

The use of reverse- flow dorsal metacarpal artery flaps after postburn metacarpophalangeal joint flexion contracture release

Research Article

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Abstract: When thermal injuries of the hand are managed inappropriately, complex hand contractures are inevitable. Patients with hand contractures may have many difficulties in their daily life because of this deformity. These patients are challenging to reconstructive surgeons. In this study we evaluated reverse-flow dorsal metacarpal artery flaps for the defects occurred after metacarpophalangeal joint contracture release of different fingers. Nineteen patients with defects on the volar surface of metacarpophalangeal joint were reconstructed by the reverse-flow dorsal metacarpal artery flaps. All operations were successful and flap losses were not seen. The DMCA flaps provide one stage coverage and permit primary closure of the recipient site. The aesthetic and functional results are satisfactory without sacrificing main arteries. The only drawback is the residual scar on the dorsum of the hand, which can be treated by conservative means and may improve over time.

Keywords: *Dorsal metacarpal artery • Thermal injury • Hand contractures*

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1. Introduction

Postburn hand contractures cause severe static and dynamic problems, including restricted range of motion, musculoskeletal discomfort and cosmetic problems. This field remains notoriously difficult for the reconstructive surgeon in terms of restoring each function [1]. Contractures often require wide release and radical excision with reconstruction using well vascularized, supple, durable tissue that will not contract following the reconstruction. Extensive literature is available for local and regional flaps that may be used for these defects [2-5].

The reverse-flow island flap is a flap that relies on a retrograde arterial inflow through the artery of the pedicle and a reverse venous outflow through the vein to ensure venous drainage. First introduced by Bostwick the reverse- flow flaps have been used widely with better understanding of the anatomy and an increase in clinical

experience [6]. These flaps have also been used in the upper extremity and hand reconstruction.

The proximally based second DMCA flap was first described in 1987 [7]. Subsequently, reverse flow DMCA flap was described and used in many ways [8-12].

In this article, we focus on using of various reverse-flow DMCA flap after metacarpophalangeal joint contracture release of different fingers.

2. Material and Methods

2.1. Patients

Reverse-flow dorsal metacarpal artery flaps were performed on 13 patients (12 men and 1 woman) between September 2003 and August 2007. The mean age of the patients was 24.4 (20-34) years. All patients had postburn metacarpophalangeal joint flexion contractures. The patients underwent operations, 14 years on average (7 to 22 years) after the main injury

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Table 1. Patient data (MCP; metacarpophalangeal, RDMCAF; reverse- flow dorsal metacarpal artery flap).

Patient no	Age (year) / Sex	Cause of burn	Duration of contracture (year)	Location of contracture (MCP joint)	Flap choice (RDMCAF)	Flap size (mm)	Follow up (month)	Donor site closure	Complication
1	20/M	Contact	9	Second	First	40x15	14	Primer	Superficial necrosis
2	21/M	Flame	8	Second	First	40x10	9	Primer	None
3	34/M	Scald	19	Second	Second	30x10	11	Primer	None
4	29/M	Flame	12	Second	Second	35x15	10	Primer	None
5	20/M	Scald	7	Third	Second	40x15	9	Primer	None
6	27/F	Flame	21	Third	Second	40x15	11	Primer	None
7	21/M	Contact	10	Third	Second	40x15	15	Primer	None
8	20/M	Scald	16	Third	Third	40x15	13	Primer	None
9	27/M	Flame	22	Fourth	Third	40x10	17	Primer	None
10	23/M	Flame	11	Fourth	Third	40x20	9	Primer	Scar widening at donor site
11	29/M	Scald	18	Fourth	Third	30x10	16	Primer	None
12	26/M	Contact	20	Fifth	Fourth	30x15	14	Primer	None
13	21/M	Scald	9	Fifth	Fourth	25x20	13	Primer	Superficial necrosis
Mean	24.4		14			36.1x14.2	12.3		

Table 2. Functional results of patients.

Patient no	Location of contracture (MP Joint)	PreoperativeExtension Lag MP Joint (degree)	PostoperativeExtension lag MP Joint (degree)	Improvement of Extension MP Joint (degree)
1	Second	80	20	60
2	Second	75	15	60
3	Second	70	0	70
4	Second	80	15	65
5	Third	85	10	75
6	Third	80	20	60
7	Third	60	10	50
8	Third	70	0	70
9	Fourth	30	0	30
10	Fourth	40	0	40
11	Fourth	80	15	65
12	Fifth	80	20	60
13	Fifth	60	30	30

The contractures of 4 patients were located on the second metacarpophalangeal joint, 4 of them were on the third metacarpophalangeal joint, 3 of them were on the fourth metacarpophalangeal joint and 2 of them were on the fifth metacarpophalangeal joint. Preoperative extantion lag of metacarpophalangeal joints were 69.7° mean (30°-90°) (Table 2). Reverse-flow first dorsal metacarpal artery flap was used in two cases, reverse-flow second metacarpal artery flap was used in seven cases, reverse- flow third dorsal metacarpal artery flap was used in seven cases and fourth one was used in two cases (Table 1).

2.2. Surgical Technique

All operations were performed under axillary block anesthesia and tournique using loop magnification. A transverse incision at the volar aspect of the metacarpophalangeal joint was performed. Tendon, nerve and vessels were exposed. Flexor tenotomy, capsulotomy, and release of volar plate were performed if necessary. The joint was fixed at the neck to the metacarpal bone by using Kirschner wires.

According to size of the defect to be covered, the flaps were planned over adjacent dorsum of the metacarpal bone. The emergence of the dorsal metacarpal artery from the dorsal metacarpal arch was marked between the adjacent metacarpals and was included with the in

Figure 1. Case 2.
a) Preoperative view of second metacarpophalangeal joint contracture
b) Planning of reverse- flow second dorsal metacarpal artery flap
c) Insetting of flap to defect.
d) View of the flap at postoperative 3 month.



skin island. The flap-margin incisions were made and the flap was raised from proximal to distal. This is a cutaneous flap and therefore the dissection is down to the paratenon of the extensor tendons lying immediately under the subcutaneous tissue. The paratenon of the extensor tendon was left intact. The dorsal metacarpal artery was ligated at its emergence from the metacarpal arch. Incisions were made from the flap to the defect on the volar aspect of metacarpophalangeal joint at web spaces. The flap was adapted to the defect and the donor area was sutured primarily. Then the tourniquet was deflated, and the flap viability was seen.

Kirschner wires were fixed to prevent contracture recurrence for 2 weeks. After the Kirschner wires were removed, passive and actively assisted motion of the metacarpophalangeal joint was initiated. Active exercise began during the fourth week after surgery and continued 2 months after.

3. Results

Nineteen patients with defects on the volar surface of metacarpophalangeal joint occurred after contracture release were reconstructed with reverse dorsal metacarpal artery flaps during period from September 2003 to August 2007. 18 of the patients were male and one of them was female, with an age range of 20 – 39 years (mean 24.1) (Table 1). Mean follow-up was 12.3 months. Maximum flap length was 40 mm and maximum flap width was 25 mm (mean 36.1x 14.2 mm).

Extension lag of metacarpophalangeal joints at postoperative 3th month was 10.2° mean (0 °- 20°). It has shown that 59.4° functional improvement was provided with these operations (Table 2).

All the flaps totally (Figures 1,2). When the flaps were assessed in physical examination, the minimal venous congestion was determined in five flaps during early period. It disappeared on the second day postoperatively.

Figure 2. Case 18.
a) Preoperative view of fifth metacarpophalangeal joint contracture.
b) Planning of reverse- flow fourth dorsal metacarpal artery flap.
c) Intraoperative view of flap dissection.
d) View of the flap at postoperative 5 month.



In two cases, minimal superficial necrosis developed at the edge of flaps. They were managed by daily dressing and healed by secondary intention without further complication. Scar widening in one case was seen in donor site.

4. Discussion

If thermal injuries of the hand are managed inappropriately, complex hand contractures are inevitable. Patients with hand contracture have difficulties in their daily life. These patients are challenging to reconstructive surgeons. The aim of treatment for these patients should be to correct contracted regions of the hands and provide an active and useful hand for daily activities.

After contracture release, defects can be covered using skin grafting, but this method usually fails to correct the deformity, since recurrence rate is high. Furthermore, skin grafting is not suitable for coverage

since important structures such as tendons, nerves and vessels are exposed. Soft-tissue defects in the metacarpophalangeal joint after a contracture release can be covered with many local and distant flaps including cross- finger flap, side finger flap, palmar transposition flaps and their modifications [4,5,13,14]. But these methods have many disadvantages including sacrificing dorsal finger tissue, long time immobilization and failure to correct the deformity. In addition to this alternative, free flaps such as medialis pedis flap, dorsal ulnar artery perforator flap and anterolateral thigh flap were used for hand defects [14-17]. These methods are successful to correct the deformity, but need microsurgical team effort and experience.

The reverse-flow DMCA flap has gained great popularity among reconstructive surgeons due to its versatility [7-9,12,18-20]. It has a constant anatomy and can better match the contours of the hand [7-11,21,22]. As burn reconstruction purpose, reverse-flow DMCA flaps used in thumb, and index finger [23,24]. In our

series, we focused on using various reverse-flow DMCA flaps in the four different fingers. It was determined that reverse-flow DMCA flaps provide durable and stable coverage to proximal phalanges and resistance to recurrent contracture in each finger. Furthermore, this flap is safe and easy to perform, although it may demonstrate venous congestion due to the reverse blood flow. In our series, this was not a serious problem.

The reverse-flow DMCA flaps have the advantage of a dorsally located scar instead of a volar or lateral finger scar [25]. Additionally these flaps are performed under local- regional anesthesia. The greatest disadvantage resides in the limited sizes available for the flap. Closure of the donor site can be achieved if it is less than 2 to 3 cm wide, giving minimal donor-site morbidity, and poor aesthetic results are observed when the donor area is skin grafted [26]. For this reason, it is not frequently indicated in the treatment of extensive palmar defect.

The first and second DMAs were anatomically constant, making them very safe as a source of pedicle flaps. However, the third and fourth DMAs were not found in 3.8% and 7.7% of cases, respectively [7,8,27,28]. We found the third and fourth DMAs in all cases. However, their presence should be confirmed with Doppler prior to surgery.

The surgical intervention did not achieve full recovery in some of our patients. The factors that still prevent patients from gaining full range of motion can be assumed as shortened of collateral ligaments at the joints, tendons and joint degeneration. It is necessary to straighten forcefully the joints at the time of operation, with overcorrection. There is a need for even deeper resection and release of any collateral ligaments at the joints, and to perform even capsulotomy and lengthening of affected tendons. We always advise this approach should be taken in to account in the chronic joint contractures.

In conclusion, in the correction of severe postburn hand deformities, the aggressive surgical release of soft tissue, tendons, and joints along with flap coverage is imperative. Reverse-flow DMCA flaps provide a thin, pliable, well-vascularized tissue for covering the exposed tendons and vessels. We believe that reverse-flow DMCA flaps represent an appropriate option for reconstruction of palmar defect in the metacarpophalangeal region.

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