International Journal of Research in Orthopaedics
Panagatla P et al. Int J Res Orthop. 2019 Nov;5(6):1144-1149
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20194820

The Holevich modification of the first dorsal metacarpal artery flap in coverage of thumb skin losses

Prakash Panagatla, Sindhuri Kondapavuluri, Parvathi Ravula*

Department of Plastic and Reconstructive Surgery, Nizam's Institute of Medical Sciences, Punjagutta, Telangana, Hyderabad, India

Received: 03 July 2019
Revised: 11 September 2019
Accepted: 12 September 2019

***Correspondence:**
Dr. Parvathi Ravula,
E-mail: paaru_raavula@yahoo.co.in

ABSTRACT

Background: Reconstruction of complex soft tissue defects of the thumb is a challenging problem. It is very important to reconstruct these defects using sensate flaps as the thumb pulp needs to be sensate for implementing the various functions of the thumb. The aim of this study is to report our experience on the safety and functional outcome of the innervated first dorsal metacarpal artery flap (FDMA) for soft tissue defects of thumb.
Methods: During 18 month period, nine patients with a mean age of 29 years, male:female ratio of 8:1 underwent coverage of soft tissue defects of the thumb, of various volar and dorsal defects, using an innervated first dorsal metacarpal artery flap. Indications were postburn deformities and acute trauma. None of the patients had any neurorraphy. Outcome of the Holevich modification of FDMA flap was assessed with regards to survival and function, reachability for different locations of the thumb, recovery of sensation in terms of two-point discrimination (2PD), donor morbidity with regards to deformity and range of motion were analysed.
Results: The mean size of the defect was 6.7 cm^2. Average hospital stay was 5 days. Average time of sensory recovery was 6 months. The mean 2PD was 4 mm (range 2-6 mm). All patients had a normal active range of motion in the donor finger. One of nine patients had distal flap marginal necrosis of 3-4 mm; it healed with debridement and regular dressings over 12 days.
Conclusions: The Holevich modification ensures the safety of the innervated FDMA flap in thumb defect coverage with good recovery of sensation.

Keywords: Thumb skin loss, First dorsal metacarpal artery flap, Holevich modification

INTRODUCTION

Reconstruction of soft tissue defects of the thumb that precludes the use of a split skin graft, need coverage using pliable, durable and sensate skin to give normal appearance and function.

Such defects result commonly after acute trauma and less commonly following tumour excisions or correction of the post burn deformity.[1-3]

The use of local tissue gives the best match and is preferred wherever possible or available. These include local transposition and advancement flaps of the residual thumb skin from its volar or dorsal aspect, the traditional cross finger flap and the neurovascular heterodigital island flaps.[4,5]

Partial toe transfer using various components of the tissues of the great or second toe nourished by the first dorsal metatarsal artery is an elegant reconstructive method that necessitates microsurgery, and is preferred

when such local tissues are not available on account of injury to adjacent digits or where it is necessary to augment the length of the amputated thumb.[6]

Regional pedicled flaps, usually from the groin or lower abdomen, are poorly suited for coverage of the volar contact surface of the thumb on account of bulk and lack of sensation; the texture of this donor skin is far different from the glabrous skin of the thumb.

The first dorsal metacarpal artery flap (FDMA) was first described by Foucher et al who demonstrated that a sensate skin island flap created from the dorsum of the index finger could be raised based upon the first dorsal metacarpal artery and sensory branch of the radial nerve.[7]

This flap is reliable, can be transferred and inset in a single stage, and is sensate on account of the terminal radial nerve branches to the index skin, harvested along with the flap; further, it can be adapted to defects of the thumb other than the volar pulp.

The obligatory skin graft in the donor finger can lead to adverse aesthetic appearance and sometimes function. At the recipient area, the difference in texture of the dorsal skin of index and residual thumb skin may be obvious; further there could be a possibility of "cortical confusion" of transferring the "index dorsal skin" to the thumb defect.

Many authors reported variable outcome with regards to sensation, we report our experience with Holevich's modification.

METHODS

Study design

This is a retrospective study, done to evaluate the outcome of the Holevich's modification of FDMA flap to resurface the thumb defects secondary to trauma or post burn deformities in 9 patients.

Study place and duration

The study was conducted in NIZAM'S Institute of Medical Sciences, Hyderabad, Telangana State, India, over an 18 month period from July 2017 to December 2018.

Selection criteria

All patients with soft tissue defects of the thumb; over the volar or dorsal aspect; extending anywhere from metacarpophalangeal joint to the tip; resurfaced with FDMA flap were included in the study.

The mean age of the subjects included in the study was 29 years (range: 9-40 years).

The defects were secondary to acute trauma in seven patients and following of release of post burn deformities in two patients. The location of the defects were volar (1) and dorsal thumb defects (2) extending distal to the metacarpophalangeal joint of the thumb, stump defects (2) and thumb pulp defects (3), volar defect extending to pulp (1). Five of the seven patients had traumatic skin and soft tissue loss only. Two of the seven following acute trauma had a non replantable amputation stump at proximal phalanx level with exposed bone needing coverage. One of the seven cases following trauma had a compound proximal phalanx fracture for which fracture reduction and fixation using kirschner wire was done.

All but one of the cases following acute trauma were operated within 72 hours of the injury (the exception was 1 who was operated 26 days after injury).

Both the cases following burns were operated between one and four years after sustaining burn injury.

Ethical approval

The patients were explained about the purpose of the study and informed consent was obtained. The study was approved by the institutional ethics committee and was performed according to the bioethical guidelines prescribed by Indian Council of Medical Research, New Delhi.

Data collection and statistical analysis

Demographic and clinical characteristics of all patients were noted. Detailed history, etiology, location of defect and size of the defect were noted. The post-operative complications in the form of flap necrosis, donor morbidity were noted. Functional outcome of all patients was assessed at 6 months follow up, by measuring 2PD and cortical reorientation. The mean 2PD was measured.

Relevant anatomy

The radial artery on dorsum of hand sends a branch to the dorsal carpal arch and then gives off first dorsal metacarpal artery just distal to the tendon of extensor pollicis longus, before diving deep into palm between the two heads of first dorsal interosseus muscle.

The FDMA runs suprafascially over the fascial layer of the 1st dorsal interosseus muscle in 57% of cases , while it takes a subfascial course in 43% of cases, then divides into the ulnar branch to the index finger , intermediate branch to the 1st web space and radial branch to the thumb (Figure 1).[8]

Surgical procedure

Preoperative marking of the course of the FDMA was done using hand held Doppler.

Surgery was performed with the patient under regional analgesia using axillary brachial block, under tourniquet control, and loupe magnification.

After debridement (in acute trauma) and contracture release (following thermal burns), the defect of the thumb was extrapolated on to the dorsum of proximal phalanx of index finger, ensuring the proximal and distal limits of the flap being metacarpophalangeal and proximal interphalangeal joint creases respectively (Figure 2A). The width of the flap did not extend beyond the radial and ulnar midaxial lines of index finger. 2 of 9 cases needed an extension of the distal end of the flap by 5 mm onto the skin over the middle phalanx for adequate coverage of the thumb defect (Figure 5B).

An exploratory incision was made along the radial border of 2nd metacarpal in a subdermal plane which helped in identifying the presence of the vascular pedicle, which was followed by flap elevation.

In all cases the ulnar branch of 1st dorsal metacarpal artery was found in the suprafascial plane in relation to the musculo-osseous groove between the ulnar head of first dorsal interosseous muscle and radial border of 2nd metacarpal.

To avoid injury to the deeper aspect of the vascular pedicle, the periosteum of radial shaft of 2nd metacarpal was included. Further, a small skin bridge, of about 5 mm along the length of the pedicle was included upto the proximal pivot point in order to transpose the flap to the defect, without tunnelling (to avoid any compression of the pedicle) (Figure 1).

The "pedicle" of the flap contained ulnar branch of 1st metacarpal artery and its vena commitantes, fascia of the ulnar head of 1st dorsal interosseus, periosteum of radial shaft of 2nd metacarpal, one or two superficial veins, sensory branch of radial nerve to make it a sensate flap and finally the 5 mm skin bridge.

The marked flap was then elevated from distal to proximal and from ulnar to radial side just above the extensor hood on the proximal phalanx, leaving the paratenon intact. The 5 mm skin bridge was then extended proximally onto the tip of triangular first web space along with pedicle, this being the pivot point of the flap and the proximal most point of pedicle dissection.

The harvested FDMA flap along with skin bridge was then transposed onto the surgical defect created over the thumb, using another linear incision along the ulnar border of the thumb, without tunnelling the flap. None of the patients underwent neurorrhaphy of the sensory branch of radial nerve with the recipient thumb digital nerves.

The donor defects were covered by either full thickness graft from groin crease or split thickness graft.

In seven of nine cases, the standard FDMA flap described was elevated. If the defect on thumb is extending on to the tip of the thumb (two out of nine cases) ,an extended FDMA flap was elevated with distal limit 5 mm beyond the proximal interphalangeal joint.

Post operatively the thumb was positioned in slight adduction to avoid traction on pedicle. The flap was dressed in a loose fluffy dressing to avoid any compression, a short arm wrist immobilization splint was applied with limb elevation to improve venous return. Within the splint, physiotherapy was initiated from 7th postoperative day. Splint was removed at 2 weeks following surgery and full range of movements of thumb and index finger were encouraged.

RESULTS

Total of nine thumb defects were resurfaced with Holevich modification of the FDMA flap. Etiology included acute trauma (7) and post burn deformity (2). Acute trauma defects included pulp (4), one pulp with volar aspect of proximal phalanx, one volar aspect confined to proximal phalanx, and two amputation stump defects at the level of proximal phalanx.

Table 1: Distribution of patients according to their demographic and clinical characteristics.

Variable	N (%)
Age distribution (years)	
<10	1 (11)
10-30	3 (33)
30-50	5 (55)
>50	0 (0)
Gender distribution	
Male	8 (88)
Female	1 (11)
Etiology	
Trauma	7 (77)
Post burn deformity	2 (22)
Location of the defect	
Volar	1 (11)
Dorsal	2 (22)
Stump	2 (22)
Pulp	3 (33)
Volar extending upto pulp	1 (11)

Table 2: Results.

Variable	N (%)
Flap necrosis	1 (11)
Donor site resurfacing	
Full thickness graft	3 (33)
Split skin graft	6 (66)
Hypertrophic scar	3 (33)
Terminal extension lag	2 (22)
Flexion contracture of thumb	1 (11)

Table 3: Range of 2PD.

Range (mm)	N (%)
≤2	4 (44)
2-6	1 (11)
6-12	1 (11)
Lost to follow up	3 (33)

Table 4: Mean 2PD and flap size.

Variable	N
Mean 2PD	2.5 mm
Mean Flap size	1188 mm^2

Post burn contracture defects included radial and volar aspect of the interphalangeal joint (IPJ) and dorsal aspect of the proximal phalanx and the IPJ.

Defect size ranged from 40 mm^2 to 120 mm^2 with mean size of 67 mm^2.

Out of nine patients, only one patient had post-operative complication in the form of distal flap marginal necrosis of 3-4 mm, which healed with conservative management. In one patient, there remained a residual flexion contracture of the interphalangeal joint following flexor pollicis longus tendon repair.

Out of nine patients, donor site was resurfaced with full thickness graft (FTG) in three patients and split skin thickness graft (SSG) in six patients; three of the nine had hypertrophy of the scar and two of the nine had terminal 5 degree loss of extension, without any functional limitation (Table 2).

Out of nine patients, three were lost to follow up to determine 2PD and cortical reorientation. Five out of nine patients had 2PD in the range of 2-6 mm and normal cortical reorientation at around six months of follow up (Table 3). One patient with distal flap marginal necrosis which healed with regular dressings had delayed sensory recovery at 8 months follow up with 2PD of 11 mm.

Figure 1: FDMA Flap elevated with a 5 mm skin bridge (top arrow) based on first dorsal metacarpal artery pedicle (bottom arrow).

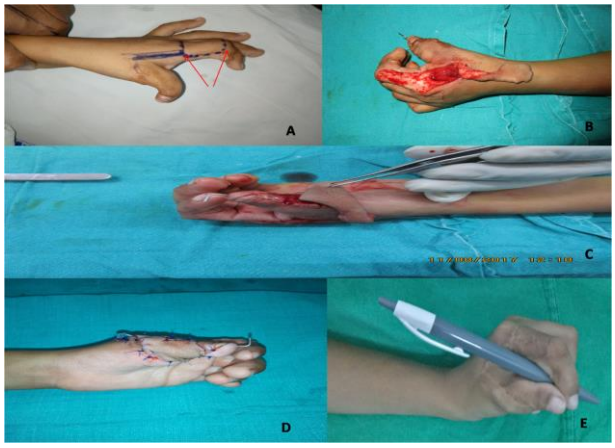

Figure 2: Post burn contracture of left thumb with radial deviation, (A) pre-operative marking of the proximal (metacarpophalangeal joint) and distal (proximal interphalangeal joint) limits of the flap, (B) harvested FDMA flap based on Holevich modification, (C) defect over the radial aspect of thumb following post burn contracture release covered with harvested flap and (D) follow up photograph with good functional outcome.

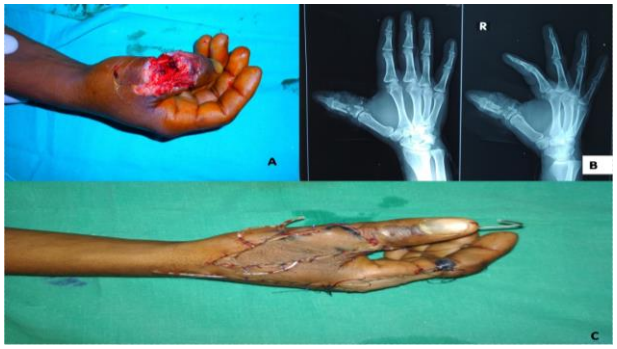

Figure 3: (A) Post traumatic compound proximal phalanx fracture of right thumb with dorsal defect, (B) X-ray and (C) post flap inset.

Figure 4: Post traumatic case of (A) right thumb pulp defect, (B) harvested FDMA flap with skin bridge of 5mm along the length of the pedicle, (C) flap inset and (D-I) follow up photographs with no donor morbidity, good ROM, and functional outcome with adequate thumb length.

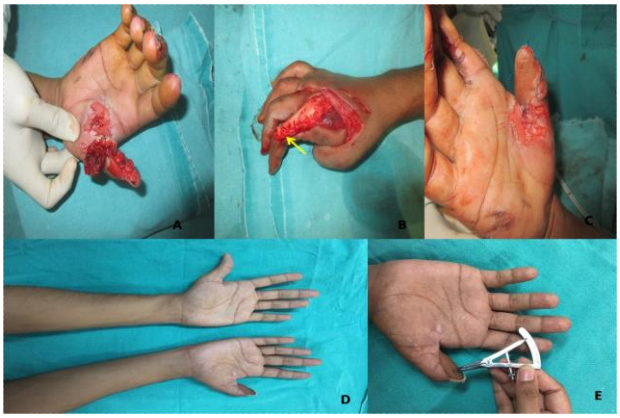

Figure 5: Post traumatic case of (A) extensive pulp and volar aspect of thumb avulsion, (B) extended FDMA flap harvested with distal limit 5 mm beyond the proximal interphalangeal joint, (C) following flap inset and (D and E) follow up photographs with good functional outcome and 2PD of 2 mm.

DISCUSSION

The FDMA runs suprafascially over the fascial layer of the 1st dorsal interosseus muscle in 57% of cases , while it takes a subfascial course in 43% of cases.[8,9] Regardless of the level of vessel during its course, it's presence can be confirmed by using a hand held Doppler.

There are various techniques of elevation of FDMA flap. With the Hilgenfeldt technique, the skin remains intact towards the base of the flap.[10]

With the Holevich technique, the skin island over the pedicle is smaller and gives the flap the form of a tennis racquet or a flag.[11] This avoids the excess of skin in the first interdigital commisure region.

With the Foucher technique, there is no skin over the neurovascular pedicle.[7] In this case, a subcutaneous tunnel is made along the ulnar aspect of the thumb from the snuffbox to the proximal margin of the pulp defect to transfer the flap into the defect by gentle traction.

The modified FDMA flap raised from both the proximal and middle phalanges of the index finger was first described by EI-Khatib.[12]

Sensation of this skin is assured by harvesting the radial dorsal branch in continuity proximally without any deliberate neurorhaphy.[13]

Zhang et al reported a modified FDMA island flap with nerve repair to improve the sensation of the resurfaced thumb and obtained good results. Neurorrhaphy between the radial dorsal branch of the proper digital nerve (DBPDN) in the flap and the ulnar stump of the proper digital nerve in the recipient thumb was done to improve sensation of the distal portion of the flap.[14]

Advancement of residual thumb volar skin is the procedure of first choice but is not recommended for defects more than 20 mm on account of the morbidity occasioned by the obligatory flexion of the interphalangeal joint.

In a series of 21 cases used for defects larger than 25 mm in 14 cases, the majority adopting the Foucher technique of complete islanding the flap, 12 of the cases were for stump coverage and 6 for dorsal skin losses. This led to two cases with early venous congestion with flap loss. The average 2PD return at follow up was 10 mm.[15]

In another series 8 patients had the FDMA flap for defects from 30×15 to 50×40 mm area; islanding and tunnelling before flap inset led to venous congestion but with complete flap survival. They further report that the 2PD in that patient at follow-up was nearly 14 mm, twice that of the normal thumb.[13]

Bilgen can state that the skin over the middle phalanx is supplied by the dorsal branches of the palmar digital arteries.[16] when the defect reaches the tip of the unamputated thumb pulp, extension of the flap over the middle phalanx is required as a random extension to increase the distal reach of the flap.[12]

All the cases in the present study underwent the Holevich modification of including a small skin island extension proximally with the two-fold purpose of giving protection to the pedicle and avoiding flap tunnelling with chances of venous congestion.

Out of nine patients, one patient had distal flap necrosis, which was managed with debridement and regular dressings. This was consequent to tight suturing in the terminal end of the flap which was used to cover a complete pulp loss in an unamputated thumb.

Subsequently in two similar defects extending to the thumb tip a random extension for 5 mm onto the dorsum of the middle phalanx ensured coverage without terminal necrosis.

Ghoraba et al in a series of 15 defects had to undo the tunnel during surgery in 7 cases to reverse venous congestion.[17]

CONCLUSION

The Holevich modification ensures the absence of any venous congestion with its possible implications of flap loss or poor sensory return. Dorsal defects, amputation stumps and the area over the interphalangeal joint can reliably be covered by the standard flap length. Complete pulp defects extending to the tip are better covered with an extended FDMA flap to prevent tip necrosis due to tight pull on suture line, leading to secondary healing.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Carreras JM, McGee C, Al-Mufarrej F. Versatility of Dorsal Metacarpal Artery Flaps for Hand Burns. J Burn Care Res. 2018;39(6):989-94.
2. Eski M, Nisanci M, Sengezer M. Correction of thumb deformities after burn: Versatility of first dorsal metacarpal artery flap. Burns. 2007;33(1):65-71.
3. Muyldermans T, Hierner R. First dorsal metacarpal artery flap for thumb reconstruction: a retrospective clinical study. Strategies Trauma Limb Reconstr. 2009;4(1):27-33.
4. Hynes DE. Neurovascular pedicle and advancement flaps for palmar thumb defects. Hand Clinics. 1997;13(2):207-16.
5. Littler JW. The neurovascular pedicle method of digital transposition for reconstruction of the thumb. Plastic Reconstr Surg. 1953;12(5):303-19.
6. Adani R, Cardon LJ, Castagnetti C, Pinelli M. Distal thumb reconstruction using a mini wrap-around flap from the great toe. J Hand Surg Eur Vol. 1999;24(4):437-42.
7. Foucher G, Braun JB. A new island flap transfer from the dorsum of the index to the thumb. Plastic Reconstr Surg. 1979;63(3):344-9.
8. Earley MJ. The arterial supply of the thumb, first web and index finger and its surgical application. J Hand Surg Eur Vol. 1986;11(2):163-74.
9. Ghoraba SM, Mahmoud WH. Outcome of Thumb Reconstruction Using the First Dorsal Metacarpal Artery Island Flap. World J Plastic Surg. 2018;7(2):151.
10. Hilgenfeldt O. Operativer Daumenersatz, Enkeverslag, Stuttgart. 1950.
11. Holevich J. A new method of restoring sensibility to the thumb. J Bone Joint Surg Br. 1963 Aug;45(3):496-502.
12. El-Khatib HA. Clinical experiences with the extended first dorsal metacarpal artery island flap for thumb reconstruction. J Hand Surg. 1998;23(4):647-52.
13. Chang SC, Chen SL, Chen TM, Chuang CJ, Cheng TY, Wang HJ. Sensate first dorsal metacarpal artery flap for resurfacing extensive pulp defects of the thumb. Ann Plastic Surg. 2004;53(5):449-54.
14. Chen C, Zhang X, Shao X, Gao S, Wang B, Liu D. Treatment of thumb tip degloving injury using the modified first dorsal metacarpal artery flap. J Hand Surg. 2010;35(10):1663-70.
15. Ege A, Tuncay I, Ercetin O. Foucher's first dorsal metacarpal artery flap for thumb reconstruction: evaluation of 21 cases. Imaj-Ramat Gan. 2002;4(6):421-3.
16. Can B. The first dorsal metacarpalartery flap: A practical operation for thumb reconstruction. Hand Microsurg. 2018;7:143-8.
17. SM, Mahmoud WH. Outcome of Thumb Reconstruction Using the First Dorsal Metacarpal Artery Island Flap. World J Plastic Surg. 2018;7(2):151.

Cite this article as: Panagatla P, Kondapavuluri S, Ravula P. The Holevich modification of the first dorsal metacarpal artery flap in coverage of thumb skin losses. Int J Res Orthop 2019;5:1144-9.