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ORIGINAL RESEARCH

Utilisation of FDMA flap for thumb reconstruction: Our experience

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ABSTRACT

Introduction- Reconstruction of the thumb defect, while creating a robust and sensate flap, is a hard endeavour. First dorsal metacarpal artery (FDMA) flap is one regional flap that has been used for thumb cover, usually for defects up to interphalangeal joint or just distal to it. The present report is our experience of utilisation of FDMA flap for thumb reconstruction in 15 patients. **Material and methods-** This prospective study was conducted at department of plastic and reconstructive surgery of a tertiary care centre during the period of two year. A total of 15 patients with complex post-traumatic soft tissue thumb defects (8 dorsal oblique, 5 volar oblique and 2 transverse) were selected and defects were covered with 1st dorsal metacarpal artery flaps. Sensory function was evaluated with static 2-point discrimination and cortical reorientation. The mobility of the thumb was tested by the Kapandji score. The aesthetic outcome was assessed. Patient's subjective satisfaction was evaluated by the visual analogue scale. **Results-** The patients included 4 females and 11 males ranging in age from 15 to 50 years (mean, 32.5 years). 8 patients underwent immediate surgery, whilst 7 patients came late following electric burn or trauma. Nine individuals (60%) experienced involvement of their dominant hand. The flap sizes ranged from 19×13 mm to 40×27 mm (mean 32.1×17.6 mm). 13 flaps were entirely viable, while 2 exhibited distal flap necrosis, which was managed conservatively and healed through secondary intention. The average follow-up duration was 18.3 months (range 9-30 months). The static two-point discrimination (s2-PD) varied from 7 to 16 mm, with a mean of 10.5 mm. Cortical reorientation was achieved in 8 patients (53.3%). The mean Kapandji score was 7.2 (range: 4-9). The average subjective satisfaction (SS) score was 8.1 (range: 4-10). The aesthetic results of the donor and recipient sites were classified as excellent in 5 (33.3%) patients, good in 8 (53.3%) patients, and poor in 2 (13.3%). **Conclusion-** The first dorsal metacarpal artery flap provides sensitive, flexible covering for mild to moderate thumb defects. The procedure yields positive functional and aesthetic results with acceptable donor site morbidity.

Keywords- defect, first dorsal metacarpal artery, flap, reconstruction, soft tissue, thumb

INTRODUCTION

The thumb is utilised in nearly all manual operations of the human hand.[1] Consequently, thumb injuries exert a far greater influence on routine everyday activities than injuries to other digits.[2] The reconstruction of intricate soft tissue defects of the thumb, involving exposure of the underlying structures, presents significant challenges for hand surgeons due to the scarcity of local soft tissue and the necessity for pliable, durable, and sensate skin coverage to maintain thumb functionality, which is crucial for the hand's overall utility.[3]

Traditionally, these defects may be addressed using the Moberg advancement flap, sensate cross-finger flap, Littler's neurovascular island flap, first dorsal metacarpal artery (FDMA) flap, reversed radial forearm flap, distant flaps, and various free flaps from the first and second toes and the web space of the foot. [4-10]

The first dorsal metacarpal artery (FDMA) flap is a time-tested alternative that is extensively utilised for thumb coverage. It was proposed by Foucher and Braun in 1979 for thumb coverage in cases of partial tissue loss. [11] The FDMA flap is derived from the ulnar branch of the FDMA. FDMA originates from the radial artery immediately distal to the extensor pollicis longus tendon, prior to the artery descending between the two heads of the first dorsal interosseous muscle. The diameter of FDMA ranges from 1.2 to 1.5 mm. Multiple accompanying veins may be observed upon dissection. The artery typically courses superficially to the fascia of the first dorsal interosseous muscle and bifurcates into three terminal branches: the radial branch, the ulnar branch, and the

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intermediate branch.[12] The radial branch extends along the thumb metacarpal and anastomoses with the dorsoulnar artery. The ulnar branch traverses the index metacarpal to the metacarpophalangeal (MCP) joint, providing branches to the periosteum and neighbouring extensor tendons. It concludes in a plexus over the dorsal fascia of the index finger. It is applicable for both volar and dorsal abnormalities. Numerous modifications have been proposed for different sorts of defects, including extended FDMA, reverse FDMA, and bilobed FDMA. It has also been utilised for flaws over the total of hand. [13-15] The present report is our experience of utilisation of FDMA flap for thumb reconstruction in 15 patients.

MATERIAL AND METHODS

This prospective study was conducted at department of plastic and reconstructive surgery of a tertiary care centre during the period of two year. Ethical clearance for conducting the study was taken from institutional ethics committee of hospital and informed consent was taken from patients before commencement of study.

A total of 15 patients with post-traumatic soft tissue thumb defects (8 dorsal oblique ,5 volar oblique and 2 transverese) were selected and defects were covered with first dorsal metacarpal artery flaps.

The flap was delineated on the dorsal skin of the proximal phalanx of the index finger. The flap width was delineated to remain within the ulnar and radial midaxial lines of the proximal phalanx, with its distal and proximal margins engineered to preserve the dorsal skin of the proximal interphalangeal (PIP) joint and the metacarpophalangeal (MCP) joint, respectively.

Pulsation of the radial artery was detected between the bases of the 1st and 2nd metacarpal bones. The FDMA course was delineated as extending radially and parallel to the second metacarpal bone from the radial pulse and hand held Doppler.

All patients had surgery under general anaesthesia, utilising pneumatic tourniquet control (250-300 mmHg) and loupe magnification. Following debridement and preparation of the thumb defect, the flap was delineated in accordance with the dimensions of the defect.

The flap elevation began from the distal to proximal side and from the ulnar to radial side, conserving the paratenon to facilitate the unobstructed movement of the extensor tendon and the integration of the skin graft. A lazy-S incision was performed between the radial margin of the metacarpophalangeal (MCP) joint and the apex of the triangular first web space (the pivot point). Subdermal dissection was subsequently performed to reveal the pedicle, with meticulous attention to prevent damage to the big superficial subcutaneous veins. The pedicle was subsequently dissected towards the pivot point. Following flap harvesting, the tourniquet was loosened to verify its vascular integrity.

The flap was subsequently conveyed through a subcutaneous tunnel into the thumb deformity using gentle traction. All patients underwent grafting of the donor sites using full-thickness skin grafts obtained from the groin. Upon completion of suturing and graft dressing, a protective splint was applied. The hand and fingers were immobilised in a neutral posture using a dorsal splint for 15 days to facilitate optimal graft integration. All patients were discharged following graft dressing on the fifth post-operative day. Sutures were excised on the 14th day following the operation. Subsequently, all patients had a six-week course of physiotherapy. The patients were directed to attend post-operative follow-up appointments monthly for three months, followed by quarterly visits for three years. All patients were assessed for the incidence of early postoperative problems, including flap necrosis, haematoma, infection, wound dehiscence, and graft loss.

The sensory function was assessed using static two-point discrimination (s2-PD) testing. Cortical reorientation was assessed by enquiring whether the patient perceived the needle prick stimulation originating from the thumb or the index finger. The mobility of the first ray was assessed using thumb opposition utilising the Kapandji score. [11] The aesthetic outcome was categorised as bad, good, or exceptional. The patient's subjective satisfaction was assessed about the functional recovery and aesthetic look of the flap and donor site, use a visual analogue scale (0=completely disappointed, 10=completely satisfied).

Pre-operative, intra-operative and post operative pictures of a case is shown in below figures [1-6].

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patient 1 pre op

Patient 1 intra op

Patient 1 Post op

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Patient 2 Pre op

Patient 2 post op

RESULTS

15 patients with intricate post-traumatic soft tissue abnormalities of the thumb were treated using island flaps from the first dorsal metacarpal artery. The patients included 4 females and 11 males ranging in age from 15 to 50 years (mean, 32.5 years). 8 patients underwent immediate surgery, whilst 7 experienced postponed procedures due to skin necrosis following trauma. 8 (53.3%) had defect at dorsal oblique site, 5 (33.3%) had volvar oblique and 2 (13.3%) had transverse defect site Nine individuals (60%) experienced involvement in their dominant hand. The flap sizes ranged from 19×13 mm to 40×27 mm (mean 32.1×17.6 mm) as shown in table 1.

Table 1 Basic details of patients

Variable	Values
Mean age (range) years	32.5±3.7 (15-50)
Male	11 (73.3)
Female	4 (26.7)
Defect site- Doral oblique	8 (53.3)
Volvar oblique	5 (33.3)
Transverse	2 (13.3)
Dominant hand	9 (60)
Mean Flap size (range) mm	32.1×17.6 (19×13- 40×27) mm

13 flaps were entirely viable, while 2 exhibited distal flap necrosis, which was managed conservatively and repaired through secondary intention. The average follow-up duration was 18.3 months (range 9-30 months). The static two-point discrimination (s2-PD) varied from 7 to 16 mm, with a mean of 10.5 mm. Cortical reorientation was achieved in 8 patients (53.3%).

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The mean Kapandji score was 7.2 (range: 4-9). The average subjective satisfaction (SS) score was 8.1 (range: 4-10); the majority of patients restored full functionality of the thumb and index finger and expressed satisfaction with the aesthetic look of both the flap and donor site as shown in table 2.

Table 2 Treatment outcomes

Variable	Values
Flap necrosis	2 (13.3)
Mean follow up period (range) months	18.3±4.2 (9-30)
s2-PD mm	10.5±1.3 (7-16)
Cortical reorientation	8 (53.3)
Kapandji score	7.2±2.4 (4-9)
Subjective satisfaction	8.3±2.5 (4-10)

The aesthetic results of the donor and recipient sites were classified as excellent in 5 (33.3%) patients, good in 8 (53.3%) patients, and poor in 2 (13.3%) instance as shown in figure 1.

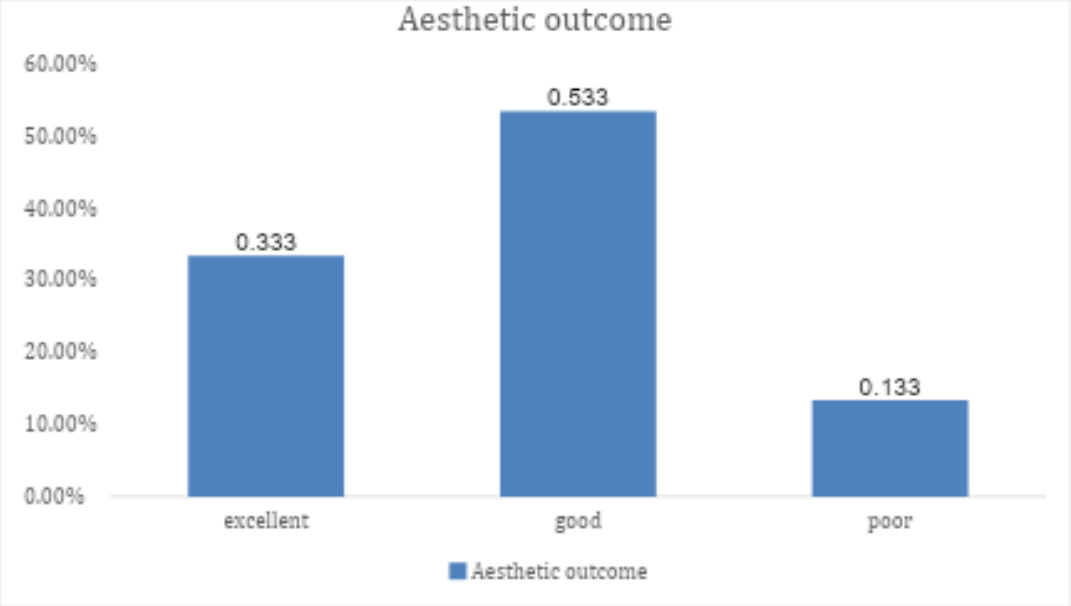

Figure 1 Aesthetic outcomes

DISCUSSION

The FDMA flap is harvested from the dorsal side of the index finger, incorporating the first dorsal metacarpal artery along with its accompanying veins and a branch of the superficial radial nerve, functioning as a pedicled neurovascular flap. Initially delineated by Hilgenfeldt [12], subsequently refined by Holevich [13], then transformed into a pure flap by Foucher and Braun [14]. It possesses an extensive range of motion and readily accesses the palmar or radial surfaces and the pulp of the thumb. The venous drainage of the concomitant veins of the FDMA is very dependable, the potential size of the flap is substantial, and the morbidity at the donor site is minimal.

Significant pulp defects of the thumb, accompanied by exposure of tendon or bone, present formidable reconstructive challenges due to the scarcity of locally accessible tissue.[15,16] The primary objectives of thumb reconstruction are the maintenance of length and sensitivity. Surgical intervention encompasses the application of local, regional, and free flaps. In 1953, Littler [17] delineated a neurovascular island flap, procured from the ulnar side of the ring or middle finger. In 1978 and 1979, several microsurgical free flaps from the first and second toes and the web area of the foot were presented as alternative options [18-20].

In our study, the average flap size was 32.1×17.6 mm, and there were only 2 instance of distal flap necrosis, which was treated conservatively. In a comparable study, Satish et al. employed 9 FDMA flaps to cover post-traumatic thumb deformities and discovered that the mean flap size was 33.3×19.4 mm and only one flap had partial necrosis that healed without secondary operation.[21] Their findings indicated that the size limitation is a disadvantage of this flap, preventing it from extending distally beyond the PIP. El-Khatib developed an augmented version of the FDMA flap for the reconstruction of combined palmar and dorsal thumb defects in five patients, noting complete survival of all flaps. This success can be ascribed to the abundant dermal and subdermal plexus that supplies the skin on the dorsal side of the

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proximal and middle phalanges of the index finger, facilitating the harvesting of skin from the dorsal aspect of the middle phalanx as a random extension.[22]

This study observed that the average value of static two-point discrimination (s2PD) was 10.5 mm. Similarly, Ege et al.22 employed 21 Foucher's flaps for thumb reconstruction and had an average s2-PD of 10.8 mm. In a separate investigation, Chang et al. noted that the average s2-PD was 8.1 mm. The brain's capacity to identify stimulation from the flap site as originating from the thumb rather than the index finger is termed "cortical reorientation."[7]

Our dataset demonstrated full cortical reorientation in 8 patients. The incomplete reorientation in the remaining patients didn't interfere with their routine daily activities. Trankle et al investigated the sensory quality of innervated FDMA flaps across various age demographics, revealing that 11 patients under fifty exhibited a s2-PD of 10.8 mm, while 14 patients over fifty demonstrated a s2-PD of 10.9 mm. [24]

After a mean follow-up duration of 18.3 months, the average Kapandji score among our patients was 7.2. Consistent with our research and results, Muyldermans et al observed that the mean Kapandji score, following an average follow-up duration of 15.4 months, was 7.43 and determined that the FDMA flap is the preferred option for covering defects of the thumb at the proximal phalanx and the proximal segment of the distal phalanx.[20] Our study revealed that the average subjective satisfaction score was 8.3, indicating that the majority of our patients were content with the functional and aesthetic outcomes.

Our data corroborated the findings of Kola et al, which indicated that the mean subjective satisfaction score was 9.3. They are in consensus.[25] Eski et al utilised 14 FDMA flaps to rectify post-burn thumb abnormalities, noting that all deformities were successfully repaired, yielding good cosmetic outcomes, functional recovery, and minimal donor site morbidity.[26] In contrast to our findings, Ege et al observed that the suboptimal aesthetic outcomes are significant limitations of this approach, particularly in females.[23]

CONCLUSION

The present study concluded that the first dorsal metacarpal artery flap provides a sensate, elastic, and versatile coverage for small to moderate-sized defect on both the dorsal and volar surfaces of the thumb. Furthermore, it provides superior functional and cosmetic benefits with low donor site morbidity.

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