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Vascular anatomy of the medial sural artery perforator flap: A new classification system of intra-muscular branching patterns

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Summary *Background:* The medial sural artery perforator (MSAP) flap is a versatile fasciocutaneous flap. The main difficulty encountered when raising the MSAP flap is in obtaining adequate pedicle length during intra-muscular dissection. The objective of this study was to determine the pattern of intra-muscular course of the MSAP flap pedicle.
Methods: 14 cadaveric specimens were dissected and CT angiograms of 84 legs were examined. The intra-muscular branching pattern and depths of the medial sural artery branches were analyzed. The number of perforators, position of the dominant perforator and both intra-muscular and total pedicle length were also recorded and compared to existing anatomical data.
Results: Three types of arterial branching pattern were identified within the medial gastrocnemius, demonstrating one (31%), two (59%) or three or more (10%) main branches. A dominant perforator from the medial sural artery was present in 92% of anatomical specimens (13/14). Vertically, the location of the perforator from the popliteal crease was on average 13 cm (±2 cm). Transversely, the perforator originated 2.5 cm (±1 cm) from the posterior midline. Using CT angiography it was possible in 10 consecutive patients to identify a more superficial intra-muscular branch and determine the leg with the optimal branching pattern type for flap harvest.
Conclusions: This study is the first to describe the variability of the intra-muscular arterial anatomy of the medial head of gastrocnemius muscle. Surgeons utilizing the MSAP flap option should be aware of the possible branching pattern types and consequently the differing perforator distribution and depths of intra-muscular branches. Routine use of pre-operative CT angiogram may help determine which leg has the most favorable branching pattern type and intra-muscular course for flap harvest.

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Background

In their search for the ideal donor site in 1975, Taylor and Daniel[1] were the first to propose the posterior calf as a versatile option for perforator-based free flap reconstruction. Later, Montegut and Allen[2] and then Hallock[3] described the topographical anatomy of the posterior calf laying the foundation for Cavadas et al.[4] to perform the first clinical series of six medial sural artery perforator (MSAP) flaps. The perforating vessels of the posterior calf have since been thoroughly investigated.[3–13] It is clear from these studies that there is a variable pattern of perforating vessels to the skin of the posterior calf and that there is usually a dominant perforator contributing to the fascial plexus.[3,7] It has also been recognized that the medial sural artery perforators are more commonly dominant[3,7,14] whilst the lateral perforators are typically fewer and less reliable.[3,4,7]

There has been no previous reported study of the pattern of the intra-muscular course of the medial sural artery. References to the nature of the intra-muscular dissection of the MSAP flap pedicle are inconsistent. Previous authors have either described the intra-muscular dissection as being tedious[4,5,8,10,12,13,15] or superficial and surprisingly straightforward.[3,16] In our clinical experience we have found the nature of intra-muscular dissection to be routinely deep and travel for a long distance within the muscle. See Figure 1. As a result of conflicting descriptions in the literature and our clinical findings we sought to carry out an anatomical and radiological study to further delineate the true anatomy of the intra-muscular course of the MSAP flap pedicle.

Patients and methods

Anatomical study

Using 14 fresh cadaveric lower limb specimens, the number of perforators, position of the dominant perforator (defined as the single largest perforator with external diameter >0.5 mm), vessel caliber (at the level of the popliteal crease) and both intra-muscular course and total pedicle length were recorded. A posterior midline incision was made and subfascial dissection performed to identify perforators. See Figure 2. The dominant perforator was identified and intra-muscular dissection was performed.

Radiological study

Radiological data of 84 lower limbs were obtained using a Siemens Definition Flash CT Scanner with Dual Source technology. The images were acquired using 100 kV and Sn140 kV with 64 × 0.6 mm acquisition, a 0.33 s rotation time and a pitch of 0.95. The contrast was Ultravist 370 at a volume of 80—120 mls at an injection rate of 4.5 ml/s—5 ml/s. The start delay after injection was between 25 s and 35 s. In Phase 1 of the study we collected data retrospectively from CT angiograms of 64 lower limbs. In Phase 2 a further 10 CT angiograms (20 lower limbs) dedicated to the calf region were collected and analyzed prospectively. Length and depth of the intra-muscular course of the branches as well as total pedicle length and internal diameter of the medial sural artery were measured using Siemens Syngo Inspace software. See Figure 3.

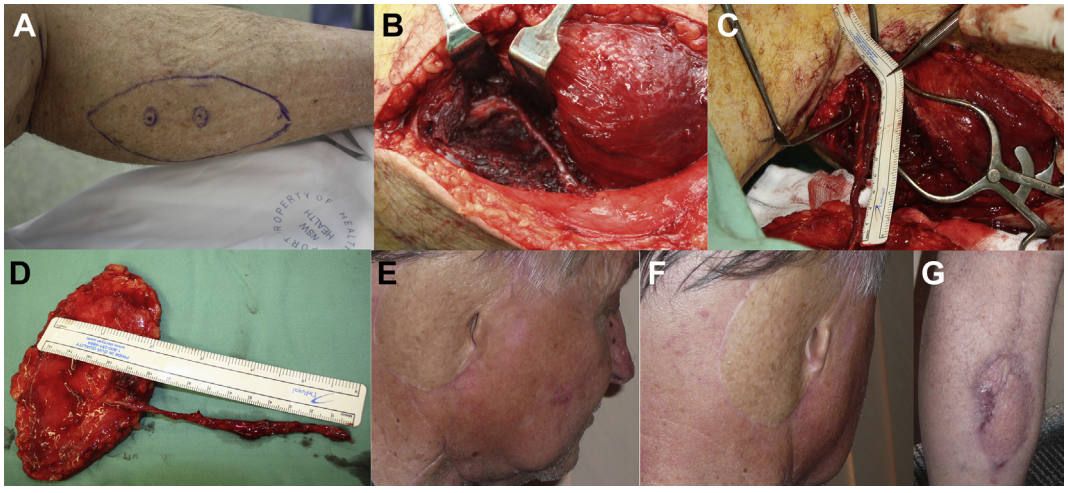

Figure 1 Pictures of a single clinical case showing: (top row, left to right) A) pre-operative positioning and flap marking B) the extent of intra-muscular dissection required in a type IIB (low take-off) dual branching pattern C) flap raised after 10 cm intra-muscular dissection; (bottom row, left to right) D) the MSAP flap harvested E) recipient site at 6 months post-operatively (posterior view) F) recipient site at 6 months post-operatively (lateral view) and G) donor site at 6 months post-operatively.