Surgical Anatomy
At the very least, the medial sural artery perforator [MSAP] flap will capture the skin territory overlying the medial gastrocnemius muscle. The medial sural artery is the source vessel to that muscle as it is to this flap; and is a branch of the popliteal artery, originating at or about the knee joint [4]. After entering the undersurface of the muscle, most commonly the medial sural artery bifurcates to run superficial [posterior] or deep within the muscle surface [5]. Although the distribution of major medial sural artery musculocutaneous perforators that can sustain this flap can be quite variable [6–9], almost always at least a single such perforator can be found [6]. On average, these can be found 13 ± 2 cm. below the popliteal crease, and 2.5 ± 1 cm from the posterior midline (Figure 1) [5]; but in reality can emanate anywhere from within the medial gastrocnemius muscle. The actual possible pedicle to practically sustain an island MSAP flap depends on the location of the perforator, and can range in length from 9–16 cm [5]. Venous outflow parallels the course of the perforators. As an island flap this will usually be insensate. Since in the lower extremity interconnections between perforasomes are oriented in a longitudinal direction [11], the major axis of any MSAP flap should also parallel that pattern to

Figure 1: On average, a medial sural artery perforator [p] will be found within a semicircle of radius 2 cm. about 8 cm. below the popliteal crease along a line drawn from the latter’s midpoint to the prominence of the medial malleolus [10].
avoid compromise of the distal portion if it were to cross instead obliquely into a neighboring angiosome.

**Surgical Technique**

The patient usually will be positioned supine with the thigh abducted, lower leg externally rotated, and knee slightly flexed. Use of a mid-thigh tourniquet is optional, but exsanguination only by elevation is important to maintain fill of venae comitantes to permit their better visualization yet insure a bloodless field that will not obscure any perforators during their dissection. Next, the removal of any skin graft, unstable scars, or unsuitable skin about the knee joint will determine the flap surface area required for replacement as measured by a template.

The actual flap design overlying the calf cannot be outlined until the precise location where the requisite perforator pierces the deep fascia is known. The surgeon should use whatever preoperative technique they are comfortable with to allow its identification, although the audible Doppler still remains the most universal method. An exploratory subfascial incision should be made anterior to this estimated point for direct visualization and confirmation of the perforator existence and adequacy of its size (**Figure 2**). The template and subsequent flap design should then be placed eccentrically as distal as possible to that point with a vertical axis to insure that the longest possible pedicle for an island flap will be obtained. If 2 reasonable perforators are found, choosing the more...

**Figure 2:** (A) Removal of hardware after a healed tibial plateau fracture left a hollow from subcutaneous tissue deficiency along the medial border of the proximal tibia and recurrent seromas, prior to proposed total knee arthroplasty to restore pain free ambulation, (B) reentry into the distal half of the vertical paramedian scar left a 4 × 13 cm. aperture, (C) anterior border subfascial exploratory incision confirmed a perforator at point “x” found initially with use of an audible Doppler, with then an eccentric design of the flap of dimensions comparable to the knee defect was made to maximize potential pedicle length, (D) after incising and retracting the medial border of the flap, actually 2 large perforator were found [on microgrids] and retained, (E) these joined quite proximally after completion of their intramuscular dissection \( p = \) perforator, MG = medial gastrocnemius muscle split, MS = medial sural branches, (F) providing a single long vascular leash to allow the MSAP flap to easily be transposed into the knee defect, (G) and healed flap allowing subsequent total knee replacement without concern, (H) Note the conspicuous linear donor site scar in the calf that is to be expected.
distal perforator will increase pedicle length and extend flap reach. However, inclusion of both perforators not only will be a safety factor in case one were injured during the subsequent dissection; but insures that unacceptable twisting of the pedicle does not occur during flap transfer.

The exploratory incision is then extended to include the entire medial or anterior flap boundary. A rapid subfascial exploration while pushing away the medial gastrocnemius muscle should complete exposure of the desired perforator(s) as the flap falls posteriorly without tension (Figure 2). Now unimpeded unroofing, then intramuscular dissection of the perforator back to its origin from a branch of the medial sural vessels requires clipping or coagulation of side branches as encountered, while carefully preserving motor nerve branches. Proximal dissection of the source vessel must continue until the pedicle length is long enough for transposition of the flap through a subcutaneous tunnel to the knee region where required.

Before insetting the flap, in situ flap perfusion must be adequate with control of any bleeding points. The medial gastrocnemius muscle rent can be closed with a running absorbable suture as long as the flap pedicle is not threatened. Closure of the deep fascia is not attempted for fear of creating a compartment syndrome [12]. For similar reasons, if primary skin closure without tension is not possible, a skin graft placed on the muscle would be proper.

**Discussion**

The medial sural artery perforator flap was originally heralded as a promising thin free flap donor site [13], most ideal for the ipsilateral distal lower extremity [14].

Because of its potentially long vascular pedicle based on the medial sural vessels, reach as an island flap NOT requiring a microanastomosis for knee coverage is another asset [4]. As such, it represents a function preservation alternative to the more commonly used medial gastrocnemius muscle local flap [15].

Casey, et al [2] found that wound healing complications after total knee replacement were virtually non-existent if some form of prophylactic flap [and usually the medial gastrocnemius muscle or instead a free flap] were first performed for that subset of patients where knee soft tissue compromise existed that would be predictable to otherwise fail. In their series, the choice of a cutaneous as opposed to a muscle flap resulted in superior knee flexion and total range of motion, supposedly because the latter had more fibrosis and rigidity [2]. They also confirmed the value of this orthoplastic approach in preventing the high number of failures if instead salvage techniques following total knee replacement had to be utilized.

Few local cutaneous flap options such as peninsular [16] or advancement flaps [17] usually remain as potential tissue augmentation options about the knee that has had multiple prior operations or otherwise significant trauma. The medial sural artery perforator flap from the calf is another nearby alternative that should be considered, although this does require familiarity with dissection of musculocutaneous perforators [18]. A major detriment, however, is the donor site deformity that at the least will be a non-aesthetic scar in the calf; or worse if a skin graft on the medial gastrocnemius muscle is required. Minimizing the chance of later failure of a total knee replacement should instead be well worth this risk.

**Acknowledgements**

Plastic Surgery the Meeting September 30, 2018.

**Funding Statement**

There was no funding received for this paper.

**Competing Interests**

The author has no competing interests to declare.

**Author Contributions**

GG Hallock sole contributor, takes responsibility for the integrity of the work, and made all publishing decisions.

**Guarantor**

GG Hallock sole guarantor.

**Peer Review**

This is a non-commissioned paper that has undergone external peer review according to journal policy.

**References**


Hallock: The Medial Sural Artery Perforator Island Flap as a Simpler Alternative for Prophylactic Skin Augmentation Prior to Total Knee Arthroplasty


