POSTERIOR TIBIAL ARTERY PERFORATOR FLAP

This is a medium- sized thin flap that is commonly harvested as a pedicled flap. It represents one of the workhorse flaps for small-medium size defects of the lower leg.

It is supplied by perforator branches from the posterior tibial artery, which communicates and anastomoses distally at the malleolar region with the anterior tibial and peroneal arteries, creating a rich network of communicating vessels that allow harvesting the flap as a distally based flap.

The posterior tibial artery and its perforators have been extensively studied and significant differences regarding the number of perforators are found between different authors. A minimum of 2 to 5 perforators reported by Wu et al.[156], between 2 and 8 by Leong Kim) to a maximum of 4 to 9 reported by Tang et al.[142]. According to Koshima et al.[83] the tibial artery gives off septocutaneous, musculocutaneous, and periosteocutaneous perforators. It is important to know that this artery may be weak or can be congenitally absent[26].

This is a highly versatile flap that can be based on inferior, middle or upper perforators, and can be transferred by rotation, V-Y advancement or as a propeller flap. It can also be raised as a fasciocutaneous or adipofascial flap, or as a composite flap containing a small cuff of muscle, bone or tendon. However, harvesting bone from the tibia is not a good idea and this version of the flap is very rarely used.

As for all perforator flaps, degloving injuries, local trauma or burns represent a complete contraindication. While relative contraindications may include diabetic and obese patients, vein thrombosis, peripheral vascular diseases and heavy smokers. All these factors are indicative of serious complications and high-risk flap necrosis.

However, some disadvantages accompany the harvesting of this flap, such as, loss of sensation distal to the flap and noticeable scars, especially if skin grafts have been used to repair the donor area.

Indications

This flap is generally used as a pedicled flap to repair minor to medium size full thickness defects of the lower leg, where tendons, joints or bone are left exposed. Though it has also been used as a free flap[79], there are numerous perforator flaps with large-diameter vessels available.

Depending on which of the perforators is selected, the flap can be raised as a proximally or distally based flap to repair defects on the proximal, medial or distal aspect of the lower leg.

Vascularization and anatomy

The posterior tibial artery perforator flap is based on perforator vessels emerging along the course of the posterior tibial artery (7.3-6). It begins at the lower border of the popliteus muscle and courses down in the deep posterior compartment between the flexor digitorum longus and soleus muscle giving off several branches. These perforator vessels arise in the intermuscular septum between the soleus muscle and flexor digitorum longus muscle and/or the medial border of the tibia[14] to anastomose superiorly with terminal branches from the descending genicular artery and anteriorly with terminal branches from the anterior tibial artery. Distal perforators are usually larger and these are the ones, which are selected to harvest the flap as a free flap[66].

According to Shaverian et al.[138] perforator vessels on the medial aspect of the leg can be found at a distance of about 4 cm -8 cm, 13 cm -17 cm and 21 cm -25 cm from the tip of the medial malleolus.

The skin vascularized by these perforators extends proximally from the tibial tuberosity and distally to the tip of the medial malleolus and, anteriorly from the anterior border of the tibia to the posterior midline of the calf.

Venous drainage of the flap mainly comes from the venae comitantes and secondarily from the superficial vein system of the leg, draining at the greater and lesser saphenous veins.

Sensory innervation mainly comes from branches of the long saphenous nerve while at its posterior aspect, cutaneous innervation comes from branches of the sural nerve.

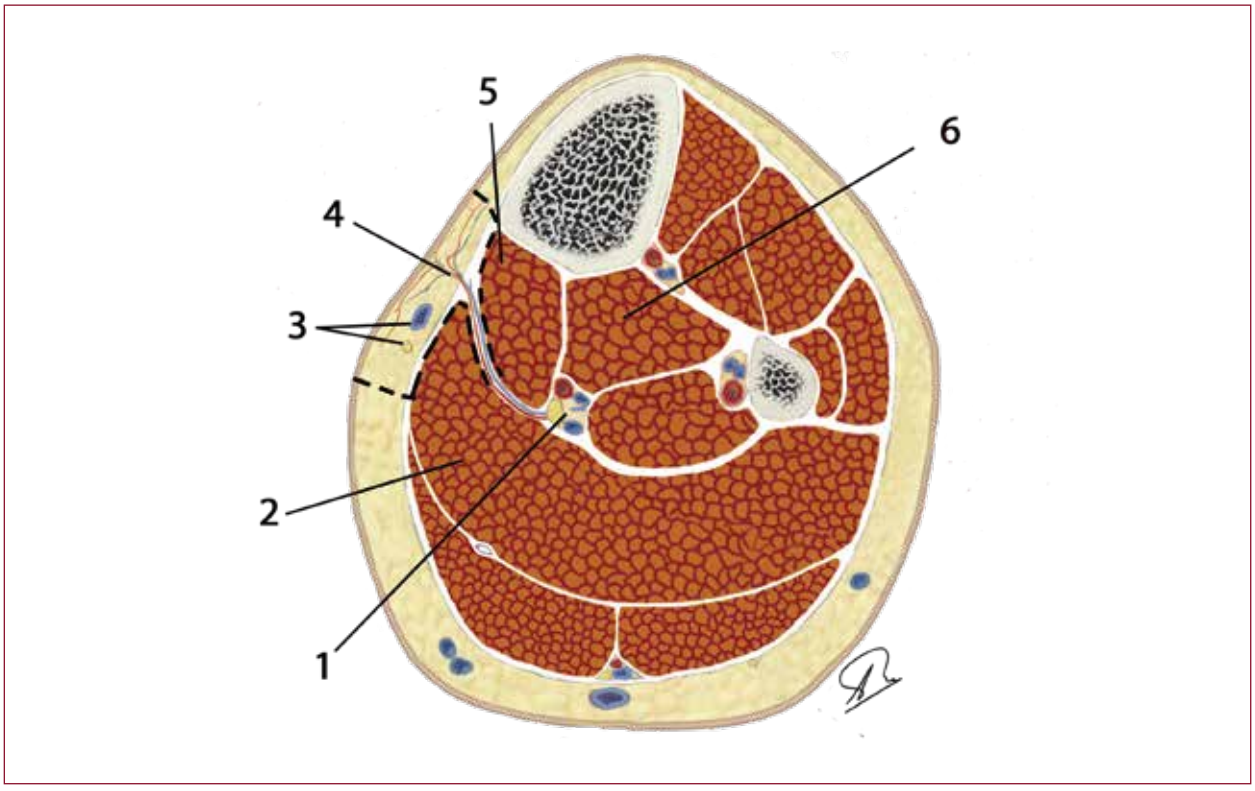

Figure 7.107. Anatomical relationships for the Posterior tibial artery perforator flap. Although the nourishing vessel shown here is a septocutaneous perforator (4), perforators supplying the flap can also be musculocutaneous (traversing the flexor digitorum longus, 5), or a combination of both, branching off from the posterior tibial vessels (1). Other references are the soleus muscle (2), the greater saphenous vein and saphenous nerve (3) and the Tibialis posterior muscle (6).

Markings

Two points are first marked out, one proximal on the tibial tuberosity and other distally on the tip of the medial malleolus. A line is traced between them. Over this line is where the majority of septocutaneous perforators from the tibial artery emerge. Depending on which cluster of vessels is intended for use, red crosses are marked out over the line at the mentioned distances (about 4-8 cm, 13-17 cm and 21-25 cm from the tip of the medial malleolus). Doppler acoustic assistance rarely localizes the exact points of emergence as the nearby presence of important arteries makes this type of exploration very difficult and inaccurate. However it is generally used as assistance.

As in most perforator flaps, external markings are approximate references and the final location and shape of the skin island is incised only after the best perforator artery has been identified. As in most perforator flaps, it is the defect that should adapt to the flap. What happens with this flap is that it is highly versatile in location and form. The skin island can be outlined as an ellipse, V-Y propeller type of flap or as an irregular triangle for V-Y advancement flap.

Elevation

The skin is incised deep to the fascia, which is left included with the flap and only over one of its margins. Through this incision the elevation is performed carefully to identify all perforator vessels emerging through the septum and entering into the cutaneous paddle. The best positioned and largest one is selected. The flap is then finally outlined according to the perforator found, and incised.

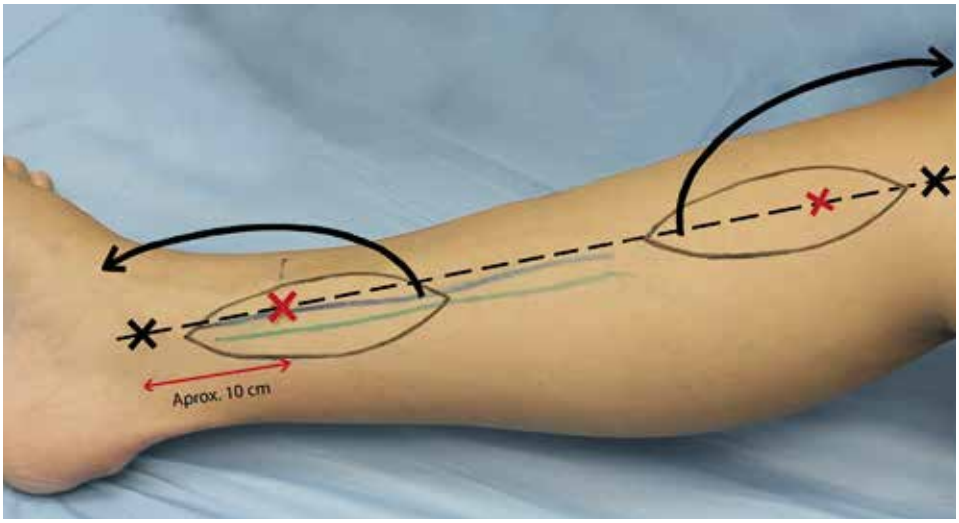

Figure 7.108. Proximal and distal types of Ellipse cutaneous island flaps. The perforator artery is always left on one extreme to allow rotation and transfer of the flap.

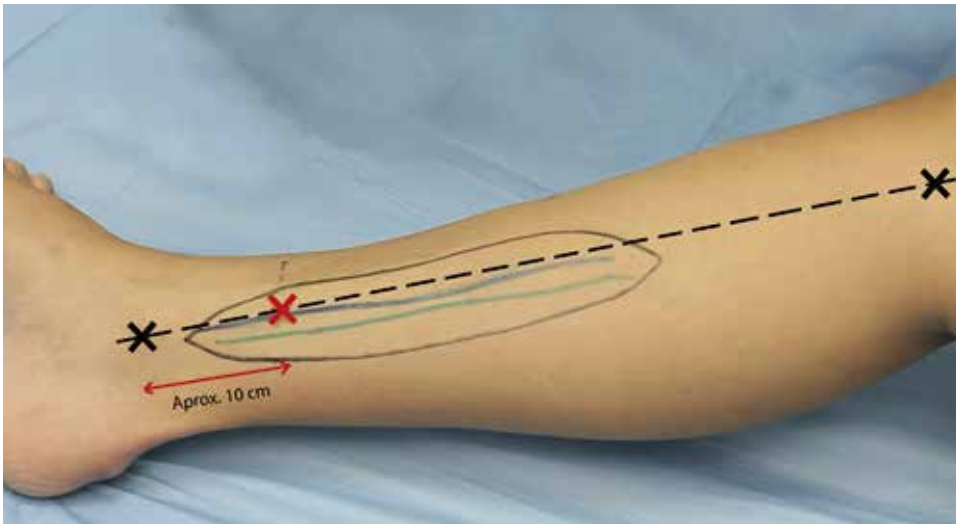

Figure 7.109. Pedicled skin island propeller flap design. Flap is designed with a perforator on one extreme and the flap rotated as needed,120º to 180º.

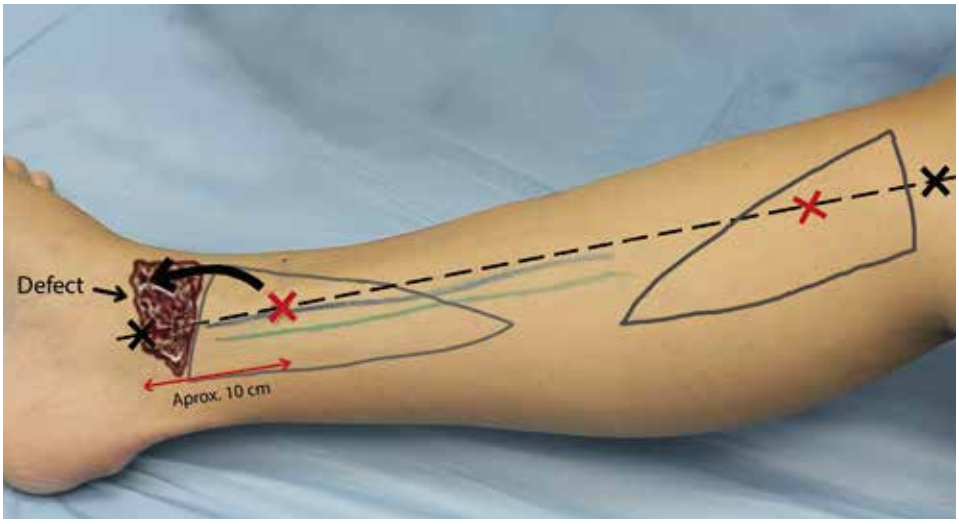

Figure 7.110. Two types of pedicled V-Y shaped skin island flaps. The irregular triangles are always designed with an oblique axis with the acute angle towards the calf where the donor site defect will be easily repaired in V-Y fashion.

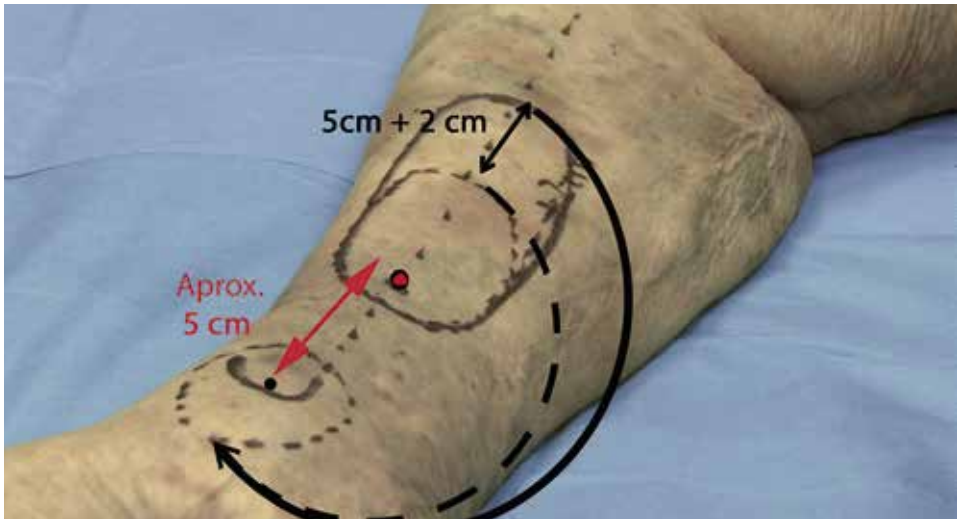

Figure 7.111. The centre of the defect is established first. Once the emergence point of the distal perforator (red point) has been localized by Doppler examination, its distance to the central aspect of the defect is measured (5 cm in this case). The propeller flap is outlined measuring the arc of rotation (dotted arrow). The flap's rotation or probably a minor displacement of the perforator artery has to be considered, and so it is advisable to add 2cm more to the proximal part of the flap length (5cm+2 cm).

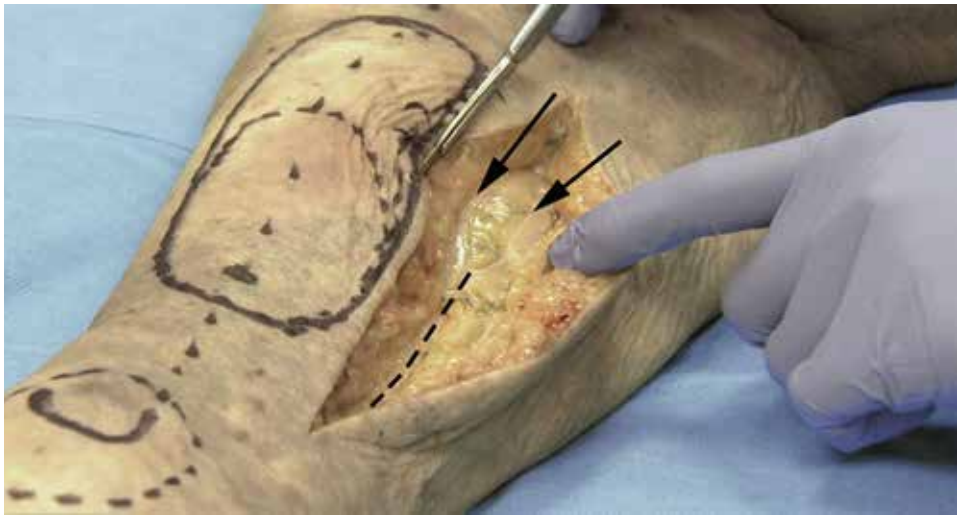

Figure 7.112. As with most perforator flaps, the skin is incised on only one of the flap's borders in order to get a clear vision of every perforator vessel emerging from below and entering the cutaneous paddle. The incision is made deep to the fascia (arrows), which is also incised from proximal to distal.

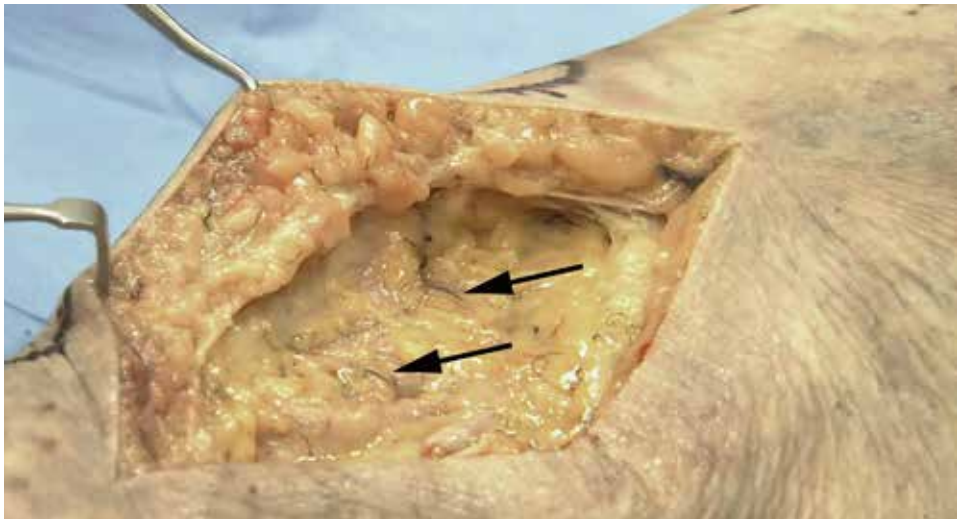

Figure 7.113. The opening of the fascia will leave exposed the septum between flexor hallucis longus and soleus muscle from where perforator vessels arise. All vessels entering the cutaneous paddle should initially be respected. The importance of incising only one side of the flap is that if the best, or the sole, perforator is displaced from the expected position, the cutaneous paddle can be conveniently modified.

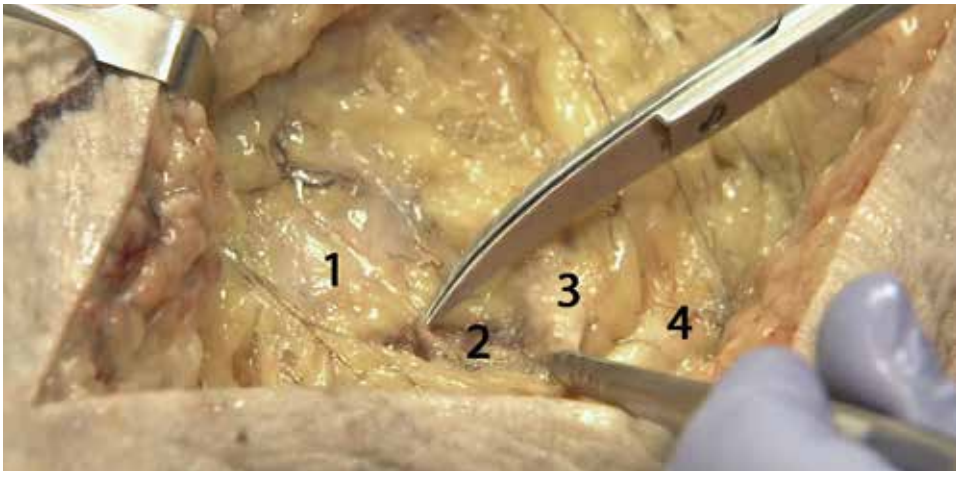

Figure 7.114. Anatomical relationship of perforators: 1: Flexor digitorum longus, 2: Soleus muscle, 3 Posterior tibial neurovascular bundle, 4: Common tendon from the gastrocnemius muscle.

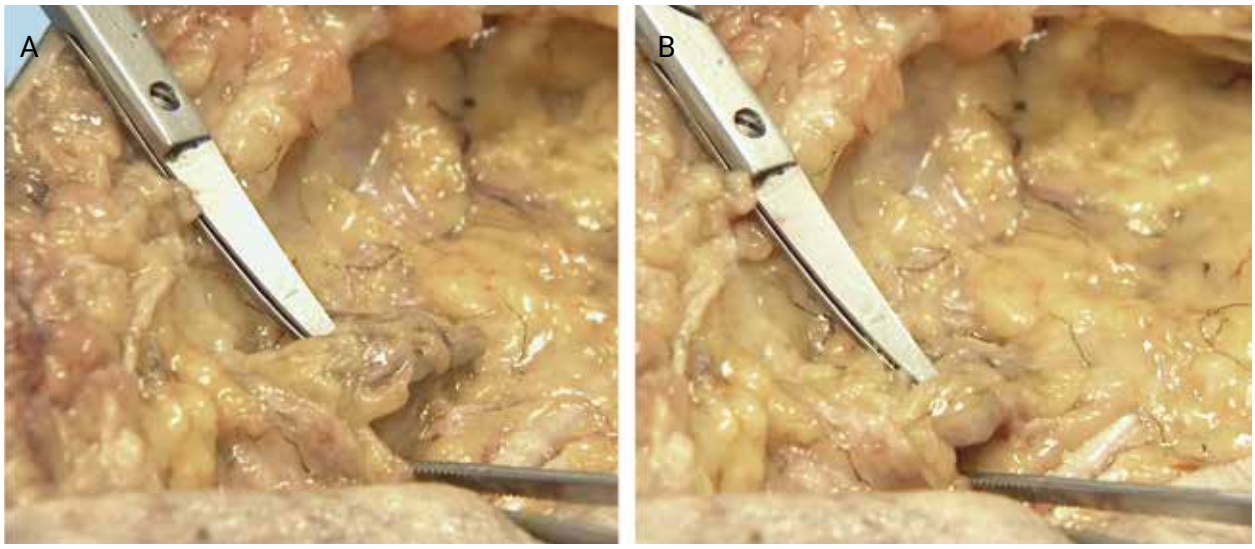

Figure 7.115. A) Posterior tibial artery. B) Posterior tibial nerve.

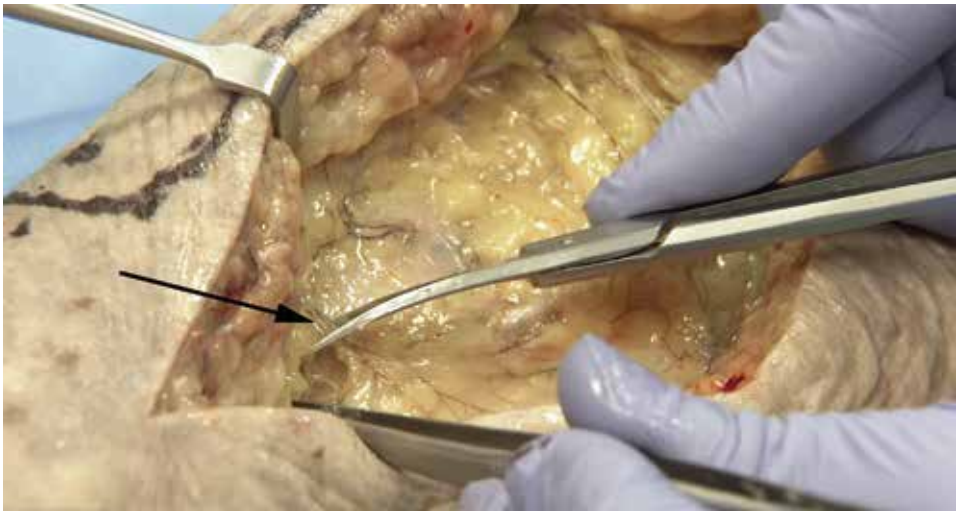

Figure 7.116. Once the main cutaneous perforator branches coming from the muscles are localized minor subcutaneous vessels (arrow) that simply bridge from one side to another are discharged and divided.

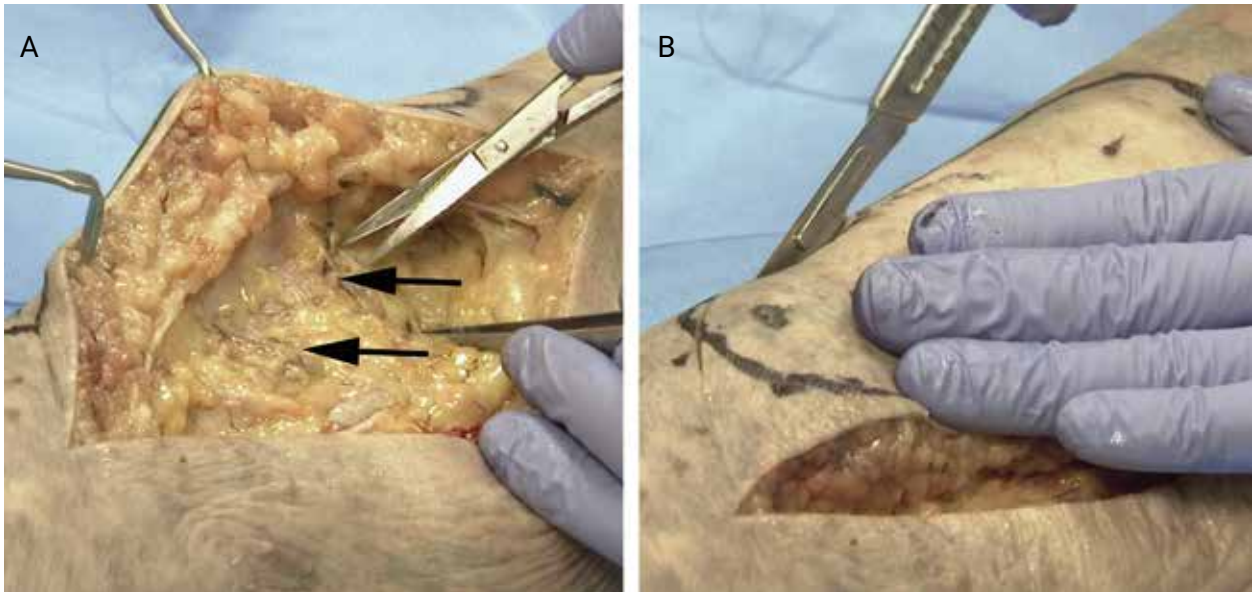

Figure 7.117. A) Each perforator emerging from below, either from the septum or muscle, should be explored and traced down, to be identified as true nourishing perforators. In the case shown, two acceptable perforators are found (arrows). B) With both perforators identified and permeable, the cutaneous paddle can then be completely incised on the opposite side.

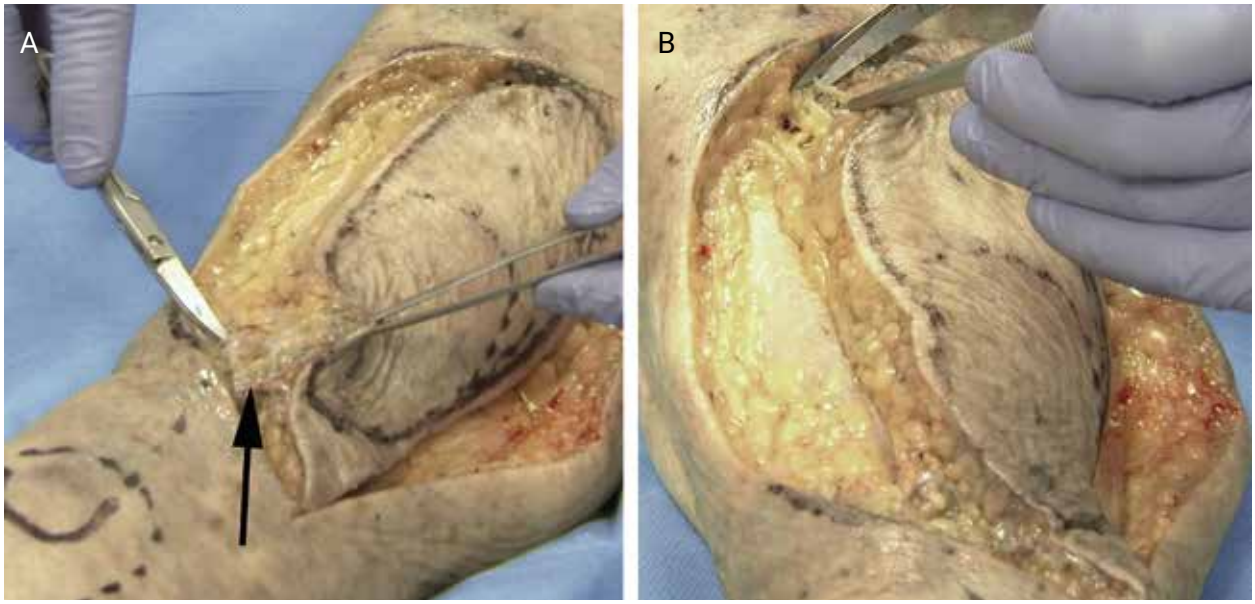

Figure 7.118. A) and B) Saphenous vein and saphenous nerve are both divided distally and proximally.

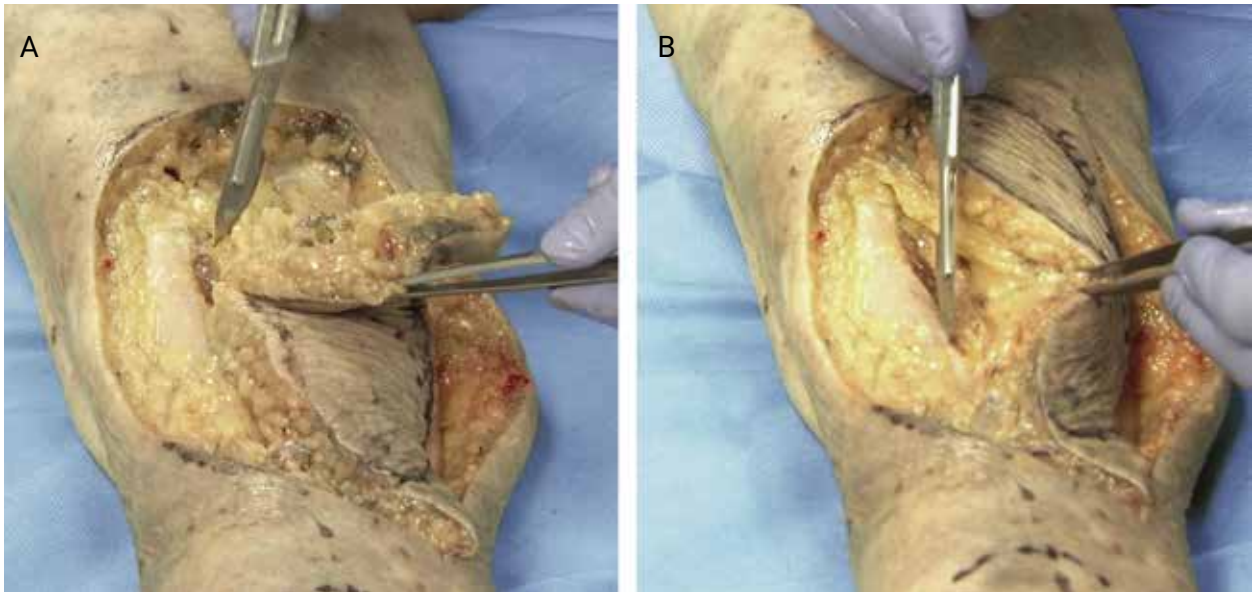

Figure 7.119. A) and B): The fascia of the extensor digitorum brevis is opened longitudinally and left attached to the flap. Elevation of the medial aspect of the flap is carried on until the lateral aspect is reached.

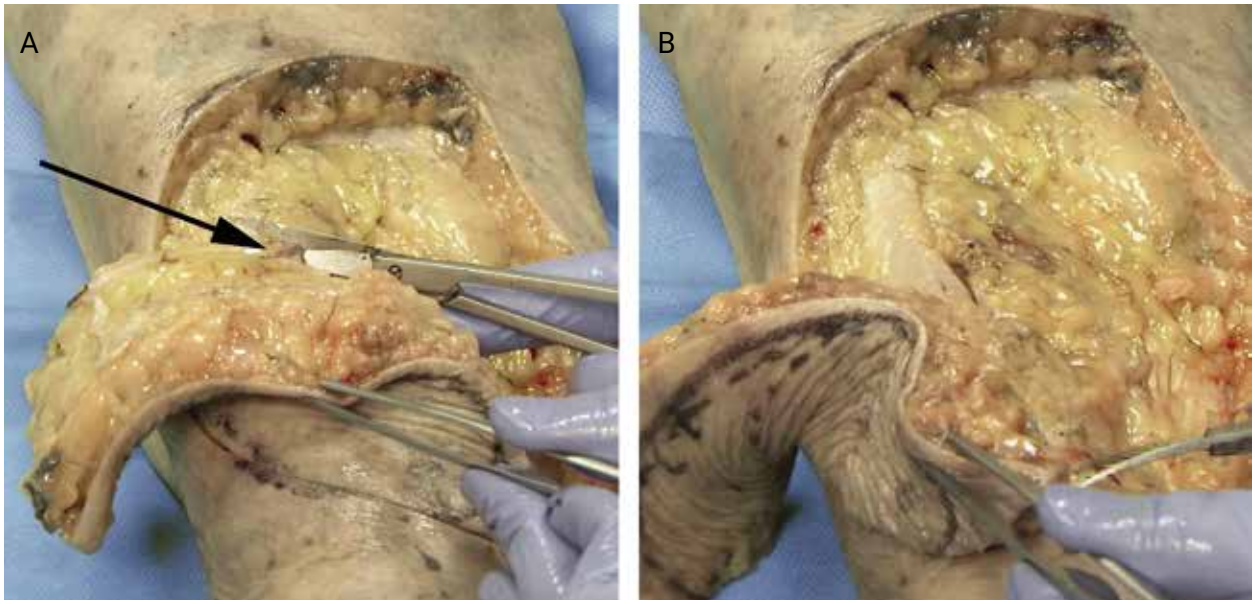

Figure 7.120. A) and B) At that moment, the perforator selected as the pedicle is preserved and the other or others divided. In this specimen the superior perforator is larger than the inferior, but the distal perforator is selected because it is better suited to rotate the flap.

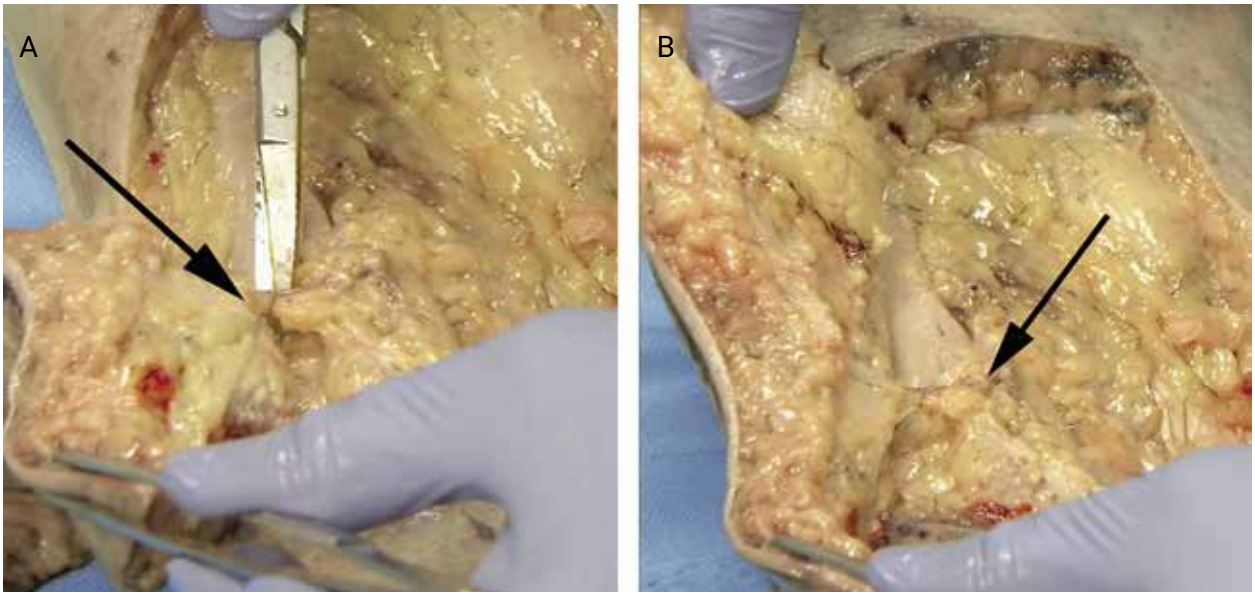

Figure 7.121. A) and B) The selected perforator (arrow) is individualized preserving a cuff of loose areolar tissue to protect the vessels and prevent torsion.

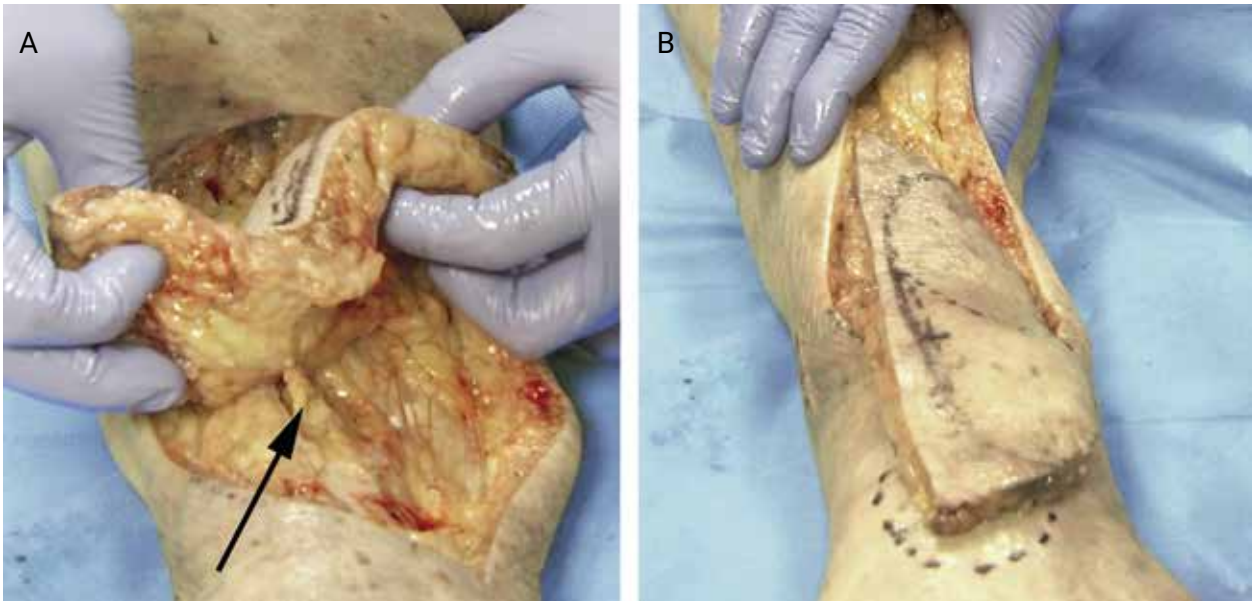

Figure 7.122. A) Rotation of the flap is performed in both directions, counter clockwise or clockwise, to check which one is better for the pedicle, avoiding torsion or compression.