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Establishing a Perforator Flap Nomenclature Based on Anatomical Principles

Sir:

Perforator flaps continue to evolve with respect to surgical technique and clinical applications, exemplified in this article in which the authors challenge traditional design of such flaps, highlight the missing link in perforator flap design, and return to the anatomical principles behind the vascular anatomy of flaps. Although previous descriptions of perforator flaps have been based almost solely on the location of the point of deep fascial penetration by a perforator, the ability to map accurately the subcutaneous course of perforators preoperatively offers a new approach to flap design, and hints at a new classification scheme to such flaps. Although the course of the vessels beneath the deep fascia challenges the technical skill of the surgeon, it is the subcutaneous course that dictates flap design and ultimate survival. Before attempting a new approach to classification, it is first necessary to return to the anatomical definition of a perforator and a perforator flap.

A perforator flap is simply a vascularized section of skin and subcutaneous tissue (local, locoregional, or free) that is based on a cutaneous perforator, a “vessel that penetrates the outer layer of deep fascia to reach the skin.” There are two types of perforators: direct or indirect. Direct perforators reach the skin by means of intermuscular septa or fascial hila, whereas indirect perforators reach the skin after passing through deep tissues such as muscle, tendon, or bone. What is not described widely in the current literature is the course of the perforator after it penetrates the outer layer of the deep fascia, and it is certainly true that each of these perforator types reaches the skin by means of a variable course.

Returning to the embryology of the blood supply to the skin, perforators early in development emerge from the outer layer of the deep fascia, supply its superficial surface, and branch in a stellate pattern.
toward an isolated area of skin, the cutaneous “per-
forator angiosome.”1,2 Initially based centrally within
this angiosome, over the course of development, with
regional growth, mobility, and with apoptosis of
some vessels, there is a resultant “stretching” of per-
forator branches in one or multiple directions. For
example, as the brain expands, limbs lengthen and
the torso extends; these alter the dominant subcu-
taneous course of a perforator. We have observed
that this results in two main patterns: either the typ-
ical vertical vessel with a stellate-type branching
pattern to supply a perforator angiosome in which
there is a centrally based perforator that radiates
relatively equally in all directions, or the vessel is
oblique and eccentrically placed with long axial
branches that course either in one dominant direc-
tion (unidirectional) or in two opposite directions
(bidirectional pattern). In the latter two axial pat-
terns, the perforator may course obliquely toward
the dermis where the skin is mobile or, where the skin
is relatively fixed, it may course close to the deep
fascia for a considerable distance, especially in the
limbs (Figs. 1 and 2). We will return to the clinical
implications of these two subcutaneous perforator
types. Where there are three or more major axial
branches (e.g., triaxial), description as a stellate
branching pattern becomes the more useful descrip-
tion clinically.

Unfortunately, perforator flap classification schemes
have become based on observations of vascular anat-
omy, seen after the flap has been harvested, rather
than on inherent anatomy before surgery. It must be
remembered that surgery is a manipulation of anat-
omy, and thus cannot be used to classify anatomy. The
original description of the perforator flap by Ko-
shima and Soeda3 differentiated perforator flaps
from fasciocutaneous flaps, highlighting the inclu-
sion or exclusion of the deep fascia with the flap.
Although such an approach is technically sound, the
range of classification schema introduced since has
often been confusing and not based on vascular anat-
omy. The “Gent” consensus on perforator flaps high-
lighted these issues, and found that consensus could
not be reached as to whether there was a difference
between “axial” fasciocutaneous flaps and septocu-
taneous perforator flaps.4 As we have discussed pre-
viously, these are the same vessels—they are both
direct perforators. It is only the means by which they
are harvested that has led to different classifications
(i.e., the surgical technique applied, not the anatomy
of the vessels).5 In other previous classification
schemes, there has been an attempt to classify per-
forators based on their route of fascial penetration
and vascular supply,6 the muscle through which the
perforator passes,7 or a combination of both.8

What has further confused the issue is the incor-
poration of surgical technique into classification
schema. The “freestyle” perforator flap became used
for local perforator flaps in which a “random” per-
forator (meaning found at random in the area as all
perforators have identity) was identified during sur-
gery and used as the basis of a locoregional perfo-
rator flap.9,10 The “propeller” perforator flap, a var-
tiant of the freestyle method, has also been
introduced and used to base a flap on an “off-center”
perforator, and through rotation at the perforator
pivot point, achieving transposition of the flap tip
into a defect.11 These two definitions have tripled the
number of named perforator flaps, combining ana-

![Fig. 2. Cadaveric total body lead-oxide injection study of the abdominal wall
(at the umbilical level) and the thigh (cross-sectional/axial views), with sche-
matic diagrams highlighting the subcutaneous course of stellate (A), biaxial (B),
uniaxial (C), and deep uniaxial (D) cutaneous perforators. DIEA, deep inferior
epigastric artery.](#)
tomical terms with surgical technique. Although the terms freestyle and propeller perforator are used to describe the ability to dissect an unnamed perforator and design a flap on a random perforator, this article removes this “randomness” from the design and is able to demonstrate the true anatomy of the perforator preoperatively—both source vessel and subcutaneous course.

In addition to selecting named perforators, imaging has enabled the introduction of a new concept based on anatomical (and not surgical) definitions (Fig. 3). With the advent of modern imaging techniques, the true subcutaneous course of a perforator can be incorporated into flap design, so that the subcutaneous course of a perforator runs centrally along the middle of the flap. In addition, adjacent perforators can be identified to select the ideal flap design, remembering that a two-territory flap can be raised safely in any radiating direction.2

**DISCLOSURE**

The authors have no financial interest to declare in relation to the content of this article.

**REFERENCES**