Original Article

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Versatility of first dorsal metacarpal artery flap for thumb reconstruction

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ABSTRACT

Background: Coverage of extensive defects of the thumb, with exposure of tendon and/or bone, presents challenging reconstructive problems. **Aim**: The aim of this study is to evaluate the versatility, applicability, and patient satisfaction with the first dorsal metacarpal artery flap for thumb reconstruction. **Methods**: This prospective case series study was conducted over approximately four years (June 2017–September 2022) in the Plastic Surgery Department at Rizgary Teaching Hospital in Erbil. Twelve patients with complex soft tissue thumb defects exposing vital structures were included and treated with first dorsal metacarpal artery island flaps. **Results**: Twelve patients participated in the study. Their mean age (SD) was 33.7 (14) years, with an age range of 9-57 years. The majority (75%) were males. Nine flaps survived, two cases experienced partial necrosis, and one case resulted in total loss. Overall, sensory function of the flap area was satisfactory for 8 patients (66.6%) and unsatisfactory for 4 cases (33.3%). **Conclusion**: The first dorsal metacarpal perforator artery flap is versatile, with a reliable vascular supply, providing satisfactory functional and aesthetic restoration. This makes it an appealing choice for addressing various soft tissue defects.

Keywords: FDMA flap, thumb reconstruction, patient satisfaction, sensory function

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INTRODUCTION

Extensive defects of the thumb, with exposure of tendon or bone, are challenging reconstructive problems.[1,2]

The first dorsal metacarpal artery (FDMA) family of flaps includes various pedicle flaps that rely on the FDMA, alone or in combination with the second dorsal metacarpal artery. These flaps include island flaps, racquet flaps, and bilobed flaps, among others.[2]

The FDMA flap was originally reported by Hilgenfeldt in 1961 and Hollevich in 1963 as a peninsular flap with conservation of the skin over the pedicle. An island flap was first described by Foucher and Braun in 1979, who demonstrated that a sensate skin island flap could be dissected from the dorsum of the index finger, relying on the FDMA and an integrated sensory branch of the superficial radial nerve.[3]

The palmar surface of the hand consists of highly specialized skin with unique structural characteristics, good sensitivity, and the ability to restore skin stability to resist friction. These features must be considered in

reconstruction. Previous articles have reported methods such as skin grafts, cross-finger flaps, local flap transfers, and free flaps. Although these approaches can meet wound coverage requirements, none are perfect.[4]

The aim of our study is to evaluate the versatility, applicability, and outcomes of the first dorsal metacarpal artery flap.

MATERIALS AND METHODS

This prospective case series study was conducted over approximately four years (June 2017–September 2022) in the Plastic Surgery Department at Rizgary Teaching Hospital in Erbil. Inclusion criteria were any patient with complex soft tissue thumb defects that were included and treated with first dorsal metacarpal artery island flaps. All patients were operated on as emergency and tertiary hospital cases.

Verbal informed consent was obtained from all patients (or their parents for those under 18 years old) after a detailed description of the procedure.

Operative technique

The patient was placed in a supine position, and the arm was positioned on a table. The operation was performed under general anesthesia in all cases. The upper limb and the contralateral groin were prepared and draped. A tourniquet (100 mmHg above systolic pressure) was applied to the upper arm. After debridement of the defect, the skin flap was marked.

The flap was harvested from the dorsal aspect of the index finger, including the first dorsal metacarpal artery and a branch of the superficial radial nerve (sensate flap) as a pedicle flap. The largest size of the skin island consisted of the dorsal skin of the proximal and along the mid-radial and mid-ulnar lines of the index finger, preserving the skin over proximal interphalangeal joint and metacarpophalangeal joint. To decrease donor site morbidity, the dorsal skin of the metacarpophalangeal joint and proximal joint was preserved. Flap dissection was performed from distal to proximal and radial to ulnar, leaving the paratenon over the extensor tendon for take at the donor site. Between the bases of the first and second metacarpal bones, the tip of the triangular first web space can be palpated, referred to as the most proximal point of the pedicle dissection. A key point in the dissection is that at radial aspect of the extensor hood of the metacarpophalangeal joint, any small arterial branches piercing the aponeurosis of the first dorsal interosseous muscle were carefully ligated or coagulated to maximize the possible length of the flap. The pedicle includes the fascia of the first dorsal interosseous muscle, the dorsal veins, and the sensory branch of the radial nerve. After raising the flap, the tourniquet was released, and vascular flow of the flap was evaluated. The flap was then transposed to the defect. Two different techniques were used: either an island flap with no skin over the pedicle or small strip of skin few millimeters over the pedicle.

The donor site was grafted with a full-thickness skin graft harvested from the groin in all patients. After suturing and graft dressing were complete, a protective splint was applied.

The hand and fingers were immobilized in a neutral position with dorsal splint for two weeks to ensure proper graft take. All patients were discharged one day post-operation. Sutures were removed in the second week post-operatively.

Patients were instructed to come for post-operative follow-up every month for one year, then every three months for the next year.

All patients were assessed for early post-operative complications such as flap necrosis, infection, hematoma, graft loss, and wound dehiscence.

Cortical reorientation was tested by asking the patient whether the needle prick stimulation was coming from the thumb or the index after one year and two years.

Patient subjective satisfaction was evaluated regarding the functional recovery and aesthetic appearance of the flap and donor site.

Data were entered into the Statistical Package for Social Sciences (SPSS, version 26). Numerical variables were presented as means and standard deviations (SDs), while categorical variables were presented as frequencies and percentages.

RESULTS

Twelve patients participated in the study. Their mean age (SD) was 33.7 (14.0) years, the median was 32 years, and the age range was 9-57 years. The largest proportion (33.3%) of the sample was aged ≥ 40 years, and the majority (75%) were males (Table 1).

Table 1: Age and Sex Distribution.		
	Number	Percentage
Age (years)		
< 20	2	16.7%
20-29	3	25.0%
30-39	3	25.0%
≥ 40	4	33.3%
Mean (SD)	33.7	14.0%
Sex		
Male	9	75.0%
Female	3	25.0%
Total	12	100.0%

The most common indication for the operation was post-traumatic injury (83.3%), and the dominant hand was affected in 58.3% of patients. The most common site of injury was the volar thumb (58.3%). The flap was used for immediate reconstruction in ten (83.3%) patients and for delayed reconstruction in two (16.7%) patients (Table 2).

Table 2: Surgical History.		
	Number	Percentage
Indications for the Operation		
Post-traumatic	10	83.3%
Replantation failure	1	8.3%
Snake bite and osteomyelitis	1	8.3%
Dominant Hand		
Affected	7	58.3%
Not affected	5	41.7%
Site of the Injury		
Volar thumb	7	58.3%
Thumb tip	1	8.3%
IP amputation	1	8.3%
Dorsal IP joint	1	8.3%
Dorsal thumb	1	8.3%
Fingertip of thumb	1	8.3%
Reconstruction		
Immediate	10	83.3%
Delayed	2	16.7%
Total	12	100.0%

Two patients (16.7%) developed partial necrosis, one (8.3%) experienced total loss, and another one (8.3%) developed pain at the MP joint (Table 3).
Eight patients (66.6%) were generally satisfied with the flap.

Table 3: Complications.		
	Number	Percentage
None		
Partial necrosis	8	66.7%
Total loss	2	16.7%
Pain at the MP joint	1	8.3%
Total	1	8.3%

Case 1

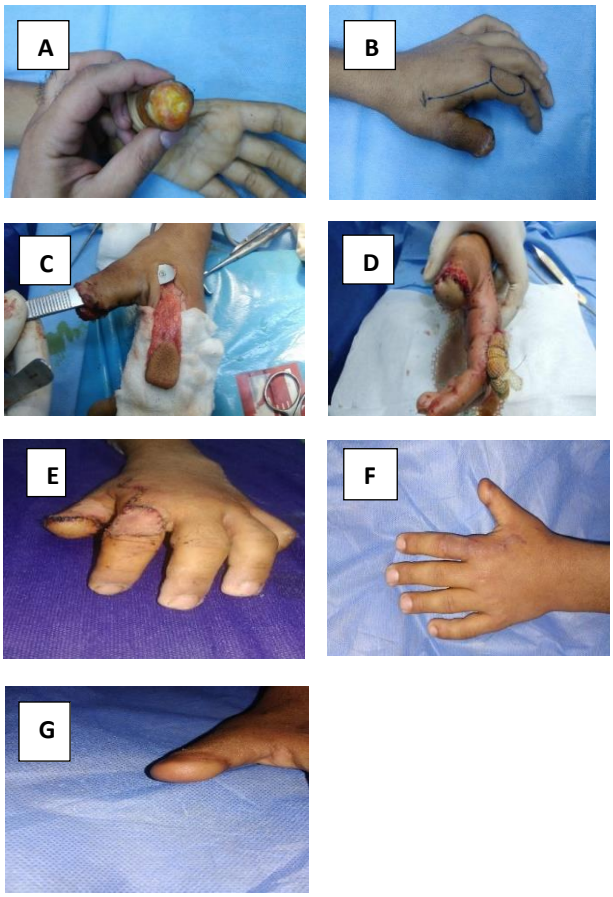

Figure 1: A 35-year-old man with a traumatic thumb tip injury (distal fingertip amputation) reconstructed with first dorsal metacarpal artery perforator flap. A, preoperative thumb tip defect. B, marking the first dorsal metacarpal artery perforator flap from the dorsal index finger. C, island-type fasciocutaneous flap raised, tunnel prepared in the thumb. D, flap inset done with donor site covered by full-thickness skin graft taken from the groin and tie-over done for the skin graft. E,

result after 3 weeks shows survived flap and skin graft. F, G, shows result after 6 months of follow-up.

Case 2

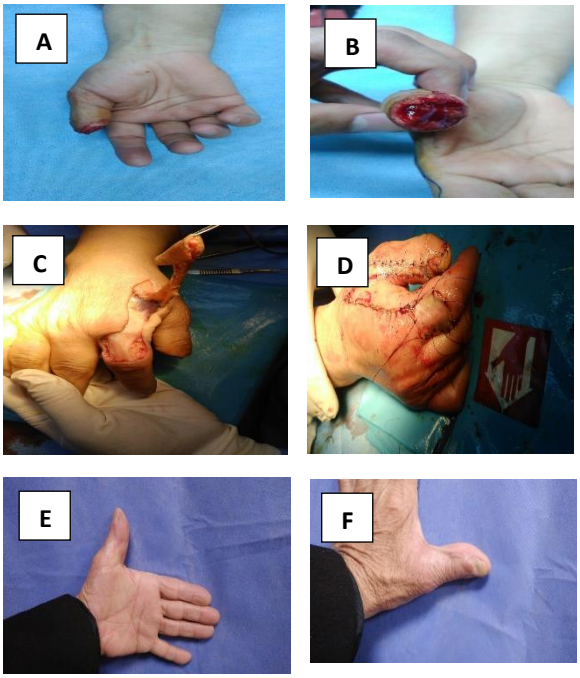

Figure 2: A 40-year-old female with a traumatic thumb amputation of partial distal phalanx planned for coverage by first dorsal metacarpal artery flap. A, B, preoperative defect shows exposure of bone. C, fasciocutaneous flap raised from dorsal index, with preservation of paratenon of extensor expansion of index finger. D, inset of flap done to the distal thumb phalanx with coverage of the donor site by a full thickness skin graft taken from the groin. E, F, show results after 3 months from the operation.

Case 3

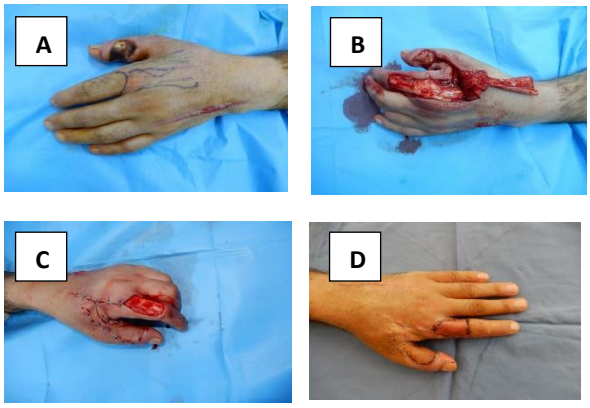

Figure 3: A 36-year-old male with a traumatic thumb injury and exposure of middle phalanx bone and interphalangeal joint planned for coverage by a first dorsal metacarpal artery flap. A, defect of thumb with bone and joint exposure, marking for the first dorsal metacarpal artery flap drawn. B, fasciocutaneous flap raised with preservation of the paratenon over extensor tendon of index finger. C, inset of flap done. D, well-healed result after one month from operation.

Case 4

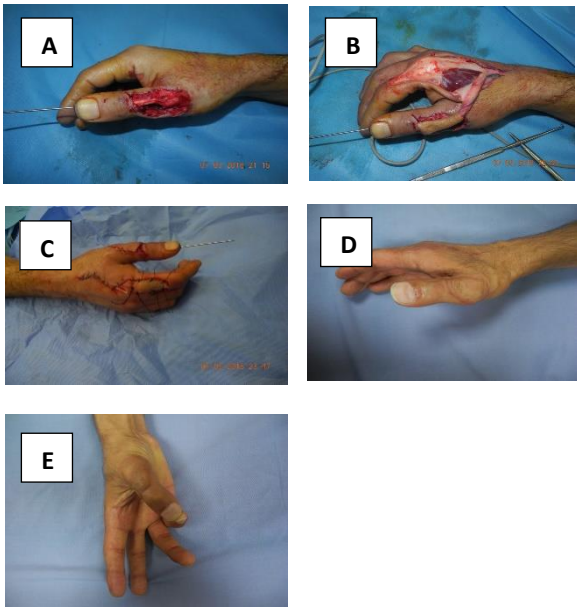

Figure 4: A 42-year-old man with a traumatic dorsal proximal thumb injury with exposure of tendon and bone planned for coverage with first dorsal metacarpal artery flap. A, proximal dorsal thumb defect with

exposure of tendon and bone. B, island fasciocutaneous flap raised with the preservation of the paratenon. C, inset of flap to the defect and closure of the donor site with a full thickness skin graft taken from the groin. D, E, show results after 3 months from the operation, with well-healed, fully functional fingers.

DISCUSSION

The first dorsal metacarpal perforator artery flap (FDMCAF) is a widely employed surgical technique in reconstructive hand surgery due to its versatility and effectiveness in treating soft tissue defects. This flap, based on the dorsal branch of the radial artery, has gained significant attention in recent years for its potential to address various types of defects, including traumatic injuries, congenital malformations, and oncological resections.[5]

The FDMCAF procedure involves dissecting the dorsal branch of the radial artery, along with its accompanying veins and nerves, and transferring it as a sensate pedicled flap to cover the recipient site. The flap's vascular supply is maintained through meticulous dissection under loupe magnification, ensuring adequate blood flow and viability. This approach offers advantages such as reduced donor site morbidity, reliable blood supply, and minimal disruption to surrounding structures.[6]

Several studies have demonstrated the utility of the FDMCAF in different clinical scenarios. In reconstructing thumb defects that usually require a durable and sensate flap, the FDMCAF has proven to be an excellent option, allowing for functional and aesthetic restoration. In comparison to other options for thumb reconstruction, such as the Moberg flap, which is reserved for lesions smaller than 1.5 cm and may leave the patient with interphalangeal joint contracture, or the cross-finger flap, which requires multiple operations and is not a sensate flap, and may leave thumb and index finger stiff due to prolonged immobilization,[4] the FDMCAF stands out. Additionally, the heterodigital neurovascular island (Littler) flap, while providing a durable and sensate flap to the thumb, is associated with donor site morbidity, long and significant palmar dissection with poor cortical relearning.[4,5]

According to Chen et al.,[5] the FDMCAF demonstrated favorable outcomes in thumb reconstruction, with improved grip strength and range of motion observed in their patient cohort. Additionally, the FDMCAF has been explored in managing soft tissue defects of the fingers. Li et al.[6] reported successful reconstruction of finger pulp defects using this flap, highlighting its ability to preserve tactile sensitivity while providing adequate soft tissue coverage. Furthermore, the FDMCAF's applicability in addressing complex hand defects has been acknowledged by studies such as the work by Smith et al.,[7] which showcased its role in cases of hand trauma involving composite tissue loss.

We have concluded that there is a satisfactory result in regaining functional and aesthetic outcomes (67.7%), which is comparable to the results by Ghoraba et al.,[3] who concluded that the majority of their patients gained satisfaction regarding aesthetic and functional outcomes. Aditionally, Trankle et al.[8] reported 88% satisfaction with the outcome, and Kola et al.[9] showed 93% satisfaction from their outcome. Ege et al.[10] indicated that the aesthetic outcome is the major restriction of this flap, as we had a 33.3% rate of non-satisfaction, mainly from an aesthetic point view. Regarding the donor site, we had a satisfactory outcome despite skin graft and scar in the area, which is also pointed out by Ractcliffe et al. and Cil et al.,[11,12] who reported no donor site morbidity.

It is worth noting that the success of the FDMCAF procedure relies on a thorough understanding of hand anatomy, meticulous surgical technique, and individual patient factors. While this technique offers promising results, careful patient selection and evaluation are imperative to optimize outcomes and mitigate potential complications.

CONCLUSIONS

The first dorsal metacarpal artery flap has emerged as a valuable tool in reconstructive hand surgery. Its versatility, reliable vascular supply, and satisfaction regarding functional and aesthetic restoration make it an appealing choice for addressing various soft tissue defects.

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