Third Toe Pulp Reconstruction Using the Contralateral Second Toe Hemi-pulp Free Flap

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Summary: A hemi-pulp flap is widely known as a flap useful for aesthetic and functional reconstruction of the fingers, and rarely used for toe reconstruction. We performed third toe pulp reconstruction using a free hemi-pulp flap harvested from the contralateral second toe to repair the tissue defect following toe replantation. An 18-year-old woman was injured with complete left third toe amputation and open fracture of the proximal phalanx of the left second toe in a traffic accident. On the same day, third toe replantation was urgently performed. After surgery, the third toe was partially taken, and had a toe pulp tissue defect due to necrosis. It was reconstructed with a free hemi-pulp flap prepared from the contralateral second toe. The flap was completely taken. Three years after surgery, the reconstructed left third toe was aesthetically favorable. Perception of the flap region was restored up to S2 without pain and there was no complication such as numbness, callus, and ulceration. In the flap donor site (right second toe), the skin graft was unnoticeable without pigmentation. Toe pulp reconstruction requires a sensory flap as low-invasive as possible with excellent sensory restoration, texture, feel, and shear property. This method is considered as one of the low-invasive, aesthetic, and functional reconstruction methods. (Plast Reconstr Surg Glob Open 2021;9:e3435; doi: 10.1097/GOX.0000000000003435; Published online 18 February 2021.

Toe replantation and reconstruction are not common from a functional viewpoint.1–4 However, they are proactively performed in Japan due to the health insurance system, especially, in young women from an aesthetic viewpoint.3 A hemi-pulp flap is a sensory flap with minimal donor site morbidity and unnoticeable. It is widely known as a flap useful for aesthetic and functional reconstruction of the fingers,6,7 and rarely used for toe reconstruction.5 We performed toe pulp reconstruction using a free hemi-pulp flap harvested from the contralateral toe to repair the tissue defect following toe replantation.

CASE REPORT

An 18-year-old woman was injured with complete left third toe amputation and open fracture of the proximal phalanx of the left second toe in a traffic accident. Amputation of the third toe was of the crush and avulsion nature, and the toe pulp was severely crushed (Fig. 1). On the same day, third toe replantation was urgently performed. The arterial route was reconstructed by anastomosing the digital artery using a vein graft. In the venous route, the dorsal subcutaneous vein was anastomosed. C-wire fixation of the proximal phalanx of the second toe was performed simultaneously. After surgery, the third toe was partially taken (Fig. 2).

It was reconstructed with a free hemi-pulp flap prepared from the contralateral second toe. The surgical procedure was as follows: Firstly, the necrotic tissue of the left third toe was resected. Then, the subcutaneous vein and first dorsal metatarsal artery (FDMA) were identified in the first web space of the contralateral foot, and the neurovascular bundle heading to the second toe was identified. The hemi-pulp flap was elevated with the neurovascular bundle of the second toe (tibial side, Fig. 3) and attached to cover tissue defect of the left third toe. For the arterial reconstruction, FDMA (flap) and second dorsal metatarsal artery (recipient) were anastomosed, and for the venous reconstruction, the subcutaneous vein (flap) and subcutaneous vein (recipient) were anastomosed with a microscope. For the nerve, the digital nerve and deep peroneal nerve (flap) were sutured to the bilateral digital nerves of the left third toe (Fig. 4). A full-thickness skin graft harvested from

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the left lower medial condyle area was carried out to cover the skin defect of the flap donor site.

The flap and skin graft were completely taken. One year after surgery, the left third toe slightly shortened but it was aesthetically favorable. (See Video [online], which shows the postoperative findings 3 years after surgery.) The range of motions of the proximal and distal inter-phalangeal joints of the third toe was not obtained, but walking was possible. Perception of the flap region was restored up to S2 without pain and there was no complication such as numbness, callus, and ulceration. In the flap donor site (right second toe), the skin graft was unnoticeable without pigmentation. (See Video [online], which shows the postoperative findings 3 years after surgery.) Scarring in the skin donor (left lower medial condyle area) was also unnoticeable, being aesthetically satisfactory.

**DISCUSSION**

The importance of the great toe for walking has been reported and reconstruction by replantation or with a flap has been occasionally reported.8,9 However, reconstruction of toes other than the great toe is not generally
considered as an indication of surgery from the viewpoints of cost and function. With a toe being lost, walking and running are functionally possible and the absence of toes is hidden by wearing a shoe and is unnoticeable.

Previously, the following points have been emphasized for plantar reconstruction: (1) durable and comfortable weight-bearing surface, (2) adequate contour (thickness, texture, and color), (3) protective sensation, (4) solid anchoring to deep tissue to resist shearing.10 For toe pulp reconstruction, (5) sensory recovery and (6) minimal donor site morbidity are additionally needed. It is important not to reconstruct toes interfering with walking because pain and numbness of the reconstructed toe strongly influence walking. Therefore, nerve suture is extremely important for toe replantation and it may be essential to select a sensory flap for toe reconstruction.

Reconstruction should be performed with similar tissue, which is widely accepted as a basic principle. The fingers are the only tissue similar to toe tissue, but toe reconstruction with a sensory flap prepared from the fingers is not applied as a surgical indication because it necessitates a big sacrifice functionally and aesthetically. Thus, in this patient, a sensory flap from the toe was selected from the viewpoints of texture, color tone, and reconstruction of perception. Sensory toe flaps include a hemi-pulp flap from the ipsilateral adjacent toes, the second and fourth toes. A case of reconstruction with an adjacent hemi-pulp flap has already been reported. Because the damage of the digital artery by open proximal phalangeal fracture of the second toe was suspected in our case, flap elevation from the second toe was difficult. Moreover, the fourth toe hemi-pulp flap was disadvantageous with small and short vascular pedicle. Based on these reasons, we selected the contralateral (healthy side) second toe free hemi-pulp flap.

A second toe hemi-pulp free flap is a useful flap for small defects of the fingers.6,7 A case of a second toe free hemi-pulp flap applied to the amputated fingertip defect was reported, in which primary closure of the flap donor site was possible.8 In our case, skin graft from the lower medial condyle area was necessary to close the wound of the flap donor site. Disadvantage of this surgical procedure includes the prolonged duration of hospitalization and a larger medical expense.

We encountered a rare case in which a hemi-pulp flap from the adjacent toe could not be selected for toe pulp reconstruction and a free hemi-pulp flap from the contralateral toe was indicated in a young woman. Toe pulp reconstruction requires a sensory flap as low-invasive as possible with excellent sensory restoration, texture, feel, and shear property. This method is considered as one of the low-invasive, aesthetic, functional reconstruction methods.

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