

MEDIAL GASTROCNEMIUS MYOCUTANEOUS FLAP

Gastrocnemius muscles, located in the posterior aspect of the calf, contribute to plantar flexion of the foot through their pull on the Achilles tendon. They also contribute to knee flexion. The Gastrocnemius muscle has two heads and bellies. Raising both heads and bellies will lead to function impairment, as the soleus muscle alone cannot sufficiently preserve the lost function. However, rotation or transfer of only one of the Gastrocnemius muscle bellies will not mean significant function impairment. It is a powerful contraction muscle and when it is used to cover a defect it has to be transferred in a completely denervated state.

It was one of the earliest muscle flaps described in Plastic surgery. Since it is relatively easy to elevate, it is a completely reliable neurovascular pedicle. Functional loss if only one head is transferred is minimal, as is the contour deformity.

In the era of perforator flaps and microsurgical transfers, when extensive use of knee prosthesis has become routine, especially in elderly patients, this flap still remains a primary preference for plastic and orthopaedic surgeons, and remains as a main tool in plastic surgery, to repair severe defects in and around the knee, as well as in the proximal third of the tibia^(29,33,103).

Indications

The medial head of the gastrocnemius muscle is more commonly and extensively used, not only because it is wider and longer than the lateral head, but also because it has an easy and shorter way to rotate (the lateral head has to overcome the fibula on its way to the anterior aspect of the knee and tibia). It will depend on where the defect is located, in order to decide whether the medial or lateral belly of the muscle will be selected.

- Defects over the anterior and medial aspect of the knee as well as defects over the proximal third of the tibia are better covered by medial belly transposition.
- Defects on the lateral aspect of the knee and lateral aspect of the proximal third of the tibia are better treated by rotation of the lateral belly. By complete liberation of its origin at the lateral epicondyle it can also be used to

cover the lateral distal quarter of the femur⁽¹⁵¹⁾. If it is intended to cover the anterior aspect of the knee, the muscle has to be transferred deep to the peroneal nerve⁽¹⁰⁰⁾.

Fasciocutaneous and perforator flaps are currently selected to repair cutaneous defects around the knee as they are thinner than the voluminous muscle flaps and adapt and fit better than them. But muscle transfer is still considered the best option to cover exposed bones, knee prosthesis and open joints. Gastrocnemius muscle has also been employed as a functional free transplant unit to restore elbow flexion, or as local transfer to restore drop foot⁽¹⁵⁹⁾.

Though gastrocnemius muscle can be transferred as a musculocutaneous flap, the skin island often challenges its capacity to fit bone defects and also acts as a physical obstacle for the muscle to reach further. That is why, if it is intended to repair bone defects, and particularly, irregular defects of the tibia, this flap is better transferred exclusively as a muscular unit and then covered by split-thickness skin grafts. Two technical manoeuvres can be employed to increase the arc of rotation:

- Perform multiple transverse incisions in the thick aponeurosis, which lies on the deep surface of the muscle.
- Divide the proximal origin of the muscle.

However, the gastrocnemius muscle can be transferred with a cutaneous island as a musculocutaneous flap. In this case, the skin paddle can include the entire width of the calf with its superior limit below the popliteal fossa and its inferior limit about 10 cm beyond the muscle belly. Cutaneous islands wider than 5-6 cm will need to be repaired by skin grafting, while narrow islands will certainly be repaired by direct suture. When small and narrow skin islands are transferred with the muscle, it is advisable to use Doppler examination to confirm that cutaneous perforators are included in the paddle. Otherwise, a trans-operative search of perforators has to be performed and if none are found, the skin island has to be appropriately modified in order to include one or two.

Gastrocnemius muscle can, however be transferred as a free flap⁽⁹²⁾ or chimeric flap⁽⁶⁷⁾.

Anatomy and Vascularization

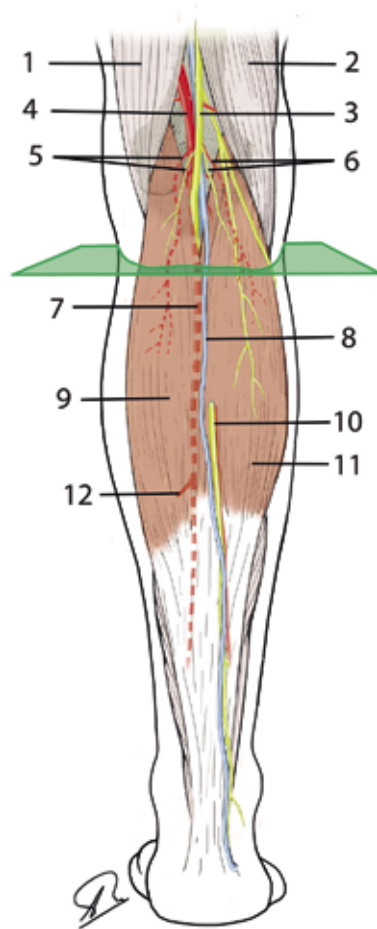
The gastrocnemius muscle has two heads and bodies with two different anatomical origins. The Medial head originates on the posterior aspect of the femur medial condyle posteriorly to the adductor magnus muscle. The lateral head originates on the lateral epicondyle of the femur. Both heads join at the upper third of the calf to end in a strong muscle aponeurosis that, joining with the distal aponeurosis of the soleus muscle, unite at the Achilles tendon that finally inserts at the posterior aspect of the calcaneus.

The Gastrocnemius muscle is vascularized separately by three types of pedicles:

- Each of the bellies has its own main neurovascular ped-

icle, and each one can be safely elevated, based on its own main pedicle, the medial and the lateral sural arteries. Medial sural artery is usually longer, an average of 5.1 cm (with a range of 1.6 cm -9.5 cm), while the lateral sural artery has an average length of 4.8 cm (with a range 1.8 cm-9 cm)

- Minor pedicle: Each muscle, at its distal half, is also supplied by branches of the opposite sural artery.
- Minor pedicle: Musculocutaneous branch from the posterior tibial artery. This branch divides itself into two muscular branches (one for the soleus and one for the distal part of the medial aspect of the medial head). This branch can be used as a pedicle for a muscular flap, in which, the entire medial body of the muscle can be elevated and transferred⁽⁶⁾.



1. Semimembranosus and semitendinosus muscles
2. Biceps femoris muscle
3. Popliteal nerve
4. Popliteal artery
5. Medial sural vessels and nerve (main pedicle)
6. Lateral sural vessels and nerve (main pedicle)
7. Posterior tibial artery
8. Lesser saphenous vein
9. Medial gastrocnemius
10. Medial Sural nerve and artery
11. Lateral gastrocnemius muscle
12. Muscular branch for gastrocnemius (minor pedicle) and soleus

Figure 7.49A. Calf anatomical references around gastrocnemius muscles.

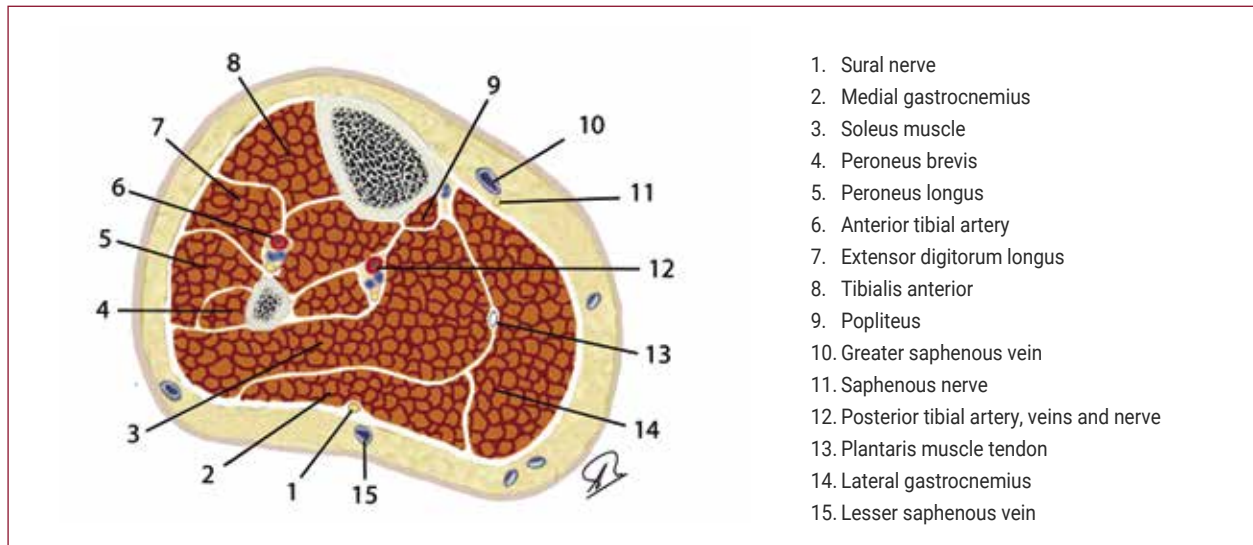


Figure 7.49B. Cross-section of the calf having as reference the Green plane shown in figure 7.49A.

Most of the musculocutaneous branches that vascularize the overlying skin are found in the distal medial half of the muscle bellies.

The medial and lateral sural motor nerves, branches of the tibial nerve, innervate the gastrocnemius muscle. They enter the muscle on its deep proximal aspect together with the vascular pedicle. The sural nerve courses at the posterior aspect of the muscle between the two heads on an aponeurotic sheet. It is a good landmark to delimitate medial from lateral bellies. The Posterior femoral cutaneous and saphenous nerves provide sensory innervation to the overlying skin of the medial belly. The saphenous nerve runs distally accompanying the greater saphenous vein near the medial side of the muscle. The sural nerve that runs distally accompanying the lesser saphenous vein in a subfascial plane innervates the skin overlying the lateral belly of the muscle.

Venous drainage of the flap is accomplished by the venae comitantes accompanying every artery nourishing the muscle and the overlying skin and subcutaneous tissue.

MEDIAL GASTROCNEMIUS FLAP

As already described, the medial gastrocnemius is the most commonly used and its elevation differs from

the lateral body. When transferred as a musculocutaneous flap, the cutaneous paddle can be harvested as an ellipse that extends vertically from the popliteal fossa to about 10 cm distally to the lower border of the muscular belly.

Upper limit of the skin paddle should not be closer than 4-5 cm to the flexion crease at the popliteal fossa, in order to avoid interferences with knee motion. Width can range from 6 cm, up to 10 cm, though it can reach 15 cm (practically the whole posterior calf). For skin islands wider than 5-6 cm, and depending on the age and biotype of the patient (skinny or obese) skin grafts will be necessary to repair the donor area.

Markings

Pre-operatively the contour and volume of the muscle belly can be assessed clinically by exploring the flexion of the foot against resistance. This will facilitate outlining the muscle and especially musculocutaneous flap. Once in theatre, the patient is usually positioned in supine with the limb in external rotation and the knee slightly flexed. The incision is marked parallel to, and 2 cm behind the posterior border of the tibia and is extended for about 10 cm.