

# Clinical Effects Of Reconstruction Of Thumb Finger Pulp With Distal Fibular Flap Of The Great Toe

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## Abstract

This study investigates the clinical effects of reconstructing thumb finger pulp with the distal fibular flap of the great toe. Twenty-four patients admitted to Hand and Foot Surgery in our hospital from June 2014 to September 2018 were treated with the distal great toe fibular flap in the refurbishment of finger pulp. There were 19 males and 5 females. The patients ages are from 21 to 65 years, with mean age of 36.2 years. Causes of injuries were mechanical wounds in 11 cases, crushing injuries in 8 cases, and cutting injuries in 5 cases. The sizes of the finger pulp defects ranged from 1.5 cm × 2.0 cm ~ 3.0 cm × 3.2 cm. All 24 cases of flap survived without vascular crisis. The participant were followed up for 6 to 18 months (average of 12 months). There was no obvious scar formation on the reconstructed finger pulp. Additionally, the distal finger pulp was full of clear texture and wear-resistance. The two-point discrimination was 6-9 mm, with no complications in the donor area. The presence of the thumb finger pulp reconstructed with the free flap of the distal fibular side of the great toe was same to normal thumb finger pulp. Moreover, sensory function recovery was satisfactory. On the basis of the successful clinical recovery observed, we conclude that using a distal great toe fibular flap is a beneficial method to consider in the reconstruction of thumb pulp.

**Keywords:** Finger pulp defect, Distal fibular flap, Great toe, Thumb finger, Reconstruction

## Introduction

The aesthetic and functional importance of hands always remains unquestionable in daily life. Defects in fingers require urgent reconstruction to improve and maintain their functional capacity and sensational capability [1, 2]. Thumb finger pulp defects are commonly observed in open hand injuries, which are mostly caused by crushing, laceration and cutting. The fundamental requirement for repairing the defect is the restoration of optimal finger shape and sensory function [3]. It has always been a challenge for hands surgeon to reconstruct complex thumb defects of soft tissue, especially when the underlying structures are exposed. Issues such as limited local soft tissue availability and the requirement for durable, pliable, and sensate skin coverage to preserve the thumb function further make the surgery a challenging task [4, 5].

There are many methods to repair finger pulp defects. Some methods meet the requirements of wound coverage but result in unsatisfactory appearance and poor sensory function of finger

pulp. This limits the fine operation of the hand following surgery [6]. The great toe fibular flap cannot only repair finger wounds but also restore sensation. Hence, using the great toe fibular flap to reconstruct thumb finger pulp has become a common method to repair thumb defects [7]. However, due to the different locations of donor flaps used in previous reports, there was wide variation in the final appearance of reconstructed thumb finger pulp.

Therefore, the current study aims to evaluate the advantages of using the distal great toe fibular flap. For this purpose, we reconstructed 24 cases of injured thumb finger pulp using the distal flap of the great toe at the fibular side from June 2014 to September 2018. We found that using great toe distal fibular flap in the reconstruction and modification of thumb pulp defects can improve the appearance and sensation of the finger.

## Materials and Methods

### General data

There were 24 cases included in our study group. They were 19 males and 5 females, ranging from 21 to 65 years of age, with an average age of

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36.2 years. There were 7 cases of the left hand and 17 cases of right hand injury. There were 11 cases of mechanical wounds, 8 cases of crushing injury, and 5 cases of cutting injury. All the tissue injuries were non-joint thumb finger pulp defects, with a defect area range of 1.5 cm × 2.0 cm ~ 3.0 cm × 3.2 cm. Injuries were accompanied by phalanx exposure in 18 cases.

### Inclusion and exclusion criteria

The inclusion criteria for enrollment included: (1) patient with thumb pulp defects; (2) patients agree for surgery to restore the function and esthetics of the injured thumb; (3) patients with age < 65 years.

The exclusion criteria included: (1) History of diabetes, peripheral vascular disorders and hypertension; (2) Patient suffering from infections or diabetic wound.

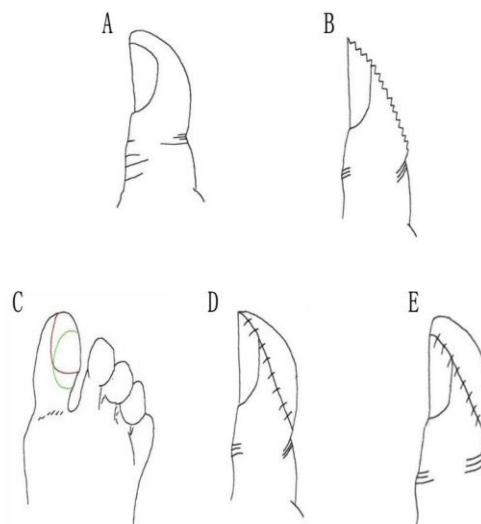
Written informed consent was obtained from all the participant or their family members for their treatment and involvement in study. The present study was approved by the ethics committee of the Affiliated Hospital of Yangzhou University, Yangzhou University.

### Surgical Procedure

#### Flap Design

The finger pulp distal end of the normal thumb was complete and round (**Figure 1A**). The wound of the injured finger was thoroughly debrided to remove inactivated and heavily contaminated tissue from the wound surface (**Figure 1B**). The proper digital artery, the proper digital nerve and the dorsal digital vein were dissected under a microscope, and the vascular and nerve ends were marked. Considering the size of the skin defect of the injured finger, an appropriately sized flap was cut from the distal end of the great toe (**Figure 1C**). The fibular edge of incision was more than 3mm from the nail fold of the toe, and the proximal end reached the toe web, avoiding callus skin at the toe base as far as possible. As the degree of flap contraction was small after the great toe flap was freed, the flap was only slightly enlarged when removed, with the flap edge enlarged by about 1 mm. The superficial fibular vein of great toe first metatarsal dorsal vein (FMDV) was used as the refluxing vein, and the fibular basal great toe digital artery or first metatarsal dorsal artery (FMDA) of great toe was used as anastomosis artery. When selecting the non-distal fibular flap of the great toe in the design step, the distal end of the reconstructed thumb would be flat and not full, and the abdominal area of the finger would be enlarged

(**Figure 1D**). In contrast, selecting the great toe distal fibular flap to reconstruct the thumb finger pulp better reproduced the original appearance of the thumb finger pulp (**Figure 1E**).



**Figure 1. Schematic diagram of reconstruction of thumb finger pulp with great toe distal fibular flap. A) Normal thumb appearance, B) Thumb pulp defect, C) Design of the great toe distal fibular flap (the red line is the distal flap cutting line, while the green line is the non-distal flap cutting line), D) Appearance of thumb pulp reconstructed with non-distal great toe fibular flap and E) Appearance of the thumb pulp reconstructed with great toe distal fibular flap.**

#### Flap Cutting

The skin was cut along the designed incision, and the superficial dorsal vein of the fibular side of great toe was separated, which was dissociated proximally to the superficial dorsal vein of the first metatarsal. Additionally, other vein branches unrelated to the flap were cut off and ligated. The skin of the toe web was cut and open to identify the proper artery of the great toe fibular side. Concurring to the length of blood vessels in the injured finger area, the basal digital artery of the great toe or the FMDA was reserved, while its branches were ligated, and the proper nerve of the fibular base of great toe was separated. After dissection, cutting off the pedicle of the vascular nerve was temporarily delayed. Then following cutting open the metatarsal side of the flap, the flap was excised, and the tourniquet was loosened. The flap was lifted under the deep fascia, and the pedicle of the vascular nerve was cut off at a high point after observing good flap blood flow.

### Flap Transplantation

The flap was transplanted to the injured finger and wrapped around the phalanx. Several stitches were sutured to fix the flap temporarily. The following were microscopically anastomosed with 9-0 microsutures (AROSuture™ T06A09N14-13): the proper or common digital artery, the fibular basal digital artery of great toe, the great toe dorsal metatarsal vein, the thumb dorsal metatarsal vein, the proper nerve at the lateral base of the great toe and the thumb nerve. Full-thick skin was transplanted and applied to cover the hallux toe wound, which was then wrapped with gauze and pressure.

### Postoperative Treatment

After the operation, the flap was treated with heat preservation and anti-infection (cefazolin), anticoagulation (heparin) and antispasmodic therapy (atropine). In case, the elevated flap was sutured, an anchoring suture (4-0 nylon) was applied for protection. Postoperative dressing was applied every 2 to 3 days to avoid any infection and puff formation. Patients were regularly monitored by attending nurse for any complications or postoperative complications. Thumb function exercise began 7 days after operation while the suture was removed after 12 days.

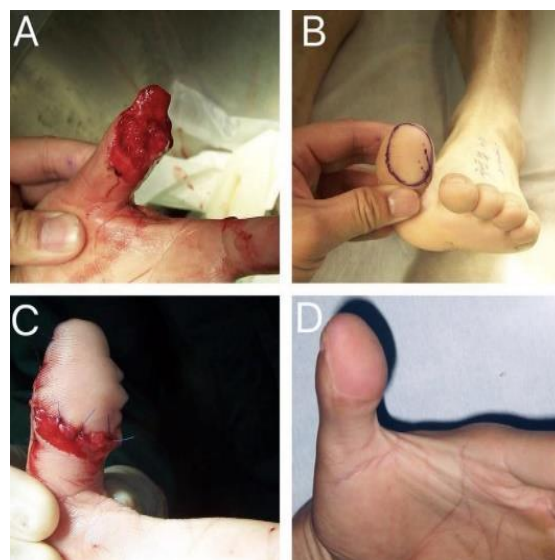
### Results

All flaps survived in the absence of vascular crisis. The follow-up period was 6-18 months (Average 12 months). The distal part of the thumb was full, with a clear fingerprint, while the skin flap had a healthy color, elasticity and texture. Hand function recovered well, and two-point discrimination was 6-9mm. The donor area was covered with a full-thickness skin graft that survived in all patients without discomfort. Furthermore, foot function was not negatively affected.

### Typical Case

The patient, a 32-year-old male, was administered to the hospital with a mechanical wound on his left thumb. Left thumb finger pulp defect area was 2.1 cm × 2.9 cm, with phalanx exposure (**Figure 2A**). Debridement was carried out in the Emergency Department following admission, and the distal fibular flap profile of the left great toe was designed. The flap edge was slightly enlarged by 1mm compared with the wound surface (**Figure 2B**). The anastomosis was performed on the fibular basal great toe digital artery, the dorsal metatarsal vein of great toe, the proper digital artery, the thumb dorsal metatarsal

vein, the proper nerve at lateral base of the great toe and the proper nerve of thumb. The flap was observed to have good blood flow (**Figure 2C**). The donor area was repaired with a full-thickness skin graft taken from the central, medial part of the left calf. The calf was then sutured directly. Following the operation, the transplanted tissue in the left thumb and skin grafts in the donor area both survived. Systemic rehabilitation began 7 days after the operation. Follow-up at 12 months post-operation showed that the texture and color of the flap of the left thumb were close to normal skin. The appearance was good, the sweating function had recovered and two-point discrimination was 8.0mm (**Figure 2D**). The loading and walking function of the left foot was normal.



**Figure 2. Reconstruction of thumb finger pulp with great toe distal fibular flap. A) Finger pulp defect of left thumb before surgery, B) Design of the distal fibular flap of left great toe, C) Reconstructed left thumb pulp immediately after surgery and D) Appearance of finger pulp at follow-up 12 months following surgery. The appearance of the finger pulp was normal.**

### Discussion

Injury or defect of thumb finger pulp is common in hand trauma, and the unique structure of finger pulp makes it play an essential role in hand function [8]. As "the eyes of the hand", finger pulp needs to complete pinching, holding, grasping and other fine activities. Finger pulp has rich nerves and high tactile sensitivity, so it can distinguish the texture and shape of objects [9]. Therefore, the repair of finger pulp defects of the thumb should not only eliminate the wound, but also pay attention to the

overall aesthetic and functional recovery of the finger [10]. Common repair methods include repairing with arbitrary and island flaps of the hand [11]. Arbitrary flap includes finger pulp flap, cross arm flap, thenar flap and adjacent finger flap [12]. The island flap of the hand includes reverse digital artery island flap and dorsal digital fascia pedicle flap. Although arbitrary flap survives well, the repaired skin flap is bloated in appearance and poor in sensory recovery. In addition, it needs a second stage operation to break the pedicle, which is not only inconvenient but also limits the early functional exercise of fingers. It takes a long time to correct joint rigidity after breaking the pedicle. The island flap can restore sensation to the finger pulp, but the appearance is unsatisfactory and not wear-resistant.

With the development of microscopy, free flap microsurgical repair has achieved good clinical results [13]. Rose and Buncke first proposed the toe pulp flap application for the repair of finger pulp defects. It has now become the most commonly used method for repairing thumb finger pulp defects [14]. The advantages of this operation include: (1) The anatomical structure, and physiological functions of the great toe pulp are same as finger pulp [15]. (2) The flap has sensory nerves, so the reconstructed finger pulp can restore good, fine sensation. In our study group, the post-surgical flap two-point discrimination was 6-9 mm, which was approximately the same as that of healthy fingers. (3) The blood vessels and nerves of the great toe fibular flap are relatively constantly located and easily dissected. (4) The fibular donor area of the great toe is concealed, with little damage, no postoperative pain scar, and no significant influence on the overall appearance and function of the foot.

In accordance with Cheng Guoliang's concept of "function first, appearance first" in finger repair and reconstruction, we improved the traditional method of repairing thumb finger pulp with great toe pulp flap. This method emphasizes selecting the great toe distal flap pulp in the flap design stage. The flap was cut from the distal end of the great toe, with the fibular edge more than 3 mm from the nail fold of the toe and the proximal end reaching the toe web, avoiding the skin calluses of the toe base (that is, the weight-bearing area of the skin of the toe base) as far as possible. We believe that hands and feet are of the same developmental origin. Thus, the structure and shape of the distal end of the great toe are close to those of the thumb finger. After reconstruction, the distal thumb pulp is full, round and appropriately thick, meeting the

requirements of "physiological repair". If the position of the great toe fibular flap was not distal, the repaired distal thumb would be flat, and the finger pulp area of the finger would be enlarged, thereby seriously affecting the aesthetic appearance of the thumb. All 24 cases in this group were treated with distal fibular flap from the great toe, which effectively reconstructed the original shape of thumb finger pulp. Beside distal fibular flap, other surgical interventions include, the use of Littler neurovascular flap, Moberg flap, Foucher's flap, Kutler's V-Y flaps, and free flaps [16]. Furthermore, regenerative medicine is also under active investigation for thumb finger pulp and other injuries [17].

There are some limitation in our current study. First the sample size was relatively small. Second, the inclusion and exclusion criteria was adequately refine. Finally, the duration of current study was very limited. Future studies will be required to include larger population and extensively investigate the effects of reconstruction of thumb finger pulp with distal great toe fibular flap.

## Conclusion

Applying the great toe distal fibular flap in the reconstruction and modification of thumb pulp defects can restore normal appearance and sensation of the finger. This occurs without affecting the function and texture of the donor foot. Therefore, we recommend it as a beneficial choice to repair thumb finger pulp defects and worthy of broader clinical advantages.

## Conflict of interest

All the authors declare no conflict of interest

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