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Clinical Experience using a Reverse Homodigital Island Flap in Nearby Fingertip Reconstruction

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Background: Fingertip amputation is the most common amputation affecting the upper extremity. Some operative procedures near the fingertip may cause soft tissue defects. Diverse techniques are used to repair these defects, including skin graft, local or regional flap procedures, and partial toe transplantation. Both functional restoration and aesthetic repair are important but controversial. This study reports the postoperative results using a reverse homodigital island flap for fingertip reconstruction based on our own clinical experiences. **Method:** From March 1996 to December 2004, we collected data from 28 patients with soft tissue defects of the distal phalanx that were reconstructed using a reverse homodigital island flap. Medical records included information about sex, dominant hand, frequency of finger injury, mechanism of injury, flap size, donor site coverage, survival rate, and sensory recovery following surgery. **Results:** Operation time ranged between 70 and 110 minutes (mean, 90 minutes). The donor site was repaired by direct closure in 16 patients and covered by a split-thickness skin graft in 12 patients. All flaps but one survived completely. Follow-up ranged from 12 to 28 months. The static two-point discrimination test score recovered to 5.6-8.8 mm. **Conclusion:** A reverse homodigital island flap is useful for fingertip reconstruction because it preserves optimal function in a one-stage procedure.

Key words: Reverse homodigital island flap, fingertip amputation, fingertip reconstruction, defects of distal phalanx, communication of proper digital arteries

INTRODUCTION

Fingertip amputation is the most common amputation injury of the upper extremity[1]. Fingertip reconstruction requires preservation of the length as much as possible and, if possible, provision of a sensate and durable tip. Various repair techniques have been developed, including skin graft, local or regional flap, and partial toe transplantation[2]. In this paper, we report our clinical experience using a reverse homodigital island flap for finger reconstruction.

MATERIALS AND METHODS

Patients and Methods

Between March 1996 and December 2004, we used reverse homodigital artery island flaps to treat 28 patients (20 men, eight women) with fingertip injuries. The patients' ages ranged from 15 to 55 years (mean, 28.4 years). Patients who smoked or had diabetes, vasculitis, peripheral circulatory disease, or any previous injury involving the same finger were excluded. The medical records of these patients were reviewed and analyzed, including information about sex, dominant versus nondominant hand, mechanism of injury, flap size, donor site coverage, survival rate, and sensory recovery.

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Surgical Technique

Under regional block or general anesthesia, following debridement, the size and shape of the defect was measured. If the soft-tissue injury was over the proximal to distal interphalangeal joint, the procedure was avoided if possible because of the risk to flap viability. The donor site of the flap was selected on the ulnar or radial side of the proximal phalanx. The central axis of the flap was along the direction of the digital artery. Following inflation of a pneumatic tourniquet, the flap was raised carefully under surgical loupe magnification. The digital artery was identified and separated from the proper digital nerve. The pedicle of the flap was elevated distally until it was 5 mm proximal to the distal interphalangeal joint. A smooth rotational arc was obtained for flap transfer and inset without tension to transfer the flap carefully. In this

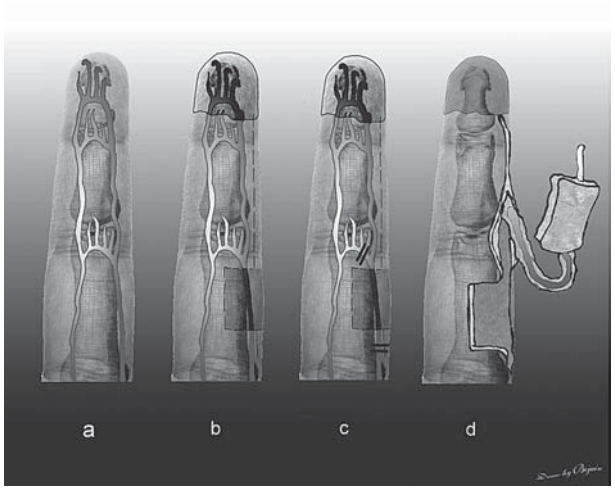

Fig. 1 (a) Three main communications between the radial and ulnar proper digital arteries. (b) Flap design. (c) The flap elevation until the pilot point middle transverse digital palmar arch. (d) Pedicle elevation as a "kite" flap to preserve the tiny perivascular venules surrounding the digital artery.

procedure, maintaining the middle transverse digital palmar arch intact is the most important factor for flap viability. Simultaneously, a generous cuff of subcutaneous tissue was preserved and included in the pedicle to create venous drainage from the tiny perivascular venules. The digital artery was ligated at the proximal end of the flap. If necessary, a skin graft was applied to the donor defect coverage by a tie-over dressing. Postoperatively, the operated hand was elevated without using a finger splint. Notably, anticoagulants were unnecessary (Fig. 1).

Case Reports

Patient 1

A 22-year-old man developed right little finger pyogenic granuloma lasting about four months. After excision, the defect was resurfaced with a reverse homodigital artery flap from the ulna side of the proximal phalanx. The wound healed well without complications. The result of the two-point discrimination test was 6 mm 10 months postoperatively (Fig. 2).

Patient 2

A 27-year-old man was injured in a vehicle accident three years before surgery. The open fracture involved the right middle finger at the base of the distal phalanx, which had a radial side condyle defect. A hypertrophic scar developed and persistent pain was caused by the osteochondral defect. An osteochondral autograft harvested

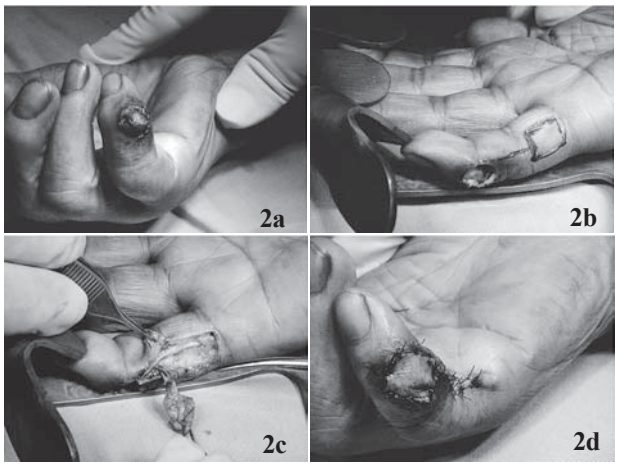

Fig. 2 (a) Right little finger pyogenic granuloma. (b) Defect and flap design. (c) Flap elevation. (d) The flap inset and adequate closure of donor site without skin graft.

from the proximal phalanx of the right second toe was performed together with scar release; the soft tissue defect was covered with a reverse homodigital island flap. Wound healing was smooth without complications. Painless full range of active motion was achieved three months following surgery (Fig. 3).

RESULTS

We used reverse homodigital island flaps to cover fingertip soft tissue defects in 28 fingers of 28 patients (20 men, eight women), whose age range was 15-55 years (mean, 28.4 years). For the hands receiving surgery, the ratio of dominant to nondominant hand was 13:1. Most of the injuries were caused by crushing, and avulsion injury and amputation were the next most common causes (Table 1). The index finger was the finger injured most frequently (Table 2). The surgery time was 70-110 minutes (mean, 90 minutes).

The flap length was 1.0-2.5 cm, and the width of the flaps was 0.8-2.0 cm. No neuropathy was observed in these patients. In most patients, the donor site could be repaired by direct closure, whereas the other donor site required a split-thickness skin graft (Table 3). All flaps but one survived completely (Table 4); the one exception displayed partial necrosis but healed eventually. The mean follow-up time was eight months (range, six months to two years). The postoperative sensory restoration results were excellent. All patients achieved recovery of light touch, sharp pain, and temperature sensation. The mean score on the static two-point discrimination was 7.4 ± 1.2 mm (range, 5.6-8.8 mm) (Table 5).

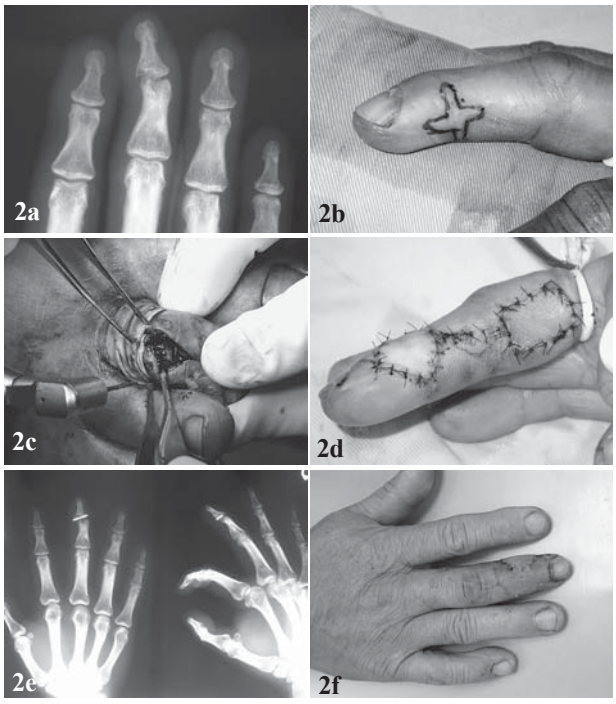

Fig. 3 (a) Traumatic distal phalanx condyle defect. (b) Scar contracture on the distal interphalangeal joint of the right middle finger. (c) Osteochondral autograft obtained from the proximal phalanx of the right second toe. (d) Soft tissue defect covered with a reverse homodigital island flap. (e) X-ray of the hand following surgery. (f) Follow-up picture two months after surgery.

Table 1 Causes of injury

Avulsion	8
Amputation	7
Crushing injury	11
Tumor excision	2
Total	**28**

Table 2 Involved fingers and flap donor sides

	Ulna	Radial	Total
Index	11	1	12
Middle	7	3	10
Ring	3	1	4
Little	1	1	2
Total	**22**	**6**	**28**

Table 3 Donor site coverage

Direct closure	16
Full-thickness skin graft	12
Total	**28**

Table 4 Flap survival rate

Complete survival	27
Partial survival	1
Loss	0
Total	**28**

Table 5 Sensory restoration

Light touch	100%
Temperature	100%
Sharp pain	100%
Two-point discrimination, mean (range)	7.4±1.2 mm (5.6-8.8 mm)

The follow-up time was six months to two years (mean, eight months).

DISCUSSION

Sensitive and durable fingertips are important for daily activity. Various techniques to reconstruct fingertip injuries have been reported, including primary closure, composite tip grafts, cross-finger flaps, V-Y advancement flaps, triangular volar advancement flaps, and digital artery-based flaps. The reverse digital flap is an arterialized homodigital flap, first described by Lai in 1989, which requires single-stage surgery and provides sensitive and durable recipient wound quality[3]. Rich vascular communications between the radial and ulnar proper digital arteries permit a reverse digital artery island flap to gain its blood supply by retrograde perfusion[3-6]. In 1990, Strauch found that the three transverse digital palmar arches and their location[4] are constant and are located at the level of the proximal cruciate ligament, distal cruciate ligament, and distal to flexor digitorum profundus insertion[7]. To avoid injuring the middle transverse palmar anastomotic branch, digital artery dissection should be stopped at a level 5 mm proximal to the distal interphalangeal joint[2]. We performed skin incision of the area only to allow the graft vessel to pass through. In some of our nontraumatic patients in whom the lesion site was on the distal interphalangeal joint only, we dissected the soft tissue carefully to avoid injuring the communication vessel.

Kaplan proposed that a pattern of venae comitantes can accompany the digital artery[8]. In a histological study, Lai et al. confirmed that the reverse digital artery island flap drains through tiny venules and capillaries in the perivascular soft tissue[3]. In our patients, we dissected the pedicle

with a cuff of soft tissue to include the digital venae comitantes, and most of the flaps achieved good survival.

Han et al. found no significant difference between sensate and the insensate reverse homodigital island flaps in a long-term follow-up study[9]. Consequently, to save surgical time, we did not use an innervated flap. The advantages of a reverse homodigital island flap are that it involves a one-stage reconstructive option, requires only a short immobilization period, does not use other fingers as donor sites, and the patient regains excellent sensory function. The flaps are supported by an extremely delicate pedicle and require careful dissection using a loupe and microsurgical instruments. In some nontraumatic patients, we used this flap to cover the superficial soft tissue defect on the distal interphalangeal joint to minimize the risk of injuring the middle transverse digital palmar arch. We think that this flap should be avoided if possible when other kinds of flaps are available, especially in traumatic cases involving the distal interphalangeal joint because of the higher risk of injury to the middle communication vessel. The homodigital flap should also be avoided in workers at high risk of finger trauma to prevent total finger devascularization should the same finger undergo a second trauma.

In conclusion, the reverse homodigital island flap is a useful option to cover the fingertip of soft tissue defects because it preserves optimal function and is a one-stage procedure.

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