

Original Article

Repair of minor tissue defect in fingers by transfer of free arterialized venous flaps

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Received November 18, 2015; Accepted January 25, 2016; Epub July 15, 2016; Published July 30, 2016

Abstract: Objective: Reconstruction of skin and soft tissue defects in the fingers is a huge challenge in recent years. We present a retrospective analysis of nine patients with arterialized venous flaps used to cover defects in the fingers. Methods: Nine patients with various finger tissue defects were treated using arterial venous flap from the hand. Seven patients were men and two were women with the mean age 28.3 years, of which eight had injury by machine crush, one by chain saw. Fracture and dislocation in five cases and with tendon rupture in five cases. The defects ranged from 2.5 cm × 2.5 cm to 4.5 cm × 4.5 cm. All flaps were transferred as free flaps. Results: Among the 9 patients, flaps survived in all patients with one experiencing partial epidermal necrosis. After flap transplantation, mild swelling occurred in the flaps, but began to decrease on the second week. All the patients reported a normal use of their finger activities in daily living and work. Except the scar, no donor-site morbidity was reported. Conclusion: The arterialized venous flap has good function with low donor site morbidity. It is an excellent flap for reconstruction for finger defects with better survival rate.

Keywords: Arterialized venous flaps, finger, skin reconstruction

Introduction

Reconstruction of skin and soft tissue defects in the fingers remains one of the biggest challenges [1]. Use of skin flaps such as palmar advancement flap, cross-finger flap, distally based homodigital island flaps, and pedicled perforator finger flaps proves to be excellent treatment but creates large scars, poor sensation, with chance of neuroma in the pedicle [2-6]. Use of free flaps in the reconstructive surgery as an alternative source is gaining moment in recent years, though it requires highly skilled surgeon. Among the free flaps commonly used in the finger reconstruction is superficial palmar branch of the radial artery flap, ulnar artery perforator free flap, posterior interosseous perforator flap, arterialized venous flap, and free serratus anterior fascia flap [1, 7-9].

Nakayama et al introduced arterialized venous flap (AVF) from the experimental study [10]. Yoshimura et al were the first to use AVFs clinically for repairing skin defects of the fingers [11]. They used thirteen arterialized venous

flaps (1.3 cm × 3.1 cm to 6.0 cm × 1.0 cm) to resurface the skin defects in the fingers in 11 cases. Of which complete survival was achieved in 12 (92.3%) and one with sustained partial superficial necrosis. In another large study, they performed A-V-A type of venous flap in 12 patients and an A-V-V type in 10 patients with the flaps size in different range (1.0 cm × 1.0 cm to 3.0 cm × 12.0 cm). However, only 17 were completely successful, 4 were partially successful and 1 in complete failure [12]. In arterialized venous flap, arterial blood flow enters through an afferent vein and venous blood flow exits through an efferent vein [13]. Nishi et al reported complete survival of the arterialized venous flaps in treating seven cases with both skin and digital arterial defects [14]. Chen et al performed A-V-V type of venous flaps in four cases and A-V-A type in seven cases with 100% survival for the skin defects on hands and digits [15]. Small-sized AVFs (1 × 1 cm to 3 × 10 cm) have a better survival rate (95-100%) than AVFs with larger surfaces which suffer partial necrosis with 40% failure rate (15). Similar satisfac-

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Table 1. Patient characteristics

Case	Sex	Age (yrs)	Affected Finger	Pattern of defect	Defect size (mm)	Flap type
1	F	23	Right middle finger	Severe damage in the dorsal skin	4 cm × 4.5 cm	Flap from the ipsilateral forearm palm
2	M	17	Left little finger	Severe damage in the dorsal skin	2.5 cm × 2.5 cm	Flap from the ipsilateral forearm palm
3	M	48	Left middle finger	Severe damage in the volar skin	3.5 cm × 2.5 cm	Flap from the ipsilateral forearm palm
4	M	29	Left index finger	Severe damage in the dorsal skin	3.0 cm × 2.5 cm	Flap from the ipsilateral forearm palm
5	M	33	Right ring finger	Severe damage in the radial volar and radial dorsal skin	4.5 cm × 4.0 cm	Flap from the ipsilateral forearm palm
6	M	42	Right index finger	Severe damage in the volar skin	3.0 cm × 2.5 cm	Flap from the ipsilateral forearm palm
7	F	22	Left ring finger	Severe damage in the volar skin	4.0 cm × 2.5 cm	Flap from the ipsilateral forearm palm
8	M	20	Left middle finger	Severe damage in the dorsal skin	4.0 cm × 3.5 cm	Flap from the ipsilateral forearm palm
9	M	26	Right index finger	Severe damage in the volar skin	3.5 cm × 3.0 cm	Flap from the ipsilateral forearm palm

tory results were reported in several other case reports with AVFs [16-18].

We present our results in nine patients with soft-tissue and skin injuries in the fingers treated with the arterialized venous flap. We designed arterialized venous flap based on the shape of the wound and the flaps had ante-grade perfusion fashion. We treated nine patients from October 2005 to November 2011 in our department by AVF and achieved satisfactory results.

Materials and methods

From October 2005 to November 2011, over a period of 6 year and 2 months 9 patients with various finger tissue defects were treated using arterial venous flap from the hand. Seven patients were men and two were women with the age ranged from 17 to 48 years (mean 28.3 years). Fingers were associated with bone and soft tissue defect having tendons, blood vessels and nerves exposed with no free skin for grafting. Eight cases had injury by machine crush, one by chain saw. Fracture and dislocation in five cases and tendon rupture in five cases All patients underwent emergency surgery, with a time delay after injury of 2 to 8 hours (mean 4.8 hours). The defects ranged from 2.5 cm × 2.5 cm to 4.5 cm × 4.5 cm. All flaps were transferred as free flaps. All of the cases were performed by the senior hand surgeon. The details of patients are presented in **Table 1**.

Surgical procedures

Healthy skin and soft tissue were retained in the site, and debris, inactive skin were removed. Before the flap placement, fracture dislocation

is fixed by Kirschner wire, tendons were repaired by surgery and nerve rupture underwent nerve anastomosis. Arteriovenous anastomosis was performed to repair the arterial defects. The flap was designed according to the size of the defect. In the donor skin from ipsilateral forearm palm, two longitudinal superficial veins region was selected and marked by methylene blue. The flap should be slightly larger than the range of defects range. The cut was made at the proximal and distal region to free the vein in the flap. The length of the vein was based according to the subject area. The flap when cut doesn't carry the deep fascia. Cut flaps ranged from 3.0 cm × 3.0 cm to 5.0 cm × 5.0 cm. The afferent vessels were anastomosed to the digital arteries and the efferent veins were anastomosed to dorsal veins. After the surgery, anti-inflammatory, anti coagulant, and anti spasm drugs were administered to the patients. Close monitoring of color, temperature, and blood flow through the flap was observed.

Results

After the first day of flap transplantation, mild swelling occurred in the flaps, with the increasing in swelling in the second day having small blisters in the peripheral region. On the fifth day swelling in the flap began to decrease with the slow disappearance of blisters. On the ninth day, complete disappearance of the swelling with the flap skin color being normal. Among the 9 patients, all flaps survived with one experiencing partial epidermal necrosis in the flap.

According to the Chinese Medical Society of Hand Surgery functional evaluation, fingers in four patients were excellent and in five patients were good. The patients reported a normal use of their finger activities of daily living and work. No donor-site morbidity was reported.

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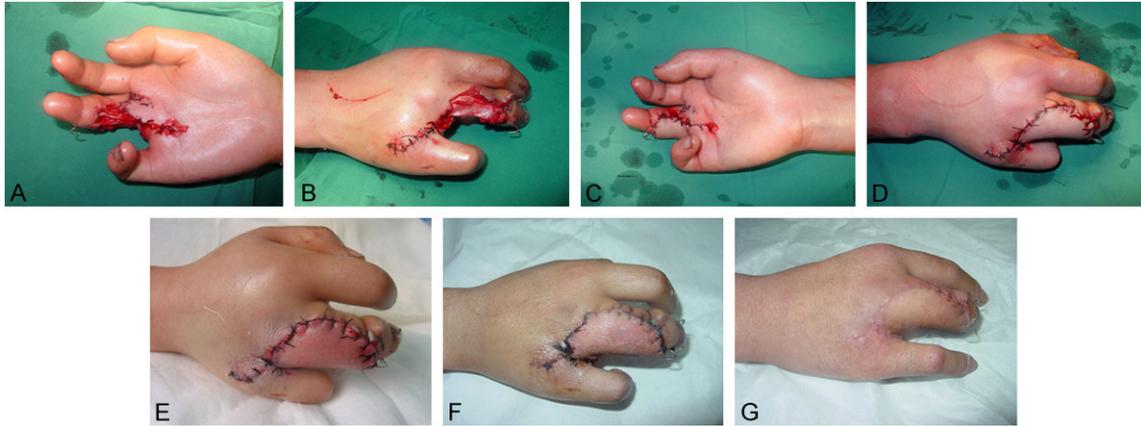


Figure 1. Reconstruction of finger injury using arterialized venous flaps. Appearance of the wound (A) and on the dorsal side of the finger (B). Appearance of the flap, post surgery (C), dorsal side (D), 4th day (E), 14th day (F), and 4th 221 month (G).

Typical case reports

A 23 years old woman suffered a mechanical injury with severe damage in the dorsal skin of right middle finger and complete loss in the ring finger while working (**Figure 1**). The patient underwent emergency surgery on January 17, 2007. After shortening ring finger by debridement surgery in proximal base plane, middle finger fracture fixed by cross section pinning. Near the middle finger, skin defect in the dorsal metacarpal region was 4 cm × 4.5 cm. A 5 cm × 5 cm venous flap was designed from the ipsilateral forearm palm. The donor site was closed primarily. Flap was grafted over the whole area of wound. The afferent vessels were anastomosed to the digital arteries and the efferent veins were anastomosed to dorsal veins. The nerve was sutured to the radial digital nerve. There was mild swelling with the skin temperature higher (ranging 0.6-1.20°C) than the normal, postoperatively. On the 2nd 105 day tiny blisters appeared at the periphery of the flap, but gradually disappeared on the 4th day. On the 9th 106 day, the swelling disappeared. After 14 days stitches, the flaps survived with the skin having soft texture and color close to the normal skin of the fingers. After 4 months follow up of the flap, texture and color of the skin was closer to the normal dorsal skin.

Discussions

Arterialized venous flaps have been widely used for the closure of smaller defects in fingers. These flaps are considered as a potential

reconstructive option for large dorsal digital defects with exposed bone, joint, and/or extensor tendons when local flaps are inadequate or unusable [8]. Designed arterialized venous flap from the venous network of the forearm applied in five patients with various defects ranging in size from 6 × 8 cm to 10 × 12 cm had full survival in 4 patients with 30% partial necrosis in one patient [19]. In another study, six patients with multiple soft tissue finger defects were covered by syndactylizing arterialized venous flaps, with palmar forearm was donor site and none of the patients suffered flap loss [20]. Large skin defects of the hand with AVFs ranging in size from 6 cm × 3 cm to 14 cm × 9 cm in 12 patients showed remarkable edema post-operatively, and partial necrosis of the flap only developed in three cases [21]. However, in our study only one case suffered partial necrosis. In another study, reconstruction of severe and extensive contractures of the palm in four patients using large AVFs showed complete survival with uneventful clinical courses [22].

Majority of AVFs were applied in antegrade perfusion fashion. However, an experiment study indicated that flaps from human cadavers indicated that retrograde arterialization could increase blood circulation in the periphery of arterialized venous flaps [23]. Studies by Koch et al applying the retrograde arterialized venous flaps in 13 patients to resurface the skin and soft-tissue defects proved effective suggesting that retrograde perfusion enhances blood flow in the periphery of arterialized venous flaps giving better results in terms of flap survival [24].

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However, in our studies all the flaps were applied in antegrade perfusion fashion, with 8 flaps survived out of 9 flaps, with one having partial necrosis. This is similar to the studies by Woo et al who applied antegrade approach in hand with a 98% (151/154) success rate with 5.2% partial loss rate [17]. Hyza et al also indicated with high survival rate with their experience of 13 venous free flaps in 12 patients with large dorsal digital defects [25].

Partial necrosis occurs in the flaps due to congestion and edema in the flaps bringing complications post operatively which requires close monitoring of color, temperature, and blood flow through the flap [26, 27]. Flap swelling was found to be most pronounced during the first post operative week, but was slowly resolving in the second week in our study. This was similar to earlier studies [17, 25]. In another reported study on ten patients, AVFT flap congestion and edema was seen in all cases. In seven cases, a single vein through the flap served as both the inflow and outflow conduits in seven cases and a separate efferent vein within the same flap was utilized as the outflow vessel in three. Congestion seen was transient due to the relatively small flap sizes (2.5 cm × 2 cm to 4.5 cm × 3 cm) [24]. Partial or complete necrosis occurs commonly when operated under less than ideal circumstances, such as a chronically infected or open wounds, or largely avascular recipient sites [27].

In our opinion, the arterialized venous flap is an attractive option to cover the finger defects with low donor-site morbidity.

Disclosure of conflict of interest

None.

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