

Definition of perforator flap: what does a "perforator" perforate?

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Abstract: Perforator flap concept plays an important role in reconstructive surgery, because it allows less invasive and more complex reconstruction by preserving major vessels and muscles with intramuscular vessel dissection. Originally "perforator" represents vessel perforating the muscle, then vessel perforating the deep fascia regardless of muscle perforation. With technical progress in reconstructive microsurgery, the previous definition becomes inappropriate for least invasive flaps, only requiring intra-adiposal vessel dissection, such as superficial circumflex iliac artery perforator flap. Based on our experience of various least invasive flap reconstructive surgeries, a new concept for perforator flap has been developed. The new definition of perforator is a vessel perforating an envelope of a targeted tissue to be transferred; the superficial fascia for skin, the periosteum for bone, the perineurium for nerve, and the deep fascia for muscle. According to the new definition, all flaps can be precisely classified based on the corresponding "perforator".

Keywords: Perforator, supermicrosurgery, reconstruction, microsurgery, flap, surgery

Introduction

With clinical application of reconstructive microsurgery, various tissues can be transferred for covering defects and for reconstructing various functions. Among various reconstructions, soft tissue (skin and fat) reconstruction is the most common (1-3). Myocutaneous (MC) flap, consisting of the vascular pedicle, the muscle, the deep fascia, the fat, and the skin, was commonly used to reconstruct a soft tissue defect in the beginning era of reconstructive microsurgery. However, MC flap sacrifices major vessel and the muscle. With advancement of anatomical study on microvasculature of soft tissue, fasciocutaneous (FC) flap and perforator flap were developed as less invasive reconstructive methods. FC flap consists of a vascular pedicle, the deep fascia and the overlying soft tissue, whereas perforator flap consists of a pedicle and soft tissue.

Perforator flap

With clinical application of reconstructive microsurgery, various tissues can be transferred as perforator flaps such as deep inferior epigastric artery perforator (DIEP) flap, anterolateral thigh (ALT) perforator flap, and thoracodorsal artery perforator flap (3-5). Since perforator flap preserves muscle function, it has become a choice of soft tissue reconstructive methods for most experienced microsurgeons. DIEP flap has been reported as the first perforator flap, which contains a muscle

perforator running through the rectus abdominis muscle. Based on the first case of perforator flap using the DIEP flap, perforator was defined as a skin flap without the deep fascia or the muscle based on a muscle perforator requiring intramuscular pedicle vessel dissection (2,3,5). The definition seemed feasible at that time, because intramuscular dissection is technically more demanding, and preservation of the muscle function allows less invasive reconstruction.

With popularization of ALT perforator flap, the definition of perforator flap has been changed to include septocutaneous perforator as a vascular pedicle of perforator flap (3,4,6). ALT flap has anatomical variations in vascular pedicle; some ALT flap is based on a muscle perforator, and others on a septocutaneous perforator, which runs between the muscles. Dissection of septocutaneous perforator is easier than that of muscle perforator, because intramuscular dissection is not required. Though, clinical usefulness of ALT flap based on a septocutaneous perforator is the same as one based on a muscle perforator. Therefore, the definition of perforator flap was changed to a skin flap based on a vessel perforating the deep fascia (muscle perforator or septocutaneous perforator), and a major advantage of perforator flap was characterized as less invasively elevated flap with preservation of muscle function (3,4).

Emergence of new various perforator flaps

As microvascular anatomy was further elucidated,

Table 1. The new definition of perforator and corresponding perforated envelope

| Target tissue | Perforator | Envelope |
|---------------|----------------------------------------------|-----------------------------|
| skin | perforator to the skin (skin perforator) | superficial fascia |
| nerve | perforator to the nerve (nerve perforator) | perineurium |
| lymph node | perforator to the node (node perforator) | lymph node capsule |
| fascia | perforator to the fascia (fascia perforator) | peri-fascial areolar tissue |
| muscle | perforator to the muscle (muscle perforator) | deep fascia |
| tendon | perforator to the tendon (tendon perforator) | paratenon |
| bone | perforator to the bone (bone perforator) | periosteum |

various flaps were reported as perforator flaps, such as chimeric perforator flap with muscle, and true perforator flap without dissection of pedicle perforating the deep fascia (7-10). Chimeric flap consists of multiple vascular pedicle branch-based various tissues such as skin, fat, fascia, muscle, nerve, and bone, allowing three-dimensional complex reconstruction. For example, chimeric ALT flap, one of the most popular chimeric flaps, consists of a skin paddle and the vastus lateralis muscle based on separate pedicle branches from one larger pedicle. True perforator flap is elevated above the deep fascia, which does not include muscle or septocutaneous perforator. These new perforator flaps have advantages of less invasiveness and clinical usability similar to conventional perforator flaps, but do not meet the definition of perforator flap. A new definition is warranted for emerging useful flaps with advantages of less invasive tailor-made reconstruction.

The new definition of perforator flap

The most important characteristics of "perforator flap" are that it consists of selectively elevated target tissues and allows three-dimensionally insets of various tissue reconstruction (6,7,10). Dissection course or technique is not essential to define "perforator flap". Since all the tissue to be transferred as flaps have envelope surrounding the tissue, it seems optimal to define a "perforator" as a vessel perforating an envelope of a target tissue to be transferred. Envelopes of various tissues can be classified as follows; the superficial fascia for the skin, the deep fascia for the muscle, the periosteum for the bone, the paratenon for the tendon, and the perineurium for the nerve (Table 1). When a target tissue (flap) is elevated with the intention to selectively include a "perforator" perforating the corresponding envelope of the target tissue, it can be classified as "perforator flap" regardless of dissection technique or course.

Using the new definition, all flaps can be easily classified and understood correctly. Superficial circumflex iliac artery (SCIA) perforator (SCIP) flap is becoming one of the most popular flaps recently, and has two patterns of vascular pedicle; the superficial branch and the deep branch of the SCIA. The superficial branch of the SCIA runs in the fat tissue above the deep fascia, and the deep branch runs through the sartorius muscle

and the deep fascia to the skin and various tissues. When a skin flap is raised based on the deep branch of the SCIA, it can also be defined as a perforator flap according to the old definition, whereas a skin flap based on the superficial branch of the SCIA cannot be defined as a perforator flap according to the old definition (7,10). The new definition can classify skin flaps based both on the superficial and deep branch of the SCIA regardless of their pedicle courses. Chimeric flaps or various flaps using tissues other than the skin can also be classified according to the new definition.

Conclusion

By defining "perforator" as a vessel perforating an envelope of a target tissue to be transferred, all emerging useful flaps such as super-thin flap and chimeric flap can be classified appropriately. The new definition allows better understanding of these flaps, which is important for microsurgeons to perform less invasive sophisticated reconstructions.

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