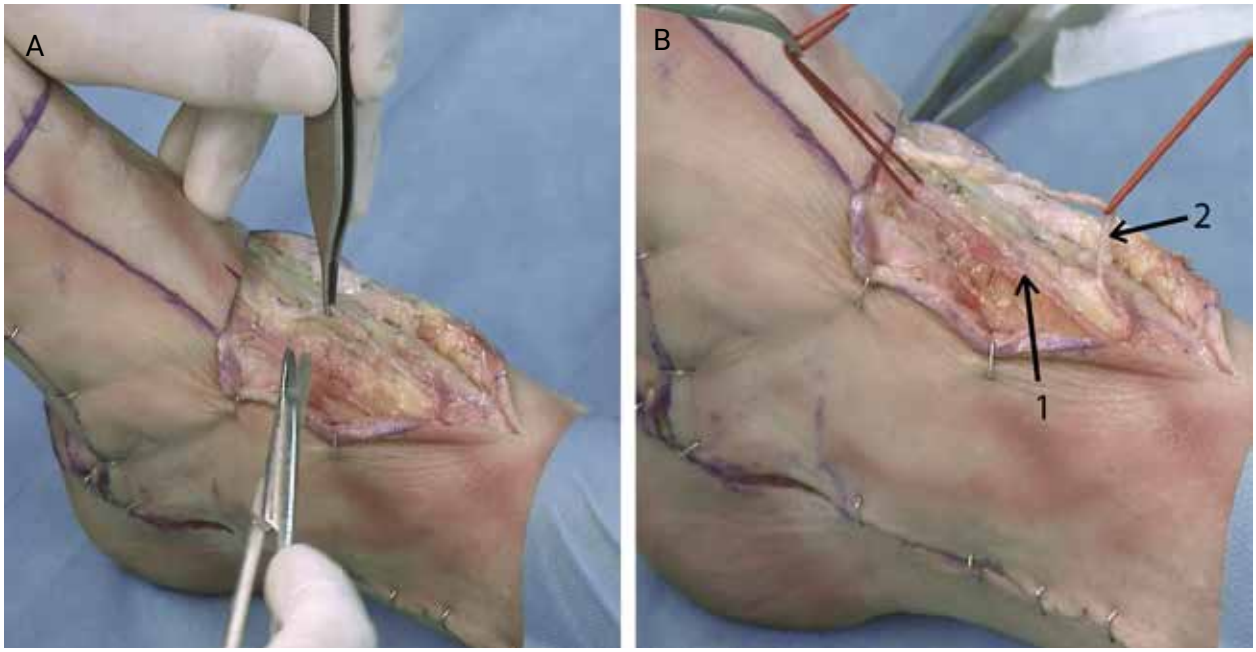

Figure 7.166. A) Superficial peroneal nerve is dissected free, and, B) both, the medial vein and the superficial peroneal nerve are isolated and pulled apart with rubber bands.

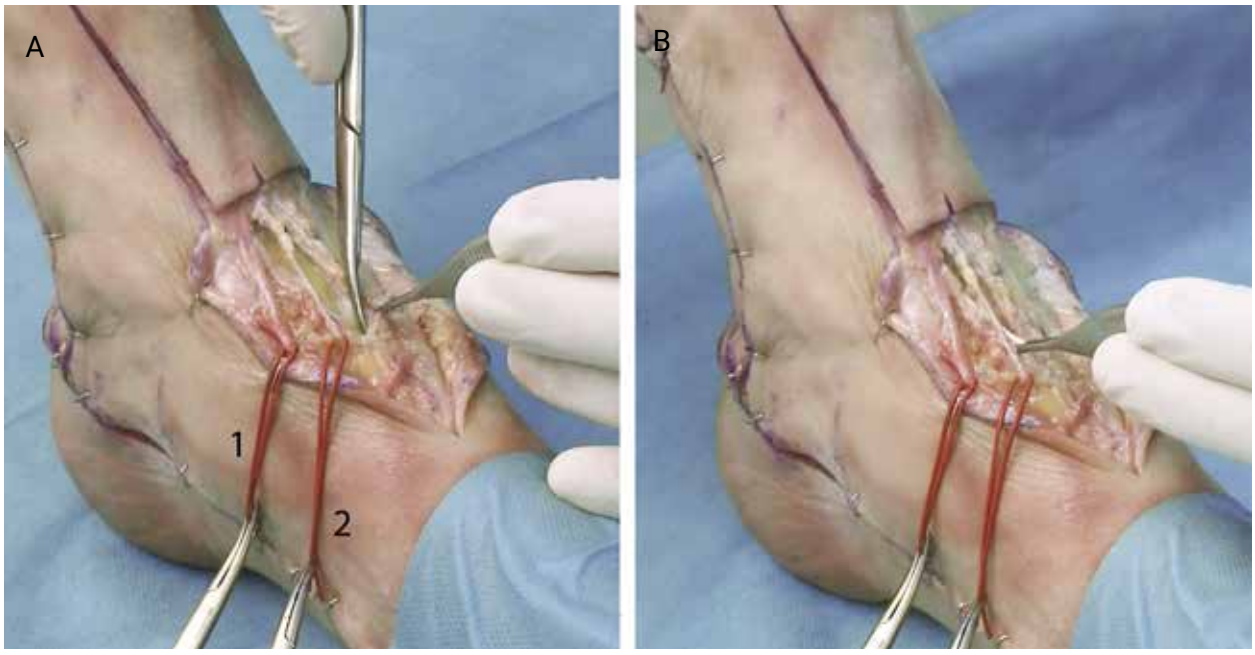

Figure 7.167. A) The extensor retinaculum is opened to expose the underlying structures while the medial vein and the superficial peroneal nerve are pulled medially by rubber bands. B) Proximally, the extensor hallucis longus is identified with great care, as the artery is found deep to the tendon at this level (as it crosses from the medial to the lateral side of the extensor hallucis longus muscle).

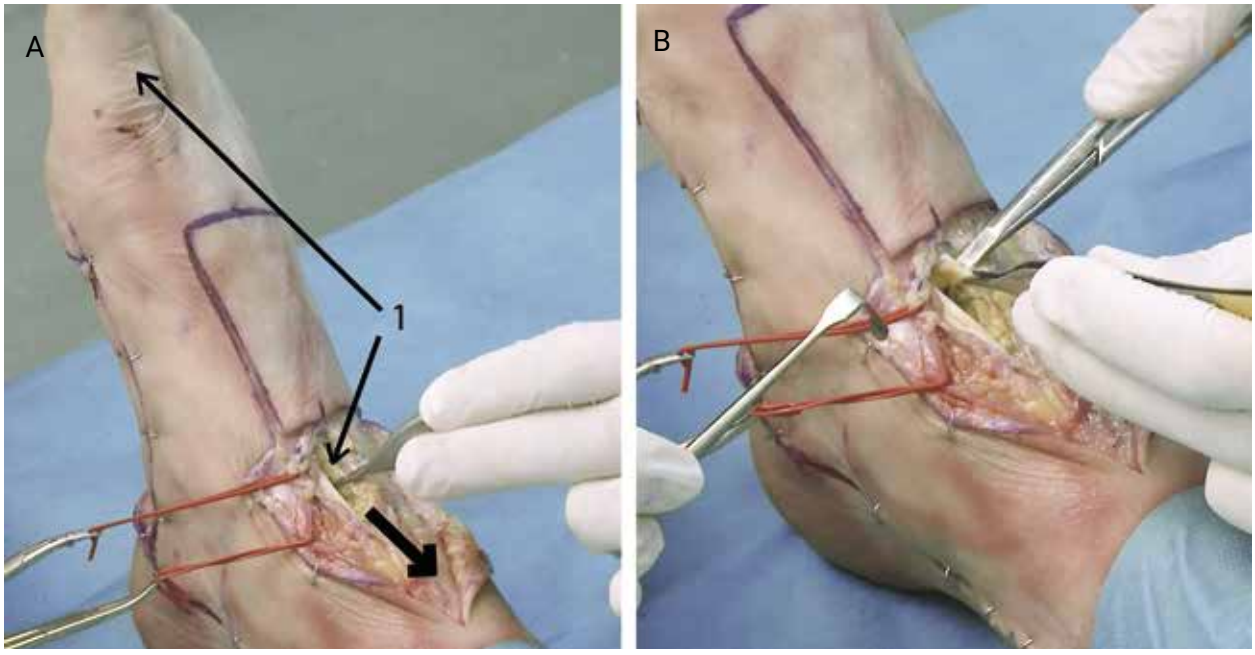

Figure 7.168. A) Extensor hallucis tendon is identified by pulling it proximally which will result in a movement of the toe. B) The extensor hallucis longus (1) is then traced down towards the skin paddle proximal boundary. At this level the Dorsalis pedis artery is found lateral to the tendon.

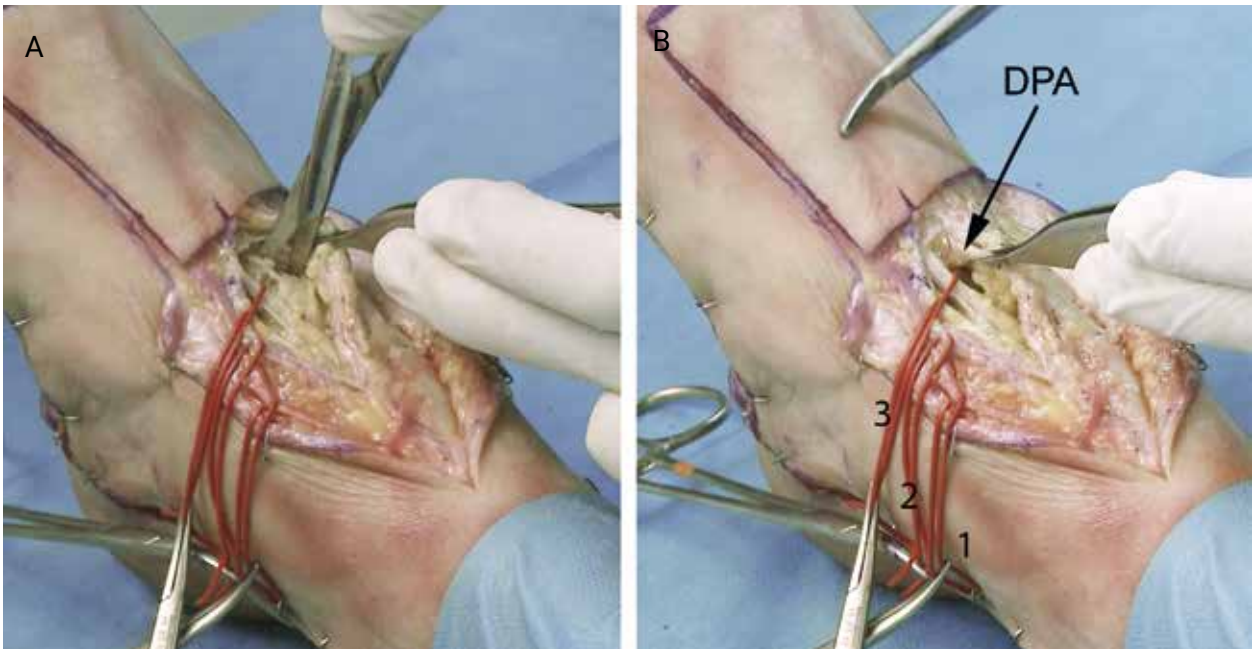

Figure 7.169. The Dorsalis pedis artery (DPA) is now dissected free by blunt dissection and isolated.

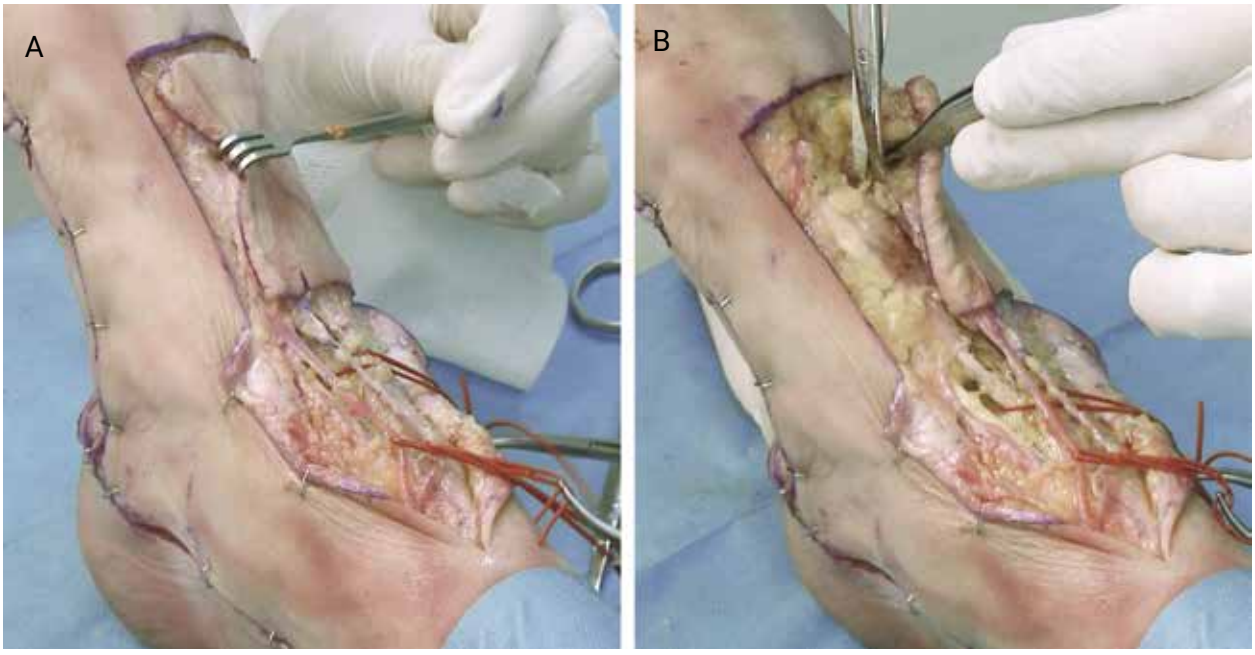

Figure 7.170. A) Skin paddle is elevated from the medial to the lateral side and veins branching off the great saphenous vein are divided and ligated. The extensor hallucis longus is identified distally and preserved. B) The extensor hallucis tendon is retracted medially and the first tendon of the extensor digitorum brevis exposed. Below this tendon the plunging branch of the Dorsalis pedis artery is found.

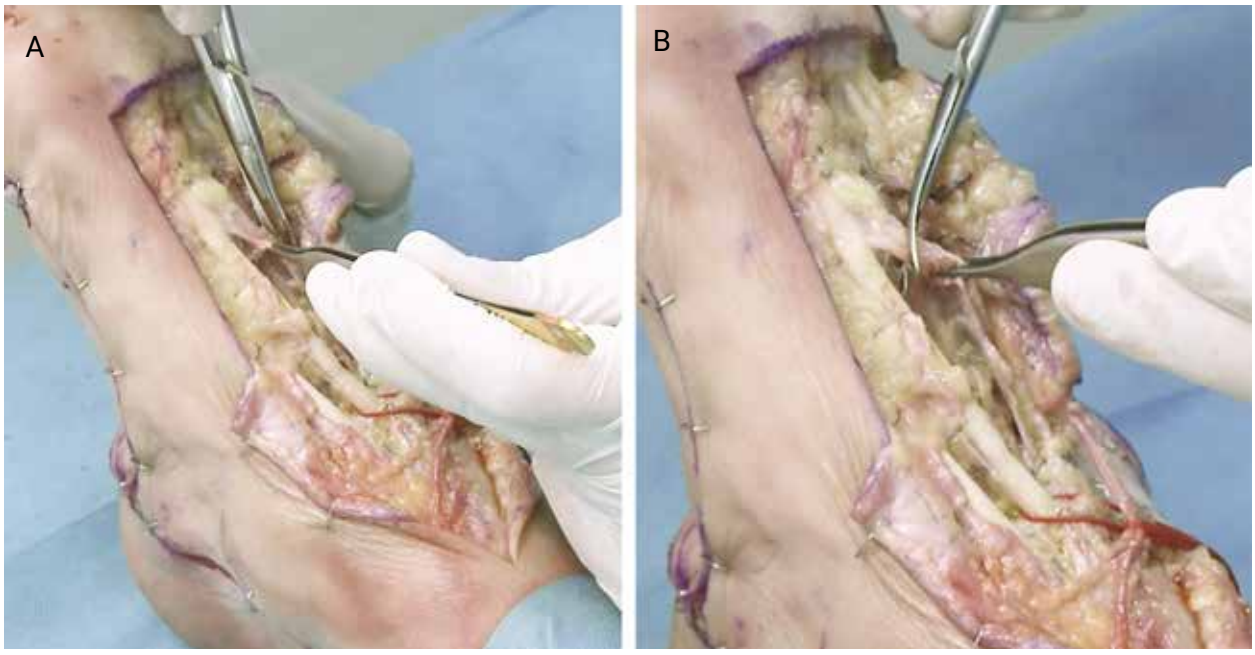

Figure 7.171. A) The first tendon of the extensor digitorum brevis is isolated, and divided where it inserts into the tendon of the extensor hallucis longus. B) Distal branches of the superficial peroneal nerve are also divided at this stage.

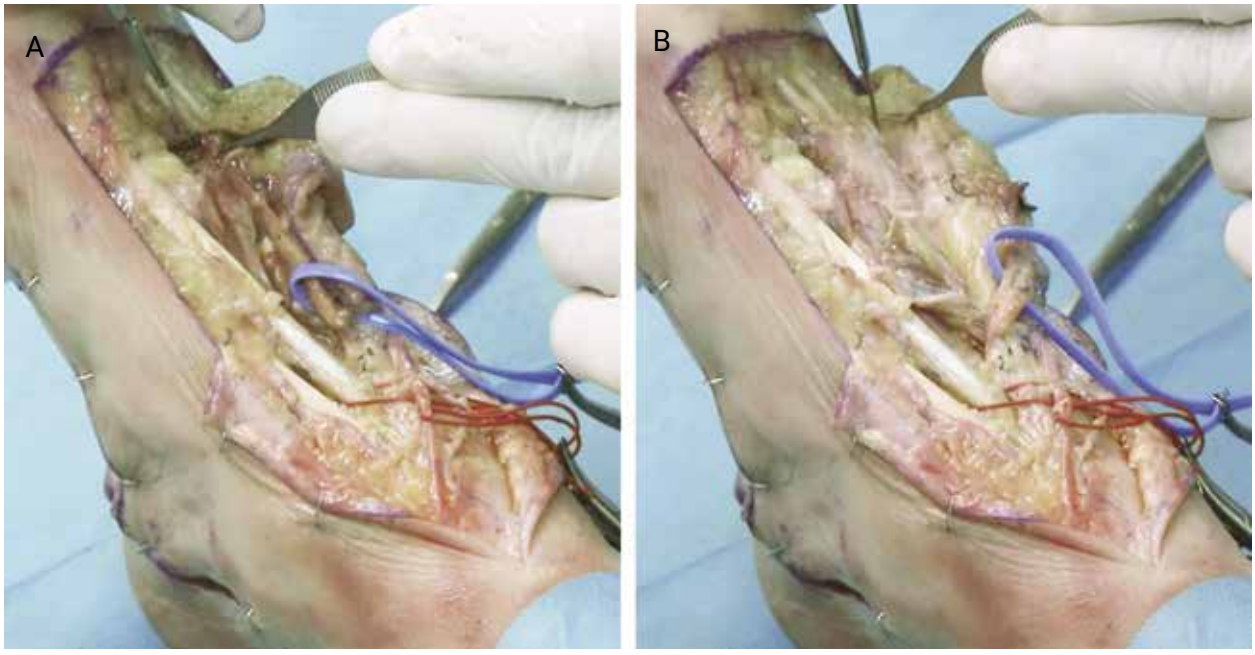

Figure 7.172. The first metatarsal space is explored to search the Dorsalis pedis artery. The plunging branch of this artery is also ligated and divided. B) The artery is ligated distally and divided and the flap is carefully elevated from distal to proximal below the first dorsal metatarsal and Dorsalis pedis arteries that are left attached to the flap.

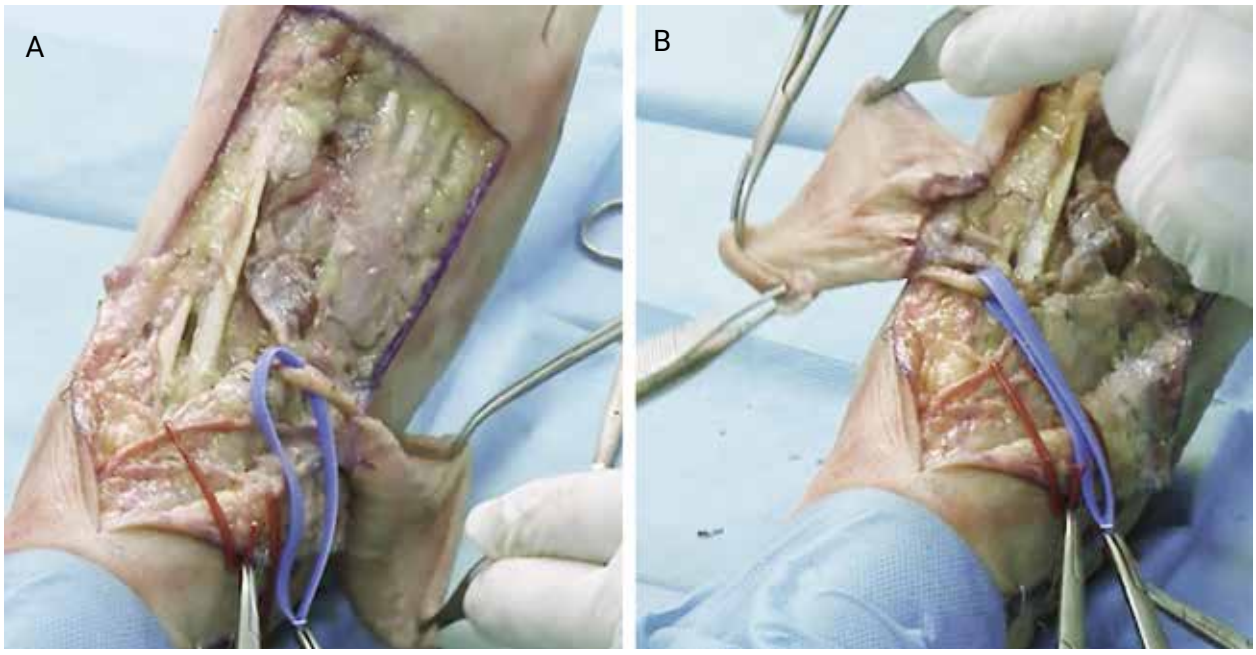

Figure 7.173. A) With the artery isolated, the flap is detached laterally. Lateral elevation should be performed carefully to preserve the paratenon, (the loose and well-vascularized areolar tissue covering the extensor tendons.) This tissue will provide a suitable bed for split-thickness skin grafting. Injuries, lacerations or accidental tears to this layer, if not properly repaired, will result in poor healing with important aesthetic and functional impairment of the donor area.

Donor area aftercare

The resulting scar and deformity in the donor area is one of the main setbacks of this flap. Donor-site healing complications will invariably occur if vascularized paratenon has not been preserved. The donor area is best repaired with split-thickness skin grafts covered by a bolus dressing.

The patient should lie in bed with the foot elevated, with bed rest for at least 10 days, avoiding movements. The ankle and foot are maintained in neutral position with a posterior splint.