Foucher's First Dorsal Metacarpal Artery Flap for Thumb Reconstruction: Evaluation of 21 Cases

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Abstract

Background: Coverage of part of a soft tissue defect in the thumb, without bone shortening and without long-lasting immobilization in an inappropriate position leading to stiffness, is difficult to achieve.

Objectives: To report our experience using Foucher's modification of the first dorsal metacarpal artery flap for thumb reconstruction in 21 cases.

Methods: Foucher's flap is based on the neurovascular structures of the first dorsal metacarpal artery flap and radial nerve-sensitive branches on the dorsum of the second metacarpal and proximal phalanx. The cause of injury was work-related in all 21 cases. The patients' mean age was 37 (range 17–68 years), and mean follow-up was 19 months (range 12–31). Emergency surgery was performed in 13 patients with a time delay after injury of 4–12 hours. The minimum defect was 12x18 mm and the maximum 20x40 mm. Pedicular length was 55–95 mm. A skin bridge was left intact in 16 cases. In two cases of early postoperative venous congestion and flap loss, a cross-finger flap was performed as a salvage procedure.

Results: Subjective satisfaction score was 8.37/10 (range 4–10); cold intolerance was experienced in 60% and dysesthesia in 33%. All except one patient are able to use their thumb in daily activity. Loss of mobility in the proximal interphalangeal joint of the index finger was less than 20 degrees. Semmes-Weinstein sensitivity evaluation score was 3.61–4.31 on the flap and 0–6.65 on the donor site. Two-point discrimination was 10.8 mm (range 8–20). Grip strength was reduced by 15% compared to the unaffected hand (hand dominance was not taken into consideration). Rehabilitation was not consistent as almost all the patients were living in another location.

Conclusions: First DMCA pedicle flap is a successful thumb reconstruction method, especially in patients not disturbed by its cosmetic appearance.

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Foucher's flap is based on the neurovascular structures of the first dorsal metacarpal artery flap and the radial nerve-sensitive branches on the dorsum of the second metacarpal and proximal phalanx. Colema in 1961 and Holevich in 1963 were the first to describe this procedure [1]. The technique was popularized by Lie and Posch and further developed by Foucher, who incorporated neural structures into the composite tissue and termed it "kite flap" [1].

Two different variations of the first dorsal metacarpal artery were described by Earley and Milner [2] in 30 cadavers. The deep muscular branch and superficial (fascial) artery, which is known as the aponeurotic vessel of Foucher, was present in 90% of the cases.

DMCA = dorsal metacarpal artery

The outer diameter of the artery at its widest point was 1.0–1.5 mm in 56% of cases. In those without a palmar branch the diameter was less than 1 mm. A muscular artery was present in 40%, arising from the radial artery at the junction of the two heads of the interosseous muscle and lying inside the ulnar head.

Oberlin's anatomic work [3] on the first DMCA indicates four different vascular variations [2]. The value of this technique is twofold: it spares further shortening and results in a sensitive quasi-normal thumb. The technique has other applications as well, such as first web reconstruction, thumb lengthening, and following resection of tumors on the dorsum of the hand [4].

Patients and Methods

Patients

We retrospectively reviewed 21 cases in which Foucher's modification of the first dorsal metacarpal artery flap was performed. In all cases the cause of injury was work-related. One patient presented with tissue loss on the thumb pulp. The other 20 patients presented with interphalangeal joint or distal thumb amputation and/or dorsal soft tissue loss: volar soft tissue defect in one, interphalangeal level amputation in 8, amputation distal to the interphalangeal joint in 4, crush injury without amputation in 6, and wrap-around procedure for reconstruction in one patient [Figure 1]. The etiology was traumatic in all cases, and all except one patient underwent elective surgery within the first 40 days after an unsuccessful first treatment performed elsewhere.

The patients' mean age was 37 (range 17–68 years) and follow-up was 19 months (range 12–31). Thirteen patients underwent emergency surgery, with a time delay after injury of 4–12 hours. The minimum defects were 12x18 mm, and the maximum 20x40 mm. Pedicular length ranged between 55 and 95 mm [Table 1]. A skin bridge was left intact in 16 cases. In two cases of early postoperative venous congestion and flap loss, a cross-finger flap was performed as a salvage procedure.

Surgical technique

The flap is prepared on the first DMCA originating in a constant manner from the radial artery while passing through the two heads of the first dorsal interosseous muscle. The DMCA lies on the fascia of the interosseous muscle, providing a nutrient branch to the bone just proximal to the second metacarpal head, and then disappears with skin branches on the dorsum of the proximal phalanx. The flap can be harvested as far as the dorsal site of the second proximal interphalangeal joint. The skin incision is a lazy S on the dorsum of

Table 1. Data of patients undergoing Foucher's flap

Patient no.	Age (yr)	Defect radius (mm)	Pedicle length (mm)	Urgent vs. elective	Follow-up (mo)	SS score	SW flap	SW donor	Two-point discri-mination	Cold into-lerance	Dyses-thesia
1	22	13x30	60	Elective	32	8	4.31	NS	15	–	–
2	17	15x30	65	Emergency	31	7	3.61	4.56	10	+	+
3	52	18x40	90	Emergency	28	10	3.61	4.31	12	–	–
4	43	12x24	55	Elective	28	6	3.61	3.61	8	–	–
5	44	13x25	65	Elective	26	4	4.31	4.56	8	+	–
6	25	15x30	70	Emergency	25	9	4.31	4.31	20	+	+
7	34	18x28	62	Emergency	21	10	4.31	4.31	12	+	+
8	45	13x35	64	Elective	21	10	4.31	6.65	8	+	–
9	67	16x35	56	Emergency	20	8	4.31	6.65	10	–	–
10	53	13x20	58	Elective	19	10	3.61	4.56	10	–	–
11	44	17x28	60	Emergency	17	5	4.31	NS	8	+	+
12	61	12x20	85	Elective	17	9	3.61	3.61	14	–	+
13	39	18x35	95	Emergency	15	10	4.31	4.31	8	+	–
14	24	13x25	62	Emergency	14	7	4.31	NS	10	+	+
15	42	15x20	84	Emergency	14	6	3.61	6.65	13	–	–
16	38	18x28	58	Elective	14	10	4.31	3.61	8	+	–
17	30	12x30	57	Emergency	13	8	4.31	4.31	10	+	–
18	23	12x25	78	Elective	13	10	3.61	3.61	14	–	–
19	27	14x32	92	Emergency	12	9	3.61	4.56	10	–	–
20	22	12x35	83	Emergency	12	10	4.31	2.83	8	+	+
21	24	15x32	74	Emergency	12	9	3.61	4.31	10	+	–

SS = subjective satisfaction, SW = Semmes-Weinstein, NS = no sensation.

Figure 1. Non-replantable distal phalanx of a thumb amputation

Figure 2. Postoperative clinical view after Foucher's flap.

the second metacarpal. Subcutaneous veins are dissected with the pedicle, leaving a very thin layer of skin. First DMCA is identified at the emergence point between the two heads of the first dorsal interosseous muscle. The fascia is cut and the periosteum is then stripped off the second metacarpal on the radial side; the nutrient branch to the metacarpal head is identified and ligated. The flap is elevated, leaving the paratenon intact. The donor area is covered by an antecubital full-thickness skin graft [Figure 2].

Results

In one of the crush injury cases, the first dorsal interosseous muscle was hemorrhagic and the circulation in the flap was found to be inadequate after the dissection and rotation flap coverage were performed. In the single case of volar-sided tissue loss in the thumb interphalangeal joint, there was no circulation in the flap, and two consecutives attempts of cross-finger flaps also failed to integrate the recipient side, probably due to a low grade chronic infection. The elective surgery performed in this series was post-replantation and post-wrap-around toe reconstruction in one patient each [Figure 3].

The average subjective satisfaction score was 8.37/10 (range 4–10). Twelve patients (60%) experienced cold intolerance, and 7 patients (33%) dysesthesia. All patients use their thumb in daily activity, except for one patient who has a low IQ. Since almost all the patients were living in another area, their rehabilitation was irregular. The index finger PIP mobility loss was less than 20

PIP = proximal interphalangeal joint

Figure 3. Late appearance after Foucher's flap

degrees. The Semmes-Weinstein sensitivity score was between 3.61 and 4.31 on the flap, and 0–6.65 on the donor site. The mean two-point discrimination was 10.8 mm (range 8–20). Grip strength was 15% less than in the unaffected hand (hand dominance was not taken into consideration).

Discussion

Paneva and Holevich [5] described another version of this flap using a second pedicle, however this carries the risk of radial-side sensation in the index finger.

Alternatives to the Foucher flap are the cross-finger flap (introduced in 1940), the de-epithelized cross-finger flap, the first web advancement flap of Earley, the neurovascular island flap, the free pulpa transfer and the venous flap [6,7]. Disadvantages associated with the neurovascular flap are low two-point discrimination, cold intolerance, hyperesthesia, difficulty in cortical adaptation, and limitation of the flap size. Anastomosis of the flap nerve to the ulnar digital nerve has not yielded the anticipated good results and carries the risk of neuroma formation on the repair side. Moreover, venous return may be a problem due to pedicular dissection. However, pedicle flaps without nerve anastomosis lead to nerve regeneration problems in smokers and older patients.

Another technique is to combine the cross-finger flap with the pediculated transfer of the dorsal branch of the index digital nerve for thumb pulpa sensation [8]. Gellis recommends intensive sensitive re-education after this modification, since the two-point discrimination on the dorsum of the index is 12–15 mm; Moberg, however, considers it useful only when the two-point discrimination is less than 15 mm [9]. Potential risks of pulpa transfer are long-lasting general anesthesia and the high cost of the operation.

Brunelli [10] reported that the reverse pediculated flap taken from the dorso-ulnar nerve survived in all of his nine cases, although the goal of 10 mm two-point discrimination could only be reached in two cases. Anastomosis of the dorso-ulnar nerve to the palmar stump did not improve the results. The author does not believe it possible to achieve more than 8 mm [10].

Our experience has shown that the major inconvenience of this technique is its less than perfect cosmetic results, especially for women. For dorsal defects associated with crush injuries, the priority is to close the defect with vascularized skin in the vicinity of the fracture and tendon repair in one stage. We did not observe any adduction contracture in the follow-up.

Fourteen of our patients presented with a defect longer than 25 mm. For a defect of this size the palmar advancement flap with proximal releasing incision (Vilain flap) is not recommended, especially for a physical laborer who has to grasp heavy objects. Similarly, the palmar advancement flap (Moberg) is also not reliable for defects larger than 20 mm. Since the cross-finger flap may lead to a first web contracture and stiffness in finger joints, we used it only for a salvage procedure.

For reconstruction of amputation stumps at the level of the interphalangeal joint or proximal to it, the outcome is better and the technique is easier to perform. In our experience, when used for closing stump defects distal to the interphalangeal joint, distraction of the pedicle is a frequently seen complication and necessitates close monitoring. When necessary, distracting stitches must be removed to release the tension. On the other hand, the sensitivity outcome is not ideal and harvesting this flap leaves an ugly scar on the dorsum of the hand, which may be undesirable, particularly among women. Although we find this procedure useful for amputations and defects proximal to the interphalangeal joint in workers who use their hands (subjective satisfaction 8.37/10), the definitive judgment regarding the validity of this technique for smaller defects distal to the interphalangeal joint should be evaluated by comparing the end results to those of the cross-finger and Moberg flap.

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