

# Retrograde Island Flap Bridge Transfer of Adjacent Phalangeal Artery Combined With Vascular Pedicle Tubular Skin Grafting to Repair Finger Pulp Defect

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## Research article

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# Abstract

**Objective:** To investigate the surgical method and therapeutic effect of retrograde island flap bridge transfer of adjacent phalangeal artery combined with vascular pedicle tubular skin grafting to repair finger pulp defect.

**Methods:** From June 2008 to May 2020, 14 patients (16 fingers) with severe contusion of proximal and middle phalangeal body combined with finger pulp defect, and 5 patients (5 fingers) with finger pulp defect more than distal interphalangeal joint were repaired by retrograde island flap bridge transfer of adjacent phalangeal artery combined with vascular pedicle tubular skin grafting. The dorsal branch of digital nerve was carried in the skin flap for anastomosis with the proper nerve at the stump of the injured finger. The donor area was covered with medium thickness skin of abdominal or elbow transverse stripes, and the vascular pedicle was wrapped with tubular skin. The pedicle was severed 16-22 days after surgery. The survival rate and complications of postoperative flaps were observed. The finger function was evaluated by the Michigan functional questionnaire and Dagan functional criteria, and the clinical effect was evaluated.

**Result:** All flaps survived and all patients were followed up for a period of 6 to 46 months. The skin flap of the affected finger was of good texture, and the appearance was naturally not bloated. The two-point discrimination was 7 ~ 11mm, and no obvious complications were observed in the donor area. Evaluation of the Michigan Hand Function Questionnaire: Nineteen patients were satisfied with the overall appearance and function of the hand. Finger joint Dagan function evaluation: excellent in 15 cases, good in 4 cases.

**Conclusions:** It is a safe and effective operation to repair finger pulp defect with the retrograde island flap of adjacent finger artery combined with vascular pedicle tubular skin grafting. the skin flap has the advantages of simple cutting, good texture and concealed donor area, which is convenient for the early functional exercise of the finger body.

## Background

Finger pulp dense texture, sensitive feeling, as the "eyes" of the hand, but finger pulp injury is very common in clinic. Due to the natural similarity of finger and toe structure, the lateral flap of toe and toe has always been the best method to repair the defect of finger pulp[1–3]. However, free toe skin flap has many disadvantages, and it is not easy for patients to accept. When the proximal end of the finger body is seriously injured, or finger pulp defect exceeds the distal interphalangeal joint, the island flap of the digital artery of the injured finger cannot be used for repair, then the island flap of the adjacent digital artery will be cut for repair. However, this surgical method will leave large scars on the palm and also have major drawbacks[4–6]. From June 2008 to May 2020, 19 cases (21 fingers) of this kind were repaired by reverse island flap bridge transfer of adjacent phalangeal artery combined with vascular pedicle tubular skin grafting, and satisfactory results were obtained, which are now reported as follows.

## 1. Clinical data

In this group, there were 19 cases (21 fingers), 12 males (12 fingers) and 7 females (9 fingers) with an average age of ages 40.5 years (ranged from 16 to 57 years). The cause of injury: all of them were crushed by the machine. The injured sites: index finger (4 cases), middle finger (5 cases), ring finger (6 cases), little finger (2 cases), index finger and little finger (1 case), middle finger and ring finger (1 case). Among them, there were 14 cases (16 fingers) with severe contusion of proximal and middle phalangeal body combined with finger pulp defect, and 5 cases (5 fingers) with finger pulp defect more than distal interphalangeal joint, and all phalangeal bones were exposed. Defect area: 2.4cm×1.8cm ~ 4.5cm×2.2cm. Operation time: emergency operation in 9 cases (9 fingers) underwent, selective operation in 10 cases (12 fingers). This retrospective study was approved by the Ethics Committee of the Affiliated Jiangnan Hospital of Zhejiang Chinese Medical University (Hangzhou Xiaoshan Hospital of Traditional Chinese Medicine) and performed in accordance with the Helsinki Declaration. All patients agreed to participate and provided written informed consent prior to treatment.

## Treatment Methods

### 2.1 Preoperative treatment

After admission, the patient received symptomatic support such as analgesia and anti-inflammatory treatment. Perform preoperative examinations to assess surgical risks.

### 2.2 Surgical methods

After the brachial plexus nerve anesthesia, the operative area was cleaned, disinfected and laid with aseptic cloth. The wound was thoroughly debridement and hemostasis. and the skin flap was designed and cut at the proximal end of the adjacent finger according to the size of the wound. A serrated incision was made on the side of the distal finger of the flap, and the subcutaneous tunnel was opened along the incision. Then the skin flap was cut, the internal digital artery of the skin flap was ligated and cut off from the proximal high position, and the digital artery and dorsal branch of digital nerve were brought into the skin flap. Then the vascular pedicle was separated retrograde along the proper digital nerve to the distal middle segment or the distal interphalangeal joint. Relax the tourniquet, stop the wound bleeding, and observe the blood circulation of the skin flap. After the skin flap became ruddy, the incision at the pedicle was sutured, and a medium thickness skin graft was taken from the abdominal or elbow stripes. Suture the wound in the donor area, and then transfer the skin flap to the recipient area. The dorsal branch of digital nerve carried by the skin flap was anastomotic with the stump of the intrinsic digital nerve in the wound surface under a microscope, and then the skin flap was sutured to cover the wound surface. The exposed vascular pedicle was covered by a tubular skin graft wrapped with excess medium thickness skin plates.

### 2.3 Postoperative management

After operation, the affected limb was fixed with plaster support and flexion of wrist joint at 60 degrees, and the distance from the grafted skin flap to of 30 ~ 40cm was kept warm by continuous baking lamp irradiation. Postoperatively, the patients were treated with anti-infection, anti-vasospasm, anticoagulation and analgesia, and blood circulation of the flap was closely observed. One week later, the fixation and dressings were removed, and the patients were instructed to take the initiative to exercise the flexion and extension function of their fingers. The pedicle was severed 16–22 days after surgery. The appearance, sensation of the finger pulp and functional recovery of finger joint were observed through follow-up.

## The Results

19 patients were followed up for 6 to 46 months. All the flaps survived, and there was no deep infection in the donor and recipient site. The texture of the skin flap was good, and the appearance was naturally not bloated. The sensation pain, temperature and touch were well recovered, the two-point discrimination was 7 ~ 11mm, and there was no obvious dysfunction in the donor area. According to the criteria of Michigan Hand Function Questionnaire at the last follow-up, 19 patients were very satisfied with the overall appearance and function of their hands. The function of finger joint was evaluated according to Dargan functional standard [7]: excellent, the tip of the flexion finger passed the transverse pattern of the palm; Good, the tip of the flexion finger reached the transverse pattern of the palm; Generally, the distance between the tip of the flexion finger and the transverse pattern of the palm was less than 2cm; Poor, the distance between the tip of the flexion finger and the transverse pattern of the palm was more than 2cm. In this group, there were 15 excellent cases and 4 good cases. Typical cases are shown in Fig. 1–2.

## Discussion

### 4.1 Research status of flap repair for finger pulp defect

With the development of handicraft industry and the popularization of mechanical operation, hand injury, especially finger pulp defect, is more and more common in clinic, and the treatment technology is becoming mature. Hand is not only a motor organ, but also an important cosmetic organ, so the repair of hand defects strive to achieve both appearance and function. Refers to the finger pulp skin is composed of dense connective tissue, containing rich nerve endings and sensory corpuscles, and there are many vertical fibers in the dermis to fix the skin to the phalanx and deep fascia, so the skin in the pulp of the finger has low slippage, good wear resistance and sensitive sensation[8–9]. The pedicled skin flap and free skin flap used routinely in clinical practice are quite different from the skin of the finger pulp in texture and nerve distribution, and are unable to restore its sensation and wear resistance. Therefore, at present, it is the best to use the lateral flap of the toe (finger) to repair the finger pulp defect[10–13]. Due to the high difficulty of operation, great trauma and high probability of failure, some patients are unwilling to accept the free toe lateral skin flap. When the finger pulp defect combined with serious injury of the proximal middle phalanx of the finger, or vascular injury, inflammatory edema and poor skin condition, the local island flap and free flap cannot be used to repair. When the finger pulp defect exceeds the distal interphalangeal joint, the island flap of the digital artery of the same finger cannot be used for repair

because of the damage of the distal digital artery arch. The vascular pedicle of the island flap of adjacent finger artery needs to be separated to the common digital artery. With a large incision, the palm will be left with a large scar, which is easy to cause scar contracture[14].

It has been reported that bridge transfer of digital artery retrograde island flap was used to repair adjacent finger defect, but additional rectangular flaps were designed at the vascular pedicle. This vascular pedicle treatment can cause a waste of finger skin. Zhang Gonglin et al.[15–16]. repaired skin and soft tissue defects of the leg with free skin flap bridge transfer: The vascular pedicle of the free skin flap was exposed and anastomosed with the posterior tibial artery of the contralateral leg, and the exposed vascular pedicle was covered with reticular skin grafting. This greatly simplifies the operation, saves the amount of skin used in the leg, and the legs can be placed in parallel, the postoperative position is comfortable, and all the flaps survive, and eliminates the concern of the vascular crisis caused by the exposed vascular pedicle. Due to the small area of the lateral flap of the finger, in order to reduce the damage to the donor area of the finger, we exposed the finger artery pedicle of the flap and covered it with a skin flap. This operation method does not need to cut the skin on the side of the finger to make a skin tube to wrap the vascular pedicle, which can greatly reduce the trauma to the donor finger, simple operation and shorten the operation time. Compared with the conventional island flap of the adjacent digital artery that needs to be separated to the common digital artery, this procedure requires a secondary pedicle amputation, but it has no collateral damage to the palm. In addition, the flap has a large contact area with the donor area, and the blood supply is reliable. The pedicle can be broken in advance, and it is easy to break the pedicle. The pedicle can be broken without suturing or with only 1–2 stitches, and the shape is beautiful[17–18].

#### **4.2 The advantages and disadvantages of this operation**

In this study, retrograde island flap bridge transfer of adjacent finger artery combined with vascular pedicle tubular skin graft was used to finger pulp defect, which has the following advantages: 1. The donor area is concealed, and the texture of the skin flap is close to the recipient area. The dorsal branch of digital nerve can be carried to anastomose with the proper digital nerve of the recipient area. The appearance of the flap is beautiful after repair, and the feeling of the finger pulp can be restored. 2. The flap with the main finger artery, reliable blood supply, fast wound healing, can be cut to take a longer vessel pedicle, easy to care, the patient's position is comfortable, and can make the finger after surgery on an axis flexion and extension function exercise. 3. The operation was performed in the same surgical field, with simple operation and no need for vascular anastomosis, and the success rate was high after operation. 4. The flap pedicle is narrow, the pedicle is easy to be cut off, the contact area is large, and the pedicle can be cut off in advance. 5. There is no damage to the proximal injury tissue of the finger body, and it will not cause necrosis of the skin and soft tissue of the finger body or even necrosis of the finger body because of new trauma. 6. Compared with other parts of the island flap, the injured finger has no open subcutaneous tunnel, and the scar is small.

However, this technique also has some shortcomings: 1. The flap was cut in a small area and could only repair two fingers pulp defect at the same time. 2. It is necessary to sacrifice the digital artery on one side

of the finger in the donor area. In order to restore the sensation of the flap, it is necessary to carry the dorsal branch of the digital nerve, and the sensation on the side of the finger may decrease after operation.

### **4.3 Precautions for surgery and postoperative management**

we should pay attention to the following points when using this operation:1. The pedicle of finger artery skin flap should carry a fascia pedicle of about 0.5cm-1.0cm to facilitate venous return and pedicle skin grafting, while avoiding vascular spasm caused by artery injury. 2. Do not twist the pedicle when the flap is transferred, cover the vascular pedicle with a thin layer of skin during skin grafting, and suture with fine nylon thread to avoid damage to the vascular pedicle. 3. Do not transfer the proper finger nerve with the skin flap to avoid damaging the function of the donor finger nerve.

In summary, this paper used the retrograde island flap bridge transfer of adjacent finger artery combined with vascular pedicle tubular skin graft to repair finger pulp defect and achieved good results. It is a safe and effective operation. The flap has the advantages of simple cutting, good texture and concealed donor area, which is convenient for early functional exercise of the finger body.

## **Declarations**

### **Ethics approval and consent to participate**

Not applicable.

### **Consent for publication**

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor of this journal.

### **Availability of data and materials**

Not applicable.

### **Competing interests**

All the authors declare that they have no conflicts of interest.

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### **Authors' contributions**

Shenghu Hong , Guohua Ren and Cheng Chen did the data collection and writing. Weibin Du , Fangbing Zhu and Qiao Hou were major contributors in writing the manuscript. Zhijing Zhang, Jun Yang and Wei Zhuang contributed to the conception and design of the study. All authors read and approved the final manuscript.

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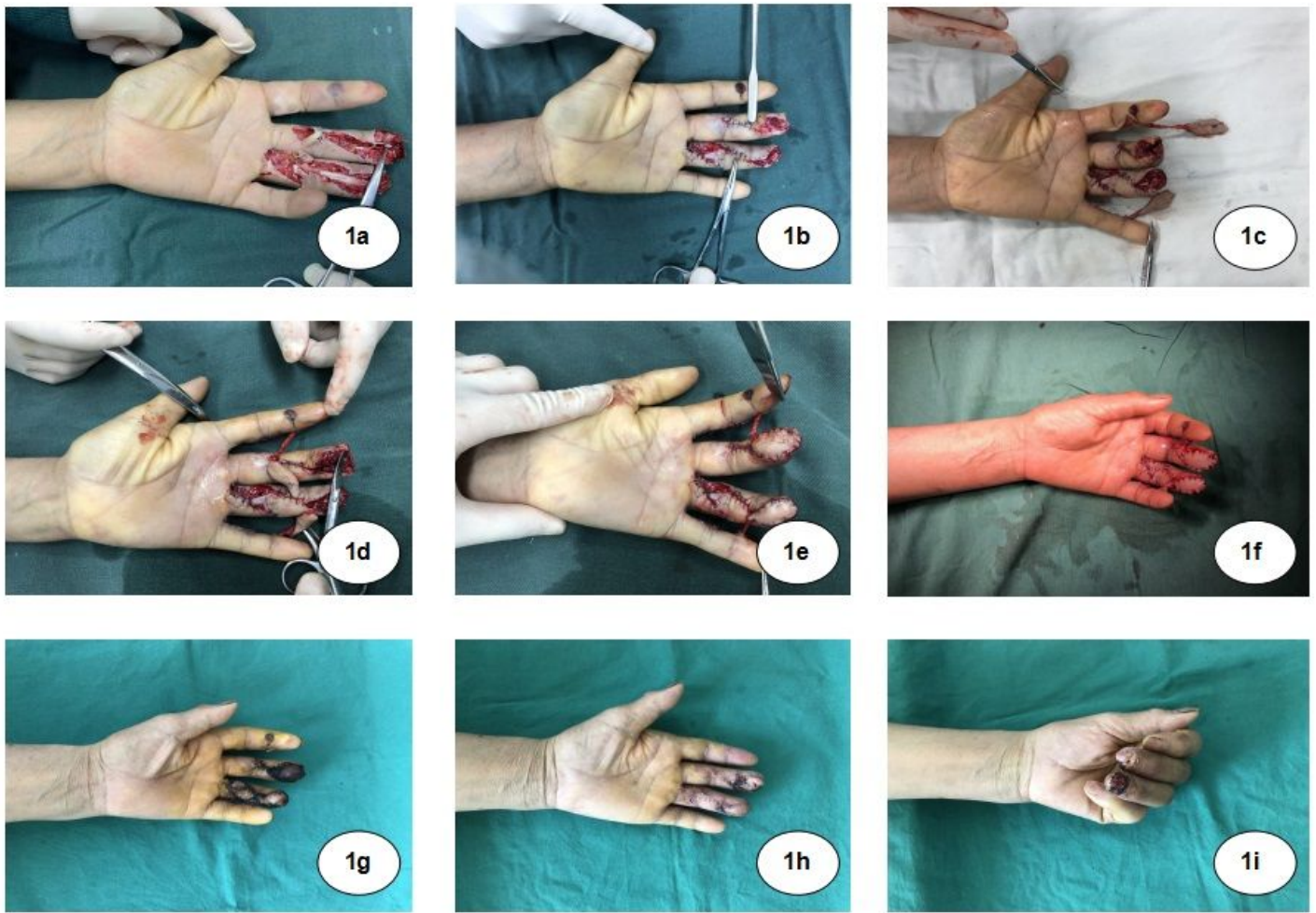
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## Figures





**Figure 1**

Patient, female, 54 years old. 1a. Preoperative appearance of left middle and ring finger injuries. 1b. The appearance of wound surface after debridement and suture during operation. 1c. The appearance of the flap was obtained during the operation. 1d-1e. Intraoperative flap transplantation. 1f. Intraoperative tubular skin grafting at vascular pedicle. 1g. Survival of the flap after pedicle amputation. 1h-1i. Postoperative skin flap appearance and finger function.



**Figure 2**

Patient, male, 16 years old. 2a. Preoperative appearance of right ring finger injuries. 2b. The appearance of the flap was obtained during the operation. 2c-2d. Intraoperative flap transplantation. 2e. Intraoperative tubular skin grafting at vascular pedicle. 2f-2g. Survival of the flap after pedicle amputation. 2h-2i. Postoperative skin flap appearance and finger function.