



Free-style free flap

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KEYWORDS

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Summary Advancements in microsurgical techniques as applied to perforator flaps have made harvesting flaps in a free-style manner a practical reality. A hand-held Doppler identifies sizable perforators on which flaps can be based. In free-style free flap harvesting, any region of the body can be chosen as a donor site as long as there is an audible pulsatile Doppler signal. The value of the free-style free flap concept lies in its ability to overcome anatomical variations. The clinical application of raising flaps in a free-style manner has been demonstrated in the thigh where flaps have been raised safely and reliably in spite of the many anatomical uncertainties in this area. Flaps can, thus, be designed and raised in any region of the body to suite the unique requirements of individual cases. However, limitations to the clinical application of the free-style free flap should be noted; the course of the perforator may be unpredictable. Small and long perforators may be difficult to harvest and inset. Furthermore, the skin territory and intra-operative flap thinning should more conservative compared with conventional flaps. These shortcomings can however be overcome by clinical experience and improvement in surgical techniques.

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Introduction

Microvascular free tissue transfer has matured as a reliable method for reconstruction of complex surgical defects with reported success rates ranging from 91% to 99%.¹ The high success rate is attributed not only to improvement of microsurgical techniques and instruments, but also to the better understanding of anatomy. Flap survival is no longer the primary concern of free tissue transfer. Increasingly,

surgeons are focusing on functional and aesthetic outcome, while minimising donor site morbidity. To this end, perforator flaps with preservation of the underlying muscles represent a technical advancement.

A clear definition of perforator was provided by Wei et al. in 2002.¹⁷ Based on this, many modifications were developed, such as thin perforator-based flap for one stage aesthetic and functional refinement.^{8,12,21} The 'free-style' concept evolved as a natural extension of the applications of perforator flaps. Raising a flap in a free-style manner entails localisation of skin perforators using the hand-held Doppler and raising perforator flaps by performing retrograde dissection until a sufficient pedicle length and size has been achieved regardless of

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the origin of the vessel. The safety and reliability for such flaps in clinical applications demonstrated by Wei and his colleague in 2003.¹⁰ This paper discusses the concept, applications and potential pitfalls of free-style free flaps.

Background

While the term 'free-style' flap was coined in the early 21st century, the concept itself is not something new and in some ways intuitive to many surgeons. However, with the formal description of 'free-style' flaps by Wei and Mardini, this type of flap has come of age as a reliable and predictable flap design.^{10,15} Whenever anatomic variations were encountered during the harvest of cutaneous flaps, surgeons in the past dissected the perforators retrogradely, often through muscles to their vascular pedicle. In 1975, Taylor and Daniel dissected the perforator of gastrocnemius musculocutaneous flap back to sural artery.¹³ Wei et al. performed the intra-muscular dissection of perforators through the soleus muscle during the anatomic study and surgical dissection of the skin paddle of the fibula osteoseptocutaneous flap.¹⁶ Retrograde dissection was also used for the harvest of the toe pedicle after its identification in the web-space.¹⁹

Perforator flaps have generated much interest and enthusiasm as a technique that results in less donor site morbidity by preservation of the underlying muscles during flap harvest. Perhaps the most significant development that has come through the use of perforator flaps has been the extension into the harvesting of flaps in a free-style manner. In conventional flap harvesting, the vessels are dissected according to the previous anatomic study of the donor region. In contrast, in free-style free flap, the surgeon can dissect out a vessel from any region of the body as long as there is an audible Doppler signal without a detailed knowledge of the regional anatomy. Free-style free flap maximises the flexibility in terms of choice of donor site. These can be selected based on factors, such as the region with lowest donor site morbidity, best colour, thickness and texture match to the recipient site, and possibility for simultaneous two-team approach.

Surgical technique

The first step in performing a free-style flap is locating sizable perforators in the selected region of the body. Hand-held Doppler ultrasonography has been shown to be an accurate method of locating

these cutaneous vessels.^{4,14} A portable Doppler (Super Dopplex II, model no. MD2/SD2; Huntleigh Diagnostics, South Glamorgan, Wales, United Kingdom) was used to locate and map all vessels in the region of interest. The operator carefully notes the quality of the Doppler sound detected with particular attention given to the location of loud, high-pitched, and pulsatile signals. The vessels with more prominent sounds are marked with a larger dot and selected as the vessel we intended to dissect.¹⁵ The flap is then designed centred on these perforators.

Dissection is performed under loupe magnification (2.5–3.5×). Only one border of the proposed design should be incised initially for exploration. This affords the flexibility to alter the flap design should this be necessary based on intra-operative findings. The flaps were dissected in the suprafascial plane to minimise donor-site morbidity by preserving fascia and cutaneous nerve that run immediately above the fascia.¹⁵ It is important to maintain meticulous hemostasis as excessive bleeding and subsequent staining of the tissues interferes with clear visualisation and accurate identification of small vessels. After sizable cutaneous vessels are found, the deep fascia is cut to start mobilising the vessels. This may entail intra-muscular dissection for musculocutaneous perforators or may be relatively straightforward in the case of septocutaneous vessels. Retrograde mobilisation of the pedicle is continued until a sufficient length and/or size are achieved. Depending on the size of the perforators and the size of the flap that need to be harvested the flap can be based on a single perforator or multiple perforators. Once all these crucial surgical decisions have been made and flap dimensions and design confirmed, the flap is completely islanded and the pedicle divided. In our previous experience, the average size of the flaps was 108 cm² (range 36–187 cm²), and the average length of the vascular pedicle was 10 cm (range 9–12 cm).¹⁵

The inherent unpredictability of pedicle size and length dictates that one should always have a 'back-up' plan when attempting a free-style free flap. The lateral thigh area is an area that we are familiar with based on our experience with the harvest of the anterolateral thigh ALT flap. With the ALT as our back-up, the thigh was used as our choice site for the harvest of free-style free flaps.¹⁰ Of course, if the free-style free flap is chosen in other part of body, another 'back-up' flap still should be drawn out and prepared. In thigh area, most arterial branches could be sacrificed without significant morbidity except the superficial femoral vessels. In other words, if the flap is designed a distance from the superficial femoral vessels; the pedicle

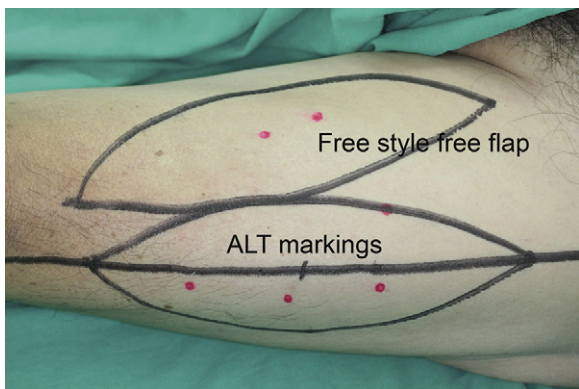


Figure 1 Perforators on the medial thigh were localised with a hand-held Doppler. The conventional ALT flap was also marked as a 'back-up' flap.

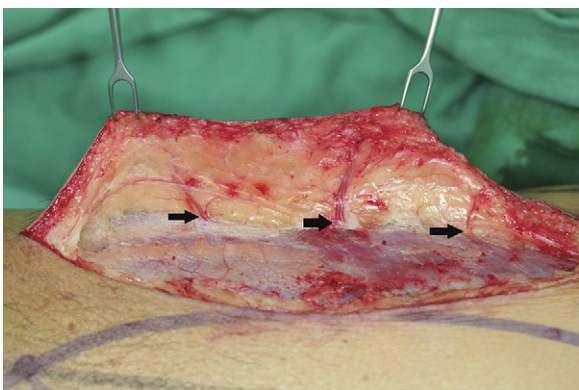


Figure 2 The flap was then elevated suprafascially until the cutaneous perforators were visualised (arrows).

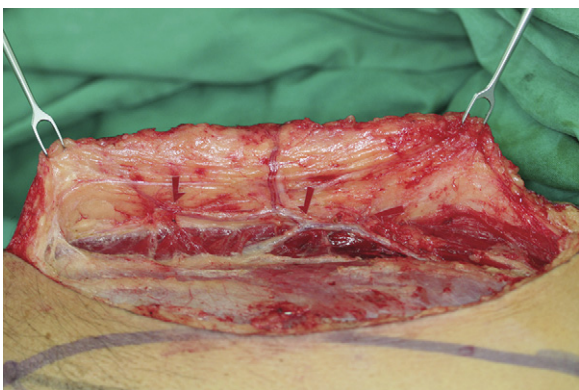


Figure 3 The deep fascia was then opened to commence retrograde dissection of the selected vessels. In this case, there were two septocutaneous vessels. The third vessel was a musculocutaneous perforator with a short intramuscular course.

length could be at least the mapped skin vessel to the superficial femoral vessels, either medially or laterally. The first incision should be always performed to allow the use of the 'back-up' flap. In the

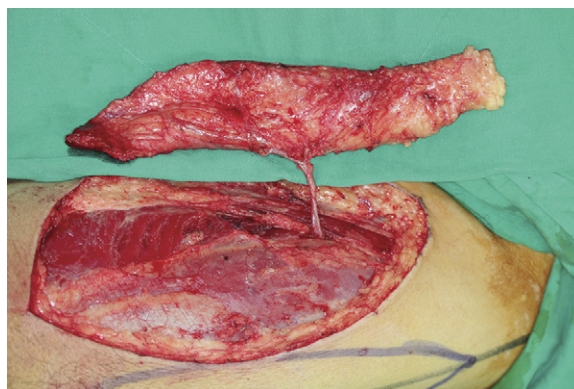


Figure 4 All the three vessels were preserved and traced to the medial circumflex femoral artery, which served as the pedicle of the flap in this case.

thigh, the mapped vessel is located in the medial thigh; the first incision should be along with the lateral margin over the skin paddle. The dissection should be from lateral to medial. If no suitable skin vessels are encountered, the dissection direction will be shifted towards lateral side for the harvest of the 'back-up' ALT flap. *Figs. 1–4* give illustrative examples of the clinical application of the free-style concept.

Discussion

Critical to the success of harvesting a free-style free flap is comfort and confidence in intra-muscular perforator dissection. One should also be comfortable dissecting small perforators of less than 1 mm in diameter. Gentle handling is important to prevent vasospasm that may sometimes irreversible. We consider the use loupe magnification (2.5–3.5 \times) or even the operating microscope to be mandatory for adequate visualisation during mobilisation of the perforators. One should bear in mind that these are very delicate flaps needing gentle handling in every stage from harvest to inset. Its pedicle consists of a small perforator that has been completely skeletonised during harvest and lacks of a protective cuff of soft tissue around the site where the perforator enters the flap. These features make it particularly susceptible to kinking, compression and even rupture during the inset. Subcutaneous tunnels, when needed should be generous and tension on the pedicle must be avoided.

The maximum dimensions of a flap that can be harvested based on a single perforator are a matter of some debate. Koshima et al. noted that the skin paddle based on a single dominant skin perforator could be up to 35 cm in length and 25 cm in width in the ALT flap.⁹ However, this is dependent on many

factors, such as the size of the perforator and its location within the flap. In our practice, the skin dimensions of a free-style flap are limited to 8 cm by 20 cm.¹⁰ If a larger flap is needed, then one may need to incorporate two or more perforators into the flap.

In some cases, to obtain better aesthetic and functional result in some area, for example, intra-oral and dorsal foot area, one may need to thin the flap.^{8,12,21} Kimura et al. describe that a 9-cm circumference of the ALT flap can be thinned to 3–4 mm in thickness by preserving a 2-cm cuff of tissue around the perforator.⁷ While this is certainly a viable estimation and we have performed thinning to this extent in selected cases, intra-operative thinning should be done conservatively. Further thinning can be done as a secondary procedure if needed in the interest of safety.

Having the free-style technique in one's armamentarium is useful when confronted by anatomical variations in the harvest of conventional flaps. For instance, the absence of sizable perforators in the lateral thigh when attempting to harvest the ALT flap, the surgeon can reliably use the free-style concept to harvest a 'back-up' flap from the vicinity of the incision.^{3,6,18} Sizable perforators can be dissected medially, proximally or distally in a free-style manner. The innovation of two ALT flaps based on same vessel in one donor site can also be resorted to the free-style free flap concept.² Knowing that free-style techniques can reliably and safely be used in any regions of the body liberates the surgeon from anatomical uncertainties during flap harvest and gives him a renewed confidence even when compelled to operate in an area unfamiliar to him.

The application of free-style techniques has sparked a renaissance in the creative use of various local flaps for coverage of various difficult defects. Based on this concept, perforators located in the vicinity of the defect are located by Doppler and flaps can be raised based on these perforators by retrograde dissection.^{5,11,20} These free-style local flaps can then be advanced into the defects. This application of the free-style concept in local flaps is both reliable and versatile in providing an alternative solution to many difficult reconstructive problems.

Conclusion

With the recent advancements in microsurgical techniques, harvesting flaps in a free-style manner have become a practical reality. This approach represents a conceptualisation of ideas and tech-

niques that has evolved over the past 30 years. Experience over the past 10 years has consistently demonstrated that free-style flaps can reliably and safely be raised. Free-style free flap techniques will add undoubtedly to the versatility and depth of the reconstructive microsurgeon's armamentarium.

Conflict of interest statement

The authors did not receive any funding for this work and declare no conflict of interest in this present work.

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