

The Innervated 1st Dorsal Metacarpal Artery Island Flap for Reconstruction of Post Traumatic Thumb Defect

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ABSTRACT

Various surgical techniques contribute to repair distal defects of the fingers, especially thumb as traumatic loss, diminishes or eliminates the thumb prehensile abilities and may affect overall hand function. The goal of reconstruction should be maximum restoration of hand function. Being the only opposing digit against the others, when thumb is involved, functional loss maybe more severe than anticipated. Because of its major contribution to overall hand function, correction of deformities involving the thumb is crucial. Adequate length, mobility, stability and sensation are the goals of a functional thumb reconstruction. It appears that the FD-MCA flap is one of the best solutions for cover of simple or complex skin loss of the thumb. Its technical performance is easy, and it gives durable, sensate and stable skin cover.

INTRODUCTION

Traumatic thumb injury presents a much more significant influence on daily living than do injuries to the other digits [1].

The most common cause of injuries was blunt trauma (50%) followed by injuries from sharp object (25%). Traumatic tissue loss of pulp on the first finger, represents a common problem which requires serious reconstructive operations [2].

The thumb is used in virtually all activities that involve the arm and hand [3]. Daily tasks involving pinch, grip, grasp and precision handling are more easily accomplished with an opposable thumb [4]. The unique features of the human hand can be viewed as adaptations for throwing and clubbing [5].

Coverage of soft tissue on the fingers may be difficult due to the size of the defect or the limitation of local flap mobilization. Moreover, exposure of the deep structures (complex defects) such as joint, bones or tendons is an emergency that requires a reliable technique for coverage [6]. Restoration of sensibility after traumatic loss of the palmar aspect

of thumb is of utmost importance for the usefulness of the hand [7].

Generally, these defects are closed by regional flaps as: Palmar advancement flap (Moberg), cross finger flap, neurovascular island flap (Littler) and the 1st dorsal metacarpal artery flap [2].

More recently various microsurgical free flaps from the first and second toe and web space of the foot were described as alternative solutions for this problem. All free flaps require coaptation of their sensory nerves in the recipient area. This limits their use in older patients in whom re-innervation may yield poor results [7] and success of this procedure is not always guaranteed [8].

The advantages of the innervated 1st dorsal metacarpal artery (FD-MCA) island flap from the dorsum of the index finger which was first described by Hilgenfeldt [9] refined by Hollevich [10] and modified as a pure island flap by Foucher and Braun [11] are its variable size, stability, pliability and the innervated skin with no major donor site morbidity [7].

This study presents a series of 10 patients who presented with degloved thumb injuries, which were reconstructed using this flap. The purpose of this study was to evaluate the quality of the flap and the donor site morbidity at the index finger.

MATERIAL AND METHODS

10 innervated FD-MCA island flap were performed from November 2010 until January 2012 (14 month) for reconstruction of thumb defect. The mean age of those patients was 35.6 (min of 19, max of 63). The defect size was between 2-3cm in 60% and more than 3cm in 40% of cases with a mean of 3.4cm. The dominant hand was

involved in 80% of cases. 70% of patient had crush injury and 10% had sustained complex trauma with injury to more than one finger. The flap was used for immediate reconstruction in 4 cases with exposed bones and delayed reconstruction in 6 cases. Delayed reconstruction was performed 3 to 4 days after the initial trauma. The donor area was grafted by either thick split thickness graft or full thickness graft.

Follow-up for more than 6 month for 7 patients and less than 6 month for the rest of the patients was done. During the follow-up period the flap was examined for sensation, cortical reorientation, opposition of the thumb as the main function and cosmetic results. The donor site also was examined for cosmetic outcome. Two points discrimination test was used to test for sensation. An analogue scale was used to subjectively evaluate paresthesia (0=no paresthesia, 4=severe paresthesia), cosmetic results were evaluated according to patients and surgeons satisfaction, whether accepted or not.

Surgical technique:

The skin island of the flap lies over the proximal phalanx of the index finger. The MP and PIP joint represent the distal and proximal extent of the skin island. The flap territory extends between midlateral lines on each side of the proximal phalanx of the index finger. After the outlines of the skin island are marked, a line is drawn along radial border of second metacarpal in a zig-zag or lazy-S fashion, beginning from the proximal base of the skin island and extending proximally up to the tip of the first web space. Between the bases of the first and second metacarpal bone, the tip of the triangular first web-space can be palpated, indicating the most proximal point of the pedicle dissection. When marked, this point represents the pivot point of the flap. In order to predict where the flap can

reach, maximum rotation arch of the flap design can be estimated by measuring the distance of PIP joint from this pivot point [12].

Dissection is performed under tourniquet ischemia. Because it is recommended to include a large subcutaneous vein in the pedicle, the skin incision is continued along the radial aspect of the second metacarpal. Great care has to be taken not to violate the paratenon over the extensor hood to secure the take of the skin graft for reconstruction of the donor site. A critical point in the dissection is the radial aspect of the extensor hood of the MP joint. Inclusion of a small strip of extensor hood is recommended to protect the vascular connection from the pedicle to the skin island. The flap occasionally may appear pale after release of the tourniquet but usually pinks up within 5 to 10 minutes [7].

RESULTS

All the flaps survived without ischaemia or venous insufficiency and all of the wounds healed uneventfully without infection or problems of delayed healing.

At three weeks follow-up, patients were able to start holding large objects and undertaking light tip pinch activities (Fig. 2).

Static two-point discrimination measured in the flaps at 6 weeks has a mean of 9.6mm (Table 1).

Cortical disorientation was noted consistently, with our patients reporting all of dual sensation. This seemed to diminish with time.

All of the patients were pleased with the quality of the reconstruction because the FD-MCA island flap transfers well-padded sensate skin (Figs. 3,4) and provide an excellent cosmetic result (Fig. 3).

Table (1): Summary of the results.

No. of case	Two point discrimination test	Cosmetic results	Paraesthesia of the flap	Cortical orientation	Paraesthesia of the donor site
Case 1	10 mm	Accepted	0	Incomplete	0
Case 2	6 mm	Accepted	0	Incomplete	0
Case 3	8 mm	Accepted	0	Incomplete	0
Case 4	12 mm	Accepted	0	Incomplete	1
Case 5	10 mm	Accepted	1	Incomplete	0
Case 6	15 mm	Accepted	0	Incomplete	0
Case 7	9 mm	Accepted	2	Incomplete	0
Case 8	6 mm	Accepted	0	Incomplete	1
Case 9	12 mm	Accepted	0	Incomplete	0
Case 10	8 mm	Accepted	0	Incomplete	0
Mean	9.6 mm	—	0.3	—	0.2

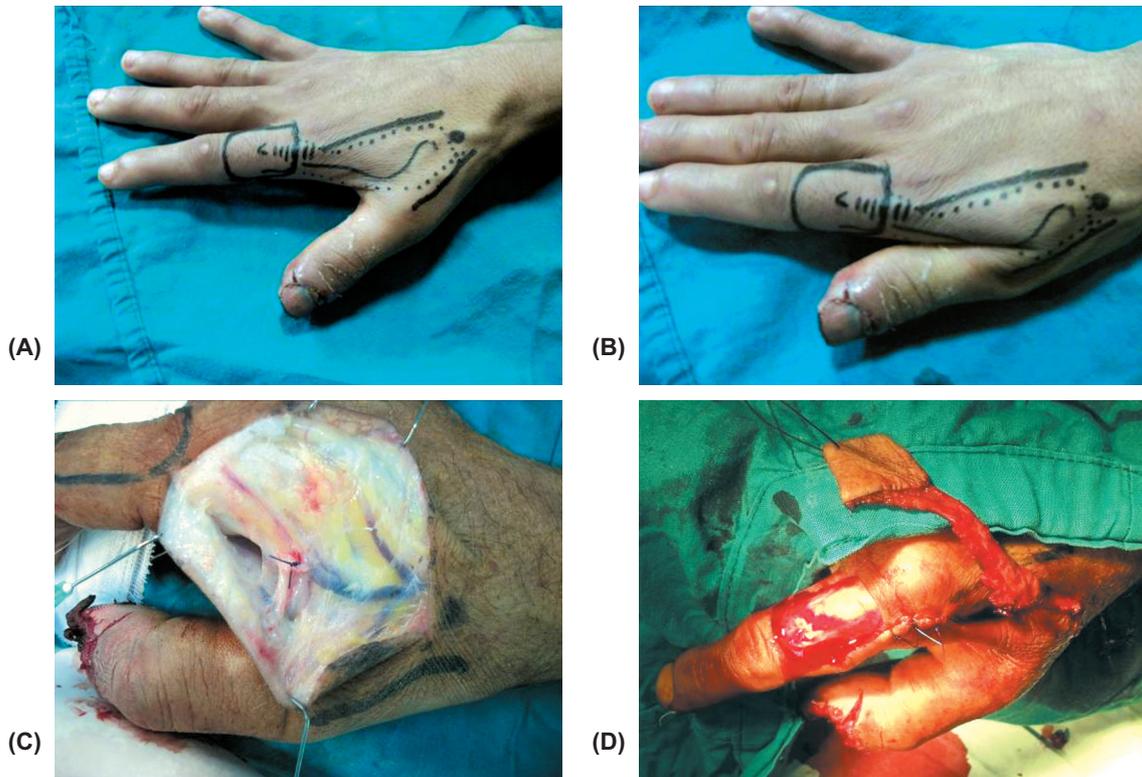


Fig. (1): a) Drawing of the flap. b) With contraction of the adductor muscle. c) The pedicle of the flap. d) Complete harvesting of the flap.

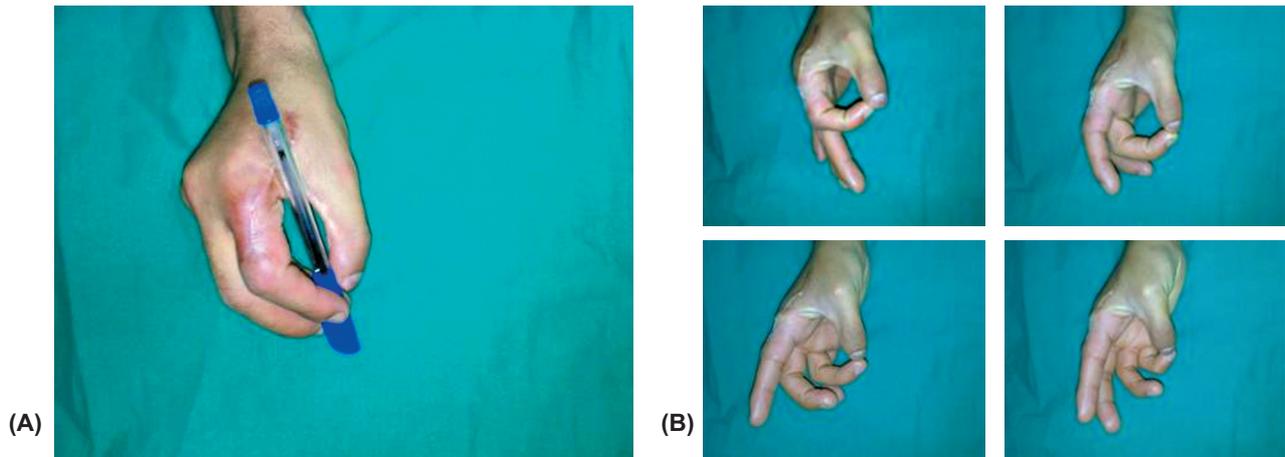


Fig. (2): a): Patient holding a pen. b) Serial opposition of the reconstructed thumb.

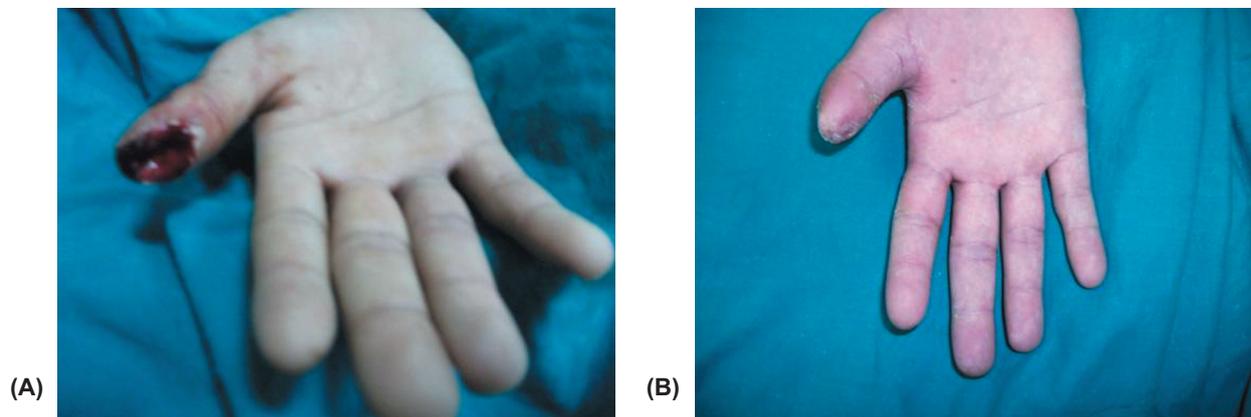


Fig. (3): a) Preoperative, b) Postoperative photograph after 4 month.

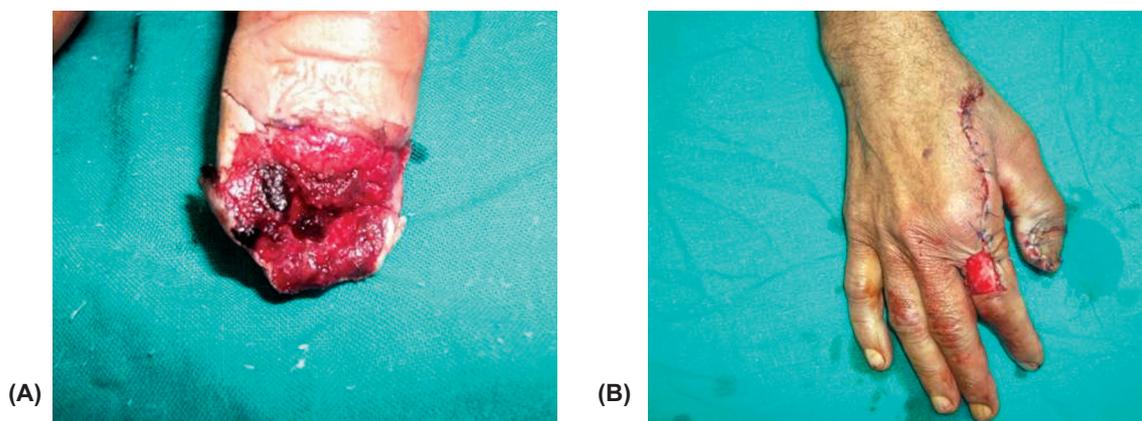


Fig. (4-A,B): Preoperative and intraoperative after inset of the flap photograph.

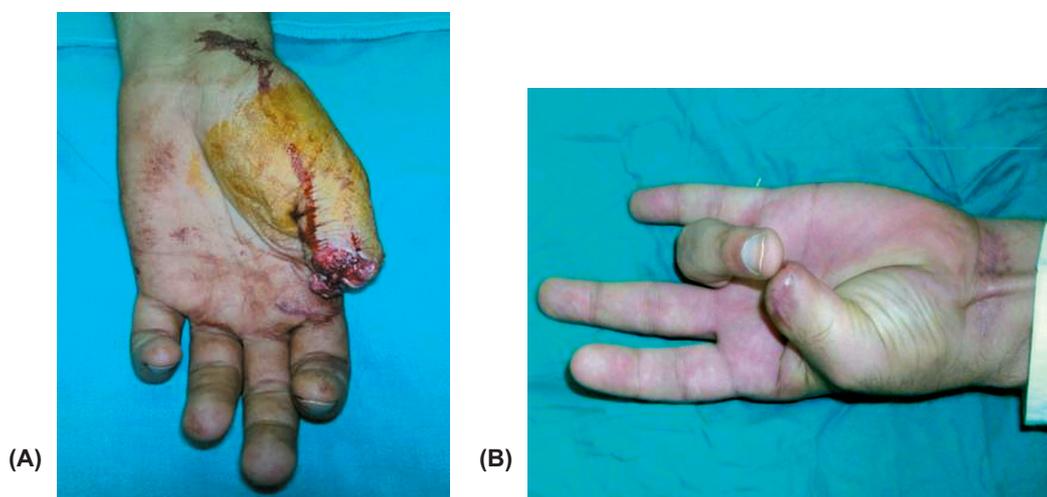


Fig. (5): (a) Preoperative, b) Postoperative after 6 month.

DISCUSSION

Extensive pulp defects of the thumb, with the exposure of tendon or bone, are challenging reconstructive problems because of the lack of locally available tissue. Surgical treatment includes the use of local, regional, and free flaps [13].

The goal of thumb reconstruction is to restore sensate non-tender thumb tip, stable interphalangeal and metacarpo-phalangeal joints, adequate strength to resist the forces of other fingers, correct posture and positioning of the thumb with a wide web space and mobility of the carpo-metacarpal joint with the intrinsic muscles to aid prehension [14].

The main goal of the plastic surgeon facing a complex soft-tissue defect is to replace “like with like” tissue at minimal donor site cost and with maximal efficacy [15].

The random pattern flaps were proven to be useful in closing defects on the dorsum of the

thumb and the adductor space providing aesthetically and functionally excellent results [16].

In spite of all this there is a limitation in the use of random pattern flaps, these are: The limited arc of rotation, proximity of the flap to the zone of injury, decreased bacterial resistance in the flap, there may be a need for a delay procedure [17].

For a defect longer than 25mm, 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 20mm. Since the cross-finger flap may lead to a first web contracture and stiffness in finger joints, it is better used only for a salvage procedure [18].

Radial forearm flap is one of the most important regional fascioutaneous flaps in thumb reconstruction, however; a disadvantage is that it sacrifices a major vessel in the forearm [19].

In 1953, Littler described a neurovascular island flap, harvested from the ulnar aspect of the ring or middle finger. Various microsurgical free flaps from the first and second toe and web space of the foot were described as alternative solutions in 1978 and 1979 [13].

The first dorsal metacarpal artery flap (FDMCA) island flap is harvested from the dorsal aspect of the index finger including the first dorsal metacarpal artery with its concomitant veins and a branch of the superficial radial nerve as a pedicled neurovascular flap. It has a wide arch of rotation and easily reaches the palmar or radial aspects and the pulp of the thumb. The venous drainage of the concomitant veins of the FDMCA is very reliable, the possible size of the flap is big, and the donor site morbidity is low [15].

The FDMCA flap has a constant anatomy and easy dissection. It has low donor site morbidity. It shows good functional and aesthetic results. The FDMCA flap is a first treatment of choice for defects of the proximal phalanx and proximal part of the distal phalanx of the thumb. The FDMA flap, which allows the surgeon to accomplish the goal better, should serve as a valuable alternative for sensory resurfacing in the thumb [20].

In our study ten cases with thumb defects ranging from soft tissue loss up to exposed structures as bones were managed with innervated FD-MCA island flap with no major complications except in one case where the flap suffered from partial necrosis, on the other hand this kind of flap was found to have excellent cosmetic results, with minimal donor site morbidity and good sensory results.

The reconstruction is performed in a single-stage surgery. With its pedicle length of up to 7cm, the flap has a wide arc of rotation (Fig. 4) and easily reaches the palmar or radial aspects and the pulp of the thumb. The venous drainage of the concomitant veins of the first dorsal metacarpal artery is very reliable [7].

Another advantage of the FDMCA flap is the area of dissection at the dorsum of the second metacarpal, which makes the procedure technically less demanding than the dissection of the palm and digit.

The dorsal skin also shows an excellent ability to withstand the stress of becoming part of the working surface of the hand.

Moberg [21] stated that precision sensory grip or tactile gnosis requires s2-PD of less than 6mm, whereas gross sensory grip would be possible with s2-PD of 6 to 15mm. Static 2-point discrimination showed variability in our series but more than 90% (9 of 10) of the patients had a 2-point discrimination of less than 15 mm and 20% (2 of 10) of the patients had 2-point discrimination of 6mm. Therefore, FD-MCA flap has a good sensory grip but we need to apply it on a larger scale.

Cortical reorientation is the fact that the brain recognizes a stimulus from the flap area as a stimulus from the thumb, and not from the index finger. This process takes some time, but is usually complete after 2 years.

Conclusion:

The first dorsal metacarpal artery flap is a reliable local neurovascular island flap option for thumb reconstruction, offering acceptable functional and cosmetic outcomes in respect to sensation, elasticity, durability, and skin match. It provides elastic, durable, and sensate coverage for soft tissue defects of the thumb in a single stage procedure. Donor site morbidity is minimal with an acceptable scar on the dorsum of index and adequate tendon gliding without producing extension deficit.

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