The Development of the Medial Circumflex Femoral Artery Perforator (MCFAP) Flap

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ABSTRACT

In the quixotic quest for the “ideal” flap, the major attribute of the medial circumflex femoral artery perforator flap is its minimal donor-site deformity even if primary closure is not possible and a skin graft must be used. This source vessel captures the medial groin skin territory, and therefore sometimes has been referred to as the “medial groin” flap. This flap can be moderately large, the donor site easily hidden by clothing, the flap almost always has at least a single relatively large musculocutaneous perforator, and the location of the vascular pedicle has a consistent location already familiar to most microsurgeons. The history and approach specifically in the development of the medial circumflex femoral artery perforator flap is presented here to explain the rationale as to why this donor site deserves consideration in the hierarchy of cutaneous flap selection.

KEYWORDS: Muscle perforator free flap, medial circumflex femoral, gracilis

The “ideal” soft tissue flap proselytized by the group from Chung Gung Hospital in Taiwan¹ is the anterolateral thigh flap. There is no question that the anterolateral thigh can be the source of a myriad of soft tissue combinations that have very versatile applications. Unfortunately, even if its donor site can be closed directly, the resulting vertical thigh scar can be conspicuous (Fig. 1) and perhaps unacceptable if a skin graft must be used. From the perspective of only the donor-site deformity, the “ideal” flap should instead leave a residue that can more easily be hidden, perhaps most simply by normal clothing.

This prerequisite for the “ideal” flap is reminiscent of the “groin” flap whose heyday was in the early days of composite tissue transfers.² Based typically on the superficial circumflex iliac artery, this flap really incorporated more the lateral groin region, where indeed hiding the donor site scar was an important attribute. Its selection fell into disfavor due to the perceived high frequency of vascular anomalies that made harvest difficult. In retro-

spect, little attention had been focused on the medial groin area, except when included by Orticochea³ and McCraw et al⁴ as part of a gracilis musculocutaneous flap. The distal portion of the usual vertical orientation of their flaps proved to be unreliable, and this site, too, fell into disrepute.

Yousif et al⁵ coupled a vector analysis of the planar coordinates of the gracilis musculocutaneous perforators with injection studies in cadavers to postulate that the “true” skin territory of the perforators of the gracilis muscle should have an orientation that paralleled the medial groin crease, and not a vertical axis. They⁵ and others^{6,7} have since shown the greater clinical reliability of a transverse or oblique alignment of the skin component, often including only a minimal amount of the proximal gracilis muscle itself.^{8–12}

With the advent of the “true” muscle perforator flap principle,¹³ it became apparent that no muscle actually ever has to be included with the cutaneous territory of what previously had been composite musculocutaneous

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Figure 1 The vertical scar even following direct closure of the donor site of an anterolateral thigh free flap can be conspicuous and poorly hidden by clothing (this should be compared with the donor-site defects of the medial groin when the MCFAP flap had been used as shown in the accompanying figures).

flaps. A muscle perforator flap based on the medial circumflex femoral artery (MCFA) and its gracilis musculocutaneous perforators seemed therefore to be a logical progression to allow capture of the attributes of the medial thigh/groin skin territory. The first MCFA perforator (MCFAP) flap was a free flap in a thin individual that was successfully used to cover an open amputation stump, for a patient who adamantly refused the use of any skin grafts and wanted no scars that could not be hidden by his underwear.¹⁴ Additional clinical cases^{15,16} corroborated Yousif and colleagues⁵ suggested axis of flap orientation as being correct, with the exception that surprisingly often the anterior portion encroaching upon the superficial femoral artery could be unreliable, although a posterior extension even almost to the posterior midline was always robust.

SURGICAL ANATOMY

The dominant source vessel to the gracilis muscle is usually the medial circumflex femoral (Fig. 2), although sometimes it can arise from the adductor branch of the profunda femoris artery.^{17,18} This dominant pedicle

Figure 2 The usual dominant source vessel to the gracilis muscle and its musculocutaneous perforators is the medial circumflex femoral. The appropriate orientation of any cutaneous flap capturing the perfused territory of these perforators should parallel the medial groin crease as depicted.

divides into three to six muscular branches at the hilum⁵ before entering the undersurface of the gracilis muscle at ~6 to 12 cm below the pubic tubercle.^{5,19–21} Afterwards, each branch proceeds distally independently in a longitudinal direction within the muscle, which is the basis for safely splitting the muscle.¹⁷

In both cadaveric^{5,21–23} and clinical dissections,^{22,23} at least one and up to four significant musculocutaneous perforators can be found emanating through the proximal gracilis muscle within an area ~3 cm in radius centered over the hilum. Most often these perforators pass through the midportion of the muscle but can also proceed through its anterior or posterior border.²² The more perforators that are found, usually the smaller their individual caliber.²¹ Septocutaneous perforators can also be found to arise from the MCFA medial to the adductor longus muscle.^{5,20,24} No musculocutaneous perforators of any consequence exit from the rest of the muscle.^{5,6,20}

The cadaveric injection studies of the MCFA by Yousif et al⁵ stained the skin of the upper thigh from the femoral triangle anteriorly to the posterior midline of the thigh and from the groin crease to

Figure 3 (A) Open distal tibia fracture with segmental bone loss and exposed intramedullary rod. (B) Proposed design of a 5×20 cm MCFAP, eccentrically centered about site of a perforator at "x" as identified with an audible Doppler probe. (C) Actually in this case, two large and adjacent musculocutaneous perforators (*p*) were found exiting through the gracilis (*G*) muscle, (D) undersurface of the free flap showing the two perforators (*p*) arising from the medial circumflex femoral (MCF) source vessel, and a retained branch of the greater saphenous vein (GSV), both in microclamps. The GSV was prophylactically used for anastomosis to another recipient site vein as a second means for venous outflow. (E) Inset flap and healed leg after bone grafting. (F) Appearance of donor-site scar following direct closure.

Figure 4 (A) Exposed repair of patella fracture and deranged knee joint. (B) Two musculocutaneous perforators (p) were found emanating from the gracilis (G) muscle. (C) A chimeric gracilis muscle and 10 × 29 cm MCFAP free flap was transferred, with the muscle component independently used to fill the exposed lateral aspect of the knee joint, and the cutaneous portion restoring the overlying skin defect. (D) Healed knee wound.

the midthigh inferiorly. As already mentioned, in clinical trials not infrequently the skin anterior to the adductor longus muscle potentially can be compromised.^{15,16}

Venous drainage for any muscle perforator flap can always be a concern. The medial circumflex femoral venae comitantes always follow the perforators through the gracilis muscle. Branches of the greater saphenous vein concurrently drain the anterior portion of this

region and provide an alternative means for venous outflow.

METHOD

The easiest approach to the MCFAP flap is to have the patient positioned in a supine position with the hip externally rotated and knee flexed. The medial groin crease should be exposed, as the flap should be oriented

Figure 4 (continued) (E) The donor-site deformity, even though a skin graft was required, is easily totally hidden by clothing.

parallel to and below it. In a thin individual in this position, the adductor longus muscle may be palpable. At a point just posterior to that and ~10 cm below the pubic tubercle, a handheld audible Doppler is a convenient means to identify the location of any gracilis musculocutaneous perforators (Fig. 3).²⁵ The desired flap should be centered about that point, although an eccentric design skewed posteriorly is preferred for an exceptionally long flap so as to avoid encroaching on the femoral triangle.

The next step is the actual identification of the gracilis musculocutaneous perforators to determine their adequacy for sustaining the flap, usually on the basis of their size or presence of visible pulsations (Fig. 3). Several approaches are possible,²² but a reasonable preference for a cutaneous flap is to incise the inferoposterior boundary first through the deep fascia to locate the gracilis muscle. It always seems to be more posterior than thought possible. The entire posterior portion of the flap can then be elevated up to the posterior muscle edge. If a large perforator is found during this dissection, it should be preserved, as it could well be that of the adductor magnus muscle and the basis of an alternative adductor flap.²⁶ Otherwise, once the posterior border of the gracilis muscle is reached, further anterior dissection must proceed cautiously to allow identification of all gracilis musculocutaneous perforators. All large perforators should be preserved.

At this point, any remaining boundaries of the flap can be dissected through the subfascial level. Any superficial veins found during this maneuvering should be preserved as a secondary source of outflow in case

venous congestion occurs later. Next, the usual tedious intramuscular dissection of the perforator(s) is performed until the medial circumflex femoral vessels are reached. Often, finding the latter by pulling the gracilis muscle medially before beginning the perforator dissection facilitates determining their intramuscular course. Division of anterior muscle fibers as necessary directly over the source pedicle also simplifies this dissection. Any identifiable septocutaneous branches should also be kept as encountered. Lengthening of the main pedicle itself requires the lateral retraction of the adductor longus muscle as needed. The usual routine for any free flap can then be followed.

DISCUSSION

Because the majority of the time the source vessel of the musculocutaneous perforators of the gracilis muscle is via the medial circumflex femoral artery, using the convention established by the Canadian system of nomenclature,²⁷ this muscle perforator flap should be called the "medial circumflex femoral artery perforator" flap. The MCFAP flap can also be used as a local pedicled flap that will reach the femoral triangle or perineum.^{16,28} In addition, as is true with any muscle perforator flap, it can be used as a chimeric flap that includes the gracilis muscle as two independent flaps that can be inset independently but retain a common source vessel (Fig. 4).^{22,24,29} Oftentimes, the cutaneous branch of the medial circumflex femoral is completely unrelated to the muscle branches even up to the vascular hilum, which easily allows harvesting this alternative

version. The chimeric flap can be used not only for coverage issues but recently has been employed as a dynamic transfer using the gracilis muscle component for correction of facial paralysis with concomitant soft tissue augmentation.^{22,24}

As with any muscle perforator flap, the encountered anatomy is never consistent. If the musculocutaneous perforators from the MCFA prove to be too diminutive and septocutaneous vessels are absent, another alternative to the MCFAP flap must be sought. This is not the correct donor-site choice if an extremely wide or long cutaneous flap or lengthy pedicle is needed. The medial thigh fat tends to lack consistency or firmness, and as with most muscle perforator flaps, in the very obese patient a proper dissection can be almost impossible. The anterolateral thigh flap in these situations may be preferable from the outset.¹ Nevertheless, the MCFAP flap should be considered under the right circumstances, especially because the residual donor deformity, much like the "groin" flap of yesterday, can be minimized.

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