Free posterior interosseous artery perforator flap for finger reconstruction

Toshihiro Ishiko, M.D.[a]

Norihiko Nakaima, M.D.[b]

Shigehiko Suzuki,M.D.,Ph.D.[a]

[a], Department of Plastic and Reconstructive Surgery

Graduate School of Medicine

Kyoto University

Kyoto

[b], Department of Orthopedics

Sumiya Orthopedic Hospital

Wakayama

CORRESPONDENCE TO: Toshihiro Ishiko, M.D.

Department of Plastic and Reconstructive Surgery

Graduate School of Medicine

Kyoto University

Sakyo-ku, Kyoto 606-8507, Japan

E-mail: ishiko@kuhp.kyoto-u.ac.jp

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Summary

We successfully transplanted two free posterior interosseous artery perforator flaps that had been harvested simultaneously from a single posterior interosseous artery system to the index and middle fingers of a 19-year-old man. Our case suggests that multiple free perforator flaps can be prepared from a single posterior interosseous artery system.

Key words

Perforator flap

Posterior interosseous artery

Finger reconstruction

Introduction

The posterior interosseous artery flap is a versatile flap that can be used to cover small and medium-sized defects in the forearm and hand, including the fingers. It was developed for use as a reverse-flow pedicled flap[1-3] or a free flap[4]. The original posterior interosseous artery flap was based on the septum including the posterior interosseous artery vessels and their perforators. In 1999, a posterior interosseous flap based on a septal perforator was reported as a pedicled flap.[5] However, there have been no reports of a free perforator flap based on the posterior interosseous artery system. We report the simultaneous transfer of two free posterior interosseous artery perforator flaps from a single posterior interosseous artery system to the index and middle fingers.

Case report

A 19-year-old man had his left index and middle fingers caught in a heat press machine for 3 minutes. Eight days after the injury (2 days after the first examination at our hospital), the wounds were debrided. All the tissues distal to the DIP joints of the index and middle fingers had become necrotic(Fig1. Above). After the debridement, the extensor and flexor superficialis digitorum tendons were exposed in the proximal two-thirds of the middle phalanges of both fingers

(Fig1 Below). To cover the skin defects, two free posterior interosseous artery perforator flaps including parts of the posterior antebrachial cutaneous nerve, measuring 3.5 X 7.5 cm, and 3.5 X 9.5 cm, respectively were outlined on the posterior aspect of the left forearm (Fig.2). Suitable perforators had previously been located by Doppler sonography. The flap was dissected from the ulnar margin until the septocutaneous perforating vessels were observed. Then, the radial border of the flap was incised. The cutaneous veins and the branch of the posterior antebrachial cutaneous nerve were dissected and included in the flap. The septal perforating vessels were carefully dissected in the intermuscular septum. The proximal flap was based on a single perforating system, and the distal flap was based on two perforating systems because one of the two perforating systems was very thin. Each perforating system included a short segment of the posterior interosseous artery and its comitant veins. The proximal flap was transferred to the previously prepared recipient defect~~s~~ of the index finger, and the distal flap was transferred to the defect of the middle finger. The digital artery of the index finger was anastomosed to the distal side of the posterior interosseous artery of the proximal flap. The digital artery of the middle finger was anastomosed to the proximal side of the posterior interosseous artery

of the distal flap. The dorsal cutaneous vein of the index finger was anastomosed to the cutaneous vein of the proximal flap. The dorsal cutaneous vein of the middle finger was anastomosed to the proximal side of the comitant vein of the posterior interosseous artery of the distal flap. Neural coaptation was achieved between the branch of the posterior antebrachial cutaneous nerve of the flaps and the digital nerves of the index and middle fingers. Most of the donor area was closed directly, but part of it was covered with a full-thickness skin graft harvested from the medial side of the upper arm.

Two days postoperatively, the patient fell down in a corridor and hit his left hand. Immediately after that, both the index and middle finger flaps became congested (Fig.3). After the intravenous administration of heparin, the index flap recovered, but the flap on the middle finger remained congested. Therefore, we immediately reanastomosed its dorsal cutaneous vein. As a result, both flaps survived completely. Three months postoperatively, the patient returned to manual work.

Eight months postoperatively, the middle phalanx of the index finger was partially exposed due to flap ulceration. It is supposed that the ulceration first developed on the fragile seam of the flap, which was placed just over the stump of the phalanx and was injured by frequent mechanical stress during manual

work. After shortening the phalanx a little, the ulceration healed. Two years postoperatively, there has not been any recurrence of the ulceration (Fig.4). Regarding the sensory recovery of the flaps, the index finger was categorized as blue and the middle finger as purple according to the Semmes-Weinstein test.

Discussion

In hand and finger reconstruction, the forearm is a useful source of flaps. The advantages of flaps harvested from the forearm are as follows: (1) the flaps can be harvested at the same time as the preparation of the recipient site under upper arm anesthesia; (2) the flaps can be harvested while a tourniquet is applied to the arm; (3) the flaps can be transferred in a single-stage procedure that enables postoperative elevation and early mobilization of the treated hand to reduce edema and fibrosis; (4) the flaps are thin and pliable; (5) the color and texture match those of the hands and fingers; (6) the flaps can be used as sensory flaps.

The radial forearm flap is very well-known to reconstructive surgeons worldwide. However, it has a major disadvantage, which is the sacrifice of a major artery to the hand. To overcome this serious drawback, several perforator flaps have been reported that preserve the continuity of the radial artery. [6-11] The free

radial artery septal perforator vessel-based flap reported by Oskan et al is particularly useful for small skin defects of fingers because of its minimal donor site morbidity and the fact that it preserves the entire radial artery.[11] However, it requires advanced techniques for microsurgical anastomosis. Safak and Akyurek reported a perforator flap that contains a short segment of the radial artery included in an inverted-T-shaped arterial pedicle.[10] Advanced skills are not necessary to anastomose the radial artery, and the donor artery can be anastomosed directly. However, when a relatively long segment of the radial artery is harvested in order to prepare plural flaps for multiple finger injuries or when a long vascular pedicle is needed even in a single flap, a venous graft is required to preserve the vascular circulation of the radial artery. In addition, as the diameter of the radial artery is larger than that of the digital artery, it is somewhat troublesome to anastomose the two vessels.

Arterialized venous flaps have been used to resurface skin defects of the hand and fingers.[12, 13] However, the survival mechanism of the flap remains unclear, although it has been investigated.[14] Severe postoperative swelling, discoloration, bullae formation, and unpredictable partial necrosis of the flaps were reported as major problems of arterialized venous flaps when they were applied to relatively

large skin defect.[15]

The free posterior interosseous artery perforator flap, which contains an inverted T-shaped pedicle that includes the posterior interosseous artery and its comitant veins, has the following advantages over the previously described flaps, which were harvested from the forearm. As the posterior interosseous artery is not the main artery of the forearm, it is not necessary to repair it. The posterior interosseous artery has an average external caliber of 1.6 mm(range 0.9 to 2.7 mm), which is in the permissible range for anastomosis to the proper or common digital artery.[1] In our case, it was possible to cover the skin defects of two fingers simultaneously with a conventional free posterior interosseous artery flap. However, when it is used, the resulting temporary surgical syndactyly should be separated later. An anatomical study demonstrated that the posterior interosseous artery has 7 to 13 septocutaneous perforators.[1] Theoretically, it may be possible to prepare multiple free perforator flaps from one posterior interosseous artery system. In addition to the versatility of the conventional free posterior interosseous artery flap, the free posterior interosseous artery perforator flap has plural productivity. The flap is useful for the repair of defects involving multiple fingers as was shown in our case. Such a perforator flap is

relatively easy to prepare because the shorter the segment of the posterior interosseous artery is, the easier and quicker the dissection of the pedicle becomes. Of course, when a longer pedicle with large diameter is necessary, dissection should proceed proximally. Dissection along the pedicle should be performed very carefully under magnification with a loupe to prevent damage to the perforating vessels. When the flap is wider than 4 cm, a skin graft is necessary for closure of the donor site. However the skin graft can be excised afterward if the patient prefers.

Hubmer et al. reported that the posterior interosseous artery is narrowest in the mid forearm, where it is joined by a recurrent branch from the anterior interosseous artery, forming a choke anastomosis.[16] It is possible that the comitant veins of the posterior interosseous artery also follow a similar pattern. The comitant veins of the flaps that we harvested could be narrower proximally than distally. Hence, in the middle finger, the congestion of the flap had not been improved when a cutaneous vein was anastomosed at the time of reexploration. This suggests that the cutaneous vein is necessary to augment the venous return of the free posterior interosseous artery perforator flap, especially in the mid forearm.

In our case, the toe to hand transfer technique would provide functioning digits with an acceptable appearance and sensibility, but the patient preferred not to lose his toe; therefore, we planned finger reconstructions using flaps.

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Figure legends

Figure 1

(Above)Preoperative views of a 19-year-old man who had his left index and middle fingers caught in a heat press machine for 3 minutes. (Below) After debridement, the extensor and flexor tendons were exposed. The distal phalanx of the index finger was eventually excised.

Figure 2

Two free posterior interosseous artery perforator flaps simultaneously prepared from one posterior interosseous artery system.

Figure 3

Two days postoperatively, both the index and middle finger flaps became congestive.

Figure 4

Two years postoperatively, the patient returned to manual work.