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Foot reconstruction using a free proximal peroneal artery perforator flap: Anatomical study and clinical application

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Summary *Background:* When a small, thin, and durable flap is required for coverage of the foot, the proximal peroneal artery perforator (PPAP) free flap may be a novel option. However, few clinical results and anatomical studies on the PPAP flap have been published.
Methods: A total of 24 PPAP flaps used in 22 patients from January 2013 to December 2016 were analyzed. All flaps were elevated in the subfascial plane based on a single perforator from the peroneal artery between the soleus and peroneus muscles.
Results: The average harvested flap size was 18.9 cm^2 (range, 9–40 cm^2), pedicle length was 4.3 cm (range, 3.1–5.5 cm), and pedicle artery diameter was 1.1 mm (range, 0.8–1.5 mm). Twenty-three of the 24 PPAP flaps survived. Average time to harvest the flap was 35 minutes (range, 20–55 minutes). Perforator location (ratio by fibula length) was confirmed at the 0.32 site (standard deviation, ±0.04) from the fibular head. Percentages of septocutaneous and musculocutaneous types were 42% (10/24) and 58% (14/24), respectively, for perforator vessel course; average intramuscular course was 1.3 cm (range, 0.7–2.4 cm). Vessel graft was conducted in four cases, with an average length of 2.2 cm (range, 1.5–3.0 cm).
Conclusions: The PPAP flap is one of the thinnest flaps available and is relatively easy to elevate. Moreover, it can be elevated in the same operative field as the foot, and primary closure is available for the donor site. Thus, the PPAP flap may be a good surgical option for soft tissue coverage of the foot.

This study was approved by the Institutional Review Board of the Catholic Medical Center Office of Human Research Protection Program.

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Introduction

Soft tissue cover to some areas of the foot can yield variable results as grafting of areas with thin skin such as the dorsum of the foot sometimes leads to tethering and contracture over tendons and bones. Flap choice for the dorsum of the foot can be limited with even current thin flaps occasionally being too bulky for sufficient ease of wearing footwear. Moreover, the foot is the terminal structure where wounds caused by ischemic vasculopathy frequently occur.[1]

Thin fasciocutaneous flaps such as the thoracodorsal artery perforator (TDAP) flap,[2] anterolateral thigh (ALT) flap,[3,4] medial sural artery perforator (MSAP) flap,[5,6] proximal peroneal artery perforator (PPAP) flap,[1,7] and superficial circumflex artery perforator (SCIP) flap[8–10] have been used for foot defect coverage. However, TDAP, ALT, and MSAP flaps require sacrifice of the source vessels, whereas SCIP and PPAP flaps can preserve the source vessels and the flap is easier to elevate. In contrast to the PPAP flap, the SCIP flap has been reported in a number of clinical applications and anatomical studies.[11,12] Most of the studies regarding the PPAP flap have been about the PAP of the middle and distal lower leg. This area is thicker and less pliable than that in the proximal area; thus, it is not beneficial to use it as a thin flap.

In the present study, we investigated the anatomy and clinical application of the PPAP flap, which can be a good method to cover soft tissue defects of the foot owing to its availability as a thin flap.

Patients and methods

A retrospective chart review was conducted on 27 PAP flaps in 25 patients who underwent reconstruction of foot defects from January 2013 to December 2016.

Flap harvest

The position of the perforator is initially marked along the posterior border of the proximal fibula using angiographic computed tomography and handheld Doppler. A pinch test is conducted to provide a rough area for primary closure around the perforator, and the defect size is determined. Subsequently, an incision is made on the anterior border of the flap, down through the fascia. Flap elevation is conducted until the perforator is located through subfascial dissection. In the case of a septocutaneous perforator, the perforator travels through the intermuscular septum between the peroneus and soleus muscles, whereas in the case of a musculocutaneous perforator, the perforator penetrates through the soleus muscle (Figure 1). After identification of the perforator (musculocutaneous or septocutaneous), flap elevation is conducted toward the peroneal artery until sufficient pedicle length is achieved. A posterior incision is then made on the designed flap to elevate it, and the circulation is re-examined using handheld Doppler. Once the flap is raised on a sufficient pedicle, the flap circulation is confirmed to be intact by assessing bleeding from the flap edge. Separation of the artery and vein is performed before ligation of the vessels and completion of the harvesting procedure. See **Video, Supplemental Digital Content 1,** which demonstrates the technique of elevating the PPAP flap. The donor sites in all cases presented in this series were closed primarily.

Anatomical data

The location of the perforator on the flap was measured in association with easily identified bony landmarks (distance from the fibular head, distance from the fibula posterior border) and were described according to perforator type (musculocutaneous or septocutaneous), pedicle length, and pedicle external diameter (artery). The location of the perforator was calculated by converting the ratio of the total length of the fibula to the ramification distance from the fibular head, considering individual differences in fibula length.

Postoperative care (ambulation protocol)

When the site of surgery is on a weight-bearing area, a splint or cast is applied and crutch ambulation is provided until 3

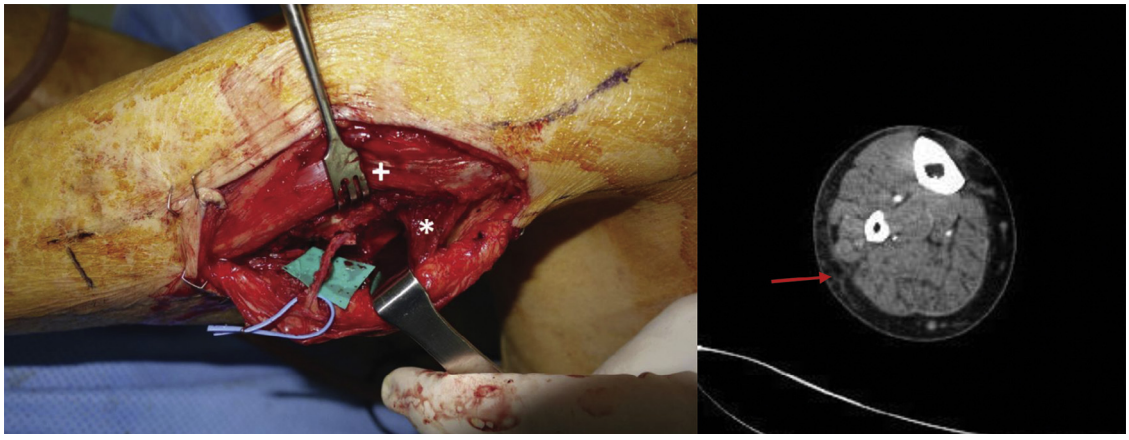

Figure 1 Perforator dissection. (Left) It shows the musculocutaneous course that the perforator penetrates through the soleus muscle (star mark). After soleus was retracted, the perforator located between the soleus and peroneous muscles (plus mark) was identified. (Right) In the case of the septocutaneous perforator, the perforator traveled through the intermuscular septum between the peroneus and soleus muscles. Angiographic computed tomography provided information about the perforator course.