

1ST DORSAL METACARPAL ARTERY FLAP: A RELIABLE OPTION TO RECONSTRUCT THE SOFT TISSUE DEFECT OF THE THUMB**Dr. Hasan Nazir Uddin^{*1}, Dr. Sharmin Akter Sumi², Dr. Md. Joynal Abeden³, Dr. Md. Abul Kalam⁴ and Dr. Md. Mamun Or Rasheed⁵**¹Consultant, Plastic surgery, Al-Manar Hospital, Mohammadpur, Dhaka, Bangladesh.²Assistant Professor, Plastic Surgery, Sheikh Hasina National Institute of Burn and Plastic Surgery, Dhaka, Bangladesh.³Assistant Professor, Plastic Surgery, Department of Surgery, Jashore Medical College, Jashore, Bangladesh.⁴Professor and Director, Sheikh Hasina National Institute of Burn and Plastic Surgery Dhaka Bangladesh.⁵Assistant Professor, Department of Oncology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.***Corresponding Author: Dr. Hasan Nazir Uddin**

Consultant, Plastic surgery, Al-Manar Hospital, Mohammadpur, Dhaka, Bangladesh.

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ABSTRACT

Background: The 1st Dorsal Metacarpal Artery (FDMA) Flap or Kite flap is a proximally based island flap based on the first dorsal metacarpal artery and its veins. A branch of radial sensory nerve is incorporated in the flap to make it a sensate flap. The aim of this study was to evaluate the 30 FDMA flaps done over a period of 9 month for distal thumb soft tissue defects. **Materials and Methods:** This is an observational study carried out on 30 patients with soft tissue loss on the Thumb who presented between the time of January 2019 to September 2019 in the Department of Plastic surgery, Dhaka Medical College Hospital. A thorough history was taken from the patient and their attendants. The wounds were examined preoperatively to assess the nature, examine the underlying structure and evaluate the appropriateness of the plan. All patients had laboratory tests required for surgery under anesthesia done. **Results:** Maximum patients (15) are in the age group of 21-30 years. Mean age is 26.17. 28 cases are male and male female ratio is 14:1. Regarding the cause of injury is Burn in 16 cases and trauma in 14 Patients. The mean length of flap is 28.20 mm and width is 15.57 mm. The results in all the cases are excellent except for four cases; one of which has marginal necrosis, and the other three has epidermal necrosis which healed without any surgical intervention. The FDMA flap is a reliable flap for thumb soft tissue coverage. 1st Web space span is excellent in 29 cases. Thumb movement in IP is excellent in 70% cases and in MP 96.67% is excellent. Donor sites are cover by full thickness skin graft in 27 cases, split thickness skin graft in two cases and fillet flap from middle finger in one case without any complication. **Conclusion:** The FDMA flap is a Reliable flap to reconstruct the Soft Tissue Defect of the Thumb. The flap is sensate, durable, provides adequate soft tissue coverage.

KEYWORDS: 1st Dorsal Metacarpal Artery (FDMA), Flap, Thumb reconstruction, Sensate Flap, Island Flap for Thumb.

INTRODUCTION

The thumb contributes 60% of all human hand functions. Therefore, thumb injuries have much more significant impact on the normal daily life activities than do other digits injuries.^[1] Thumb injury is a common incident now a days due to increased frequency of machinery injury, burns and road traffic accident. However there are few other causes like household accident, excision of neoplasm or infection. Reconstruction of complex soft tissue defects of the thumb, with exposure of the underlying structures, is challenging to hand surgeons. To preserve the function of the thumb, always it requires coverage with pliable, durable and sensate skin. Limited local soft tissue availability makes the requirement difficult.^[2] The coverage options are variable ranging from secondary healing to free flap depending upon the

amount and type of tissue lost. Conventionally, these defects can be reconstructed by skin graft, V-Y advancement flap,^[3] Moberg advancement flap,^[1,4] cross-finger flap,^[2,5] Littler's neurovascular island flap,^[1,6] first dorsal metacarpal artery (FDMA) flap,^[1,2,3,7] reversed radial forearm flap,^[8,9] distant flaps and various free flaps.^[1,4] Skin grafting is not suitable when bone or tendon is exposed. V-Y advancement flap is applicable for small defect like finger tip injury. Moberg flap is suitable for limited area of soft tissue defect in expense of extension of IP joint. Cross finger flap requires a staged approach and has limitations including a considerable period of immobilization, risk of joint stiffness and a limited arc of flap transposition.^[10] With the Neurovascular island flap, two major digital arteries are sacrificed and extensive digital and palmar dissection

is needed.^[10] Microvascular transfer of a free flap like partial toe transfer, ADP free flap, free groin flap can be used but such a technique requires microsurgical experience and prolonged operative time.^[4]

Among these flaps, FDMA flap is a reliable flap for covering thumb defects on dorsal or volar aspects. The flap can be made sensate by including a branch of the superficial radial nerve. Hence it is a single stage surgery with less donor site morbidity.

FDMA flap was first reported by Hilgenfeldt in 1961 and Hollevich in 1963 as a peninsular flap with preservation of the skin over the pedicle.^[11] An island flap was demonstrated for the first time by Foucher and Braun in 1979, who described that a sensate skin island flap could be harvested from the dorsum of the index finger, based on the 1st dorsal metacarpal artery and incorporated a sensory branch of the superficial radial nerve.^[6] The FDMA flap comes into play in thumb reconstruction as there is deficiency of locally available tissue and tendon or bone is exposed. The main goal of thumb reconstruction is preservation of length and sensibility.

1st dorsal metacarpal artery (FDMA) flap, a sensate skin island harvested from the dorsum of the index finger, based on the 1st dorsal metacarpal artery and incorporated a sensory branch of the superficial radial nerve. The FDMA flap can extend proximally to the MP joint and distally to the PIP joint. If the flap is extended beyond the PIP joint, then its distal part is doubtful.^[7] An islanded sensory FDMA flap has a pedicle length of around 7 cm, thus it allows for wide arc of rotation and resurfacing soft tissue defects of the thumb. Compared to hetero digital island flap for resurfacing thumb defects the FDMA flap has negligible donor site morbidity, complete cortical reorientation and better overall hand function.^[12]

The FDMA flap has been successfully used for reconstruction of thumb soft tissue defects as it is a durable flap with a constant vascular anatomy. It can cover both the dorsal and the volar aspect with restoring the sensation and maintaining the length.

Besides, it has very few limitations like it demands high quality dissection and donor site skin grafting.

AIMS AND OBJECTIVES

The aim of this study is to implement the advantages of FDMA in soft tissue reconstruction of thumb, for which it has been termed as a reliable flap. Objectives are followings-To evaluate the clinical outcome of 1st dorsal metacarpal artery (FDMA) flap as a reliable option for reconstruct soft tissue defect of thumb, to assess the maximum dimension of flap that can be raised, observe the viability of the flap, to find out any complications and to assess the thumb function.

MATERIALS AND METHODS

This is an observational study carried out on 30 patients with soft tissue loss on the thumb who presented between the time of January 2019 to September 2019 in the Department of Plastic surgery, Dhaka Medical College Hospital. A thorough history was taken from the patient and their attendants. The wounds were examined preoperatively to assess the nature, examine the underlying structure and evaluate the appropriateness of the plan. All patients had laboratory tests required for surgery under anesthesia done. Sample size was 30 (Thirty) cases. Sampling method was Purposive sampling. Sample population - All the patients with soft tissue defects on the thumb in the Department of Plastic Surgery, Dhaka Medical College Hospital was the study population. 30 (Thirty) patients fulfilled the inclusion criteria and were included into the study.

Inclusion criteria

1. Patients with soft tissue defect in thumb following trauma, burn and post burn deformity.
2. Patients age between 1 - 60 yrs.

Exclusion criteria

1. Patients with potential injuries to the pedicle of donor site due to previous trauma or surgery.
2. Patients with significant major co-morbid medical conditions.
3. Patients with poly trauma and other life threatening injury (like head injury) that causes delayed resuscitation.

OPERATIONAL DEFINITION

Dimension of wound

Measured by measurement of length and width of the wound by scale in mm.

Length means maximum dimension at long axis of wound.

Width means maximum dimension at short axis of wound.

Flap Survivability

- No loss of flap
- Epidermal flap loss - Only epidermis of the flap loss
- Marginal flap loss - Upto 1 mm of marginal flap loss.
- Partial flap loss - Upto one third of the flap loss.
- Subtotal flap loss - Upto two third flap loss.
- Complete flap loss – whole portion of the flap loss.
- Wound Dehiscence - Is the partial or total disruption of any or all layers of the operative wound.

FLAP OUTCOME

- **Excellent**
- No flap loss.
- No Donor site morbidity.
- Functional outcome good.

- **Good**
- Marginal flap loss/Epidermal necrosis managed by secondary healing.
- <10% graft loss managed by secondary healing.
- Functional outcome satisfactory.
- **Poor**
- Complete/ Partial flap loss alternative procedure needed.
- 10%-100% graft loss managed by STSG.
- Functional outcome poor.

Surgical Technique

Patient was under regional or general anesthesia. Under tourniquet control with good illumination and magnification wound excision done.

Then the wound dimension was measured and flap was marked on the dorsum of index finger. Flap is marked few millimeters larger than that of the wound. The distal limits were the proximal interphalangeal (PIP) joints and the proximal limits were usually the metacarpophalangeal Joint but in 5 cases it cross metacarpophalangeal Joint. As the FDMA is a constant artery, Doppler was not used. The tip of the first web space can be palpated between the bases of the first and the second metacarpal bone, which denotes the proximal most point of pedicle dissection and hence the pivot point.



Figure 1.1: Wound and flap marking.

Under tourniquet, the flap was raised in the loose areolar plane above the extensor tendon paratenon; Great care was taken to preserve the paratenon to ensure later skin graft take and the free gliding of the tendon. The flap dissection was started from distal to proximal. The fascia pedicle will be taken through a zigzag or lazy s-shaped skin incision and subdermal dissection along the radial border of the MP joint toward the pivot point; thus, the maximal potential length of the flap pedicle can be achieved, allowing it to reach the thumb tip without tension. The pedicle includes 1st dorsal metacarpal artery, epimysium of the first dorsal interosseous muscle, the dorsal veins, and the sensory branch of the radial nerve. Although the ulnar branch of the FDMA is tiny and courses deeply within the musculo-osseous groove, no attempt is made to visualize the artery. Instead, safe dissection can be achieved by including the epimysium of the first dorsal interosseous muscle. Then an open tunnel was made from the proximal part of the pedicle up to the wound margin. It should be ensure that the tunnel should be adequate enough to transfer the pedicle and tension less closer of the tunnel.



Figure 1.2: Flap raised.

The tourniquet was released and the flap vascularity assessed. The flap was then passed through the open tunnel to the defect area and sutured without any tension. Then the tunnel was closed without any tension. The

donor sites were covered by full thickness skin grafts in maximum case, in two cases by split thickness skin graft and in one case by fillet flap from the middle finger.



Figure 1.3: Flap coverage done.

The hand and the fingers were immobilized in neutral position with dorsal splint for 14 days to ensure proper graft take.

Follow-up: Patient was followed up to the 1st POD, 5th POD, 14th POD and 21st POD and 30th POD. Flap was evaluated at that time according to the preset criteria.

Post-operative care: 1st dressing was done on 5th POD. Stitches removed on 14th to 21st POD.



Figure 1.5: 21st POD after stitch off



Figure 1.6: 30th POD

RESULTS

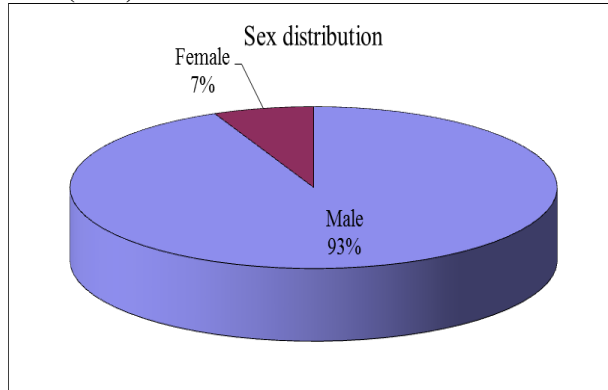
Table I: Age group distribution of the study cases (n-30).

Age group	Frequency (n)	Percentage (%)
01 – 10 years	03	10.00%
11 – 20 years	05	16.67%
21 – 30 years	15	50.00%
31 – 40 years	04	13.34%
41 – 50 years	03	10.00%
Mean age (±SD): 26.17 (±1.027) Range: (08 - 48)	30	100%

Table 1: shows age group distribution of the study population. The maximum patient 15 belongs to age

group 21 - 30 years which was about 50% of the study population.

Sex distribution of the study cases (n-30)



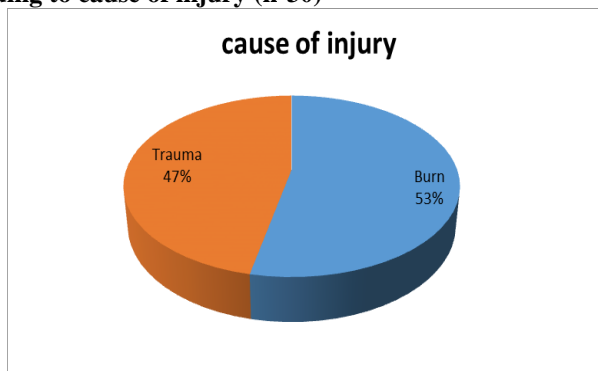
Pie chart 1: Shows sex distribution of the study population. Out of 30 patients 28 (93.33%) were male and rest 02 (6.67%) were female. Male female ratio: 14:1.

Table II: Occupational status of the study cases (n-30).

Occupational status	Frequency (n)	Percentage (%)
Day labor	10	33.34%
Housewife	02	6.67%
Service Holder	08	26.67%
Student	09	30.00%
Businessman	01	3.33%
Total	30	100 %

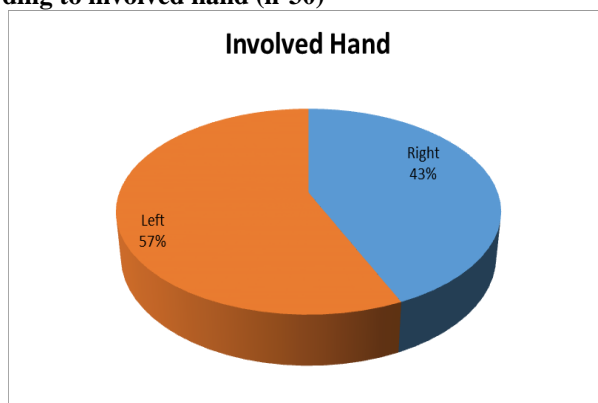
Table II: shows occupational distribution of the study population. Maximum suffered group were the day labor 10 (33.34%) and student 09 (30.00%).

Distribution of sample according to cause of injury (n-30)



Pie Chart II: shows Causes of the injury was burn in Maximum 16 (53.33%) cases.

Distribution of patients according to involved hand (n-30)



Pie Chart III: shows among 30 cases, 13 (43.33%) cases were done over wound of right hand and 17 (56.67%) cases were done over wound of left hand.

Table III: Distribution of patients according to involved area of thumb (n-30).

Location of wound	Frequency (n)	Percentage (%)
Dorsum	05	16.67%
Volar	13	43.33%
Medial	05	16.67%
Lateral	01	3.33%
Complex	06	20.00%
Total	30	100%

Table III shows among 30 cases, 13 (43.33%) cases sustained wound over volar aspect of thumb and 06 (20.00%) cases had complex defect in thumb.

Table IV: Exposed vital structure among study cases (n-30).

Type of exposed structures	Frequency (n)	Percentage (%)
Bone	07	23.33%
Tendon	06	20.00%
Both bone and tendon	04	13.33%
Both bone and implant	01	3.33%
No structure exposed	12	40.00%
Total	30	100%

Table IV shows out of 30 cases, 07 (23.33%) cases had exposed bone and 06 (20.00%) cases had exposed tendon on the floor of wound.

Table V: Per-operative dimension of the soft tissue defect after excision among study cases (n-30).

Dimension of the Defect	Variables (mm)	Frequency (n)	Percentages (%)	Mean \pm SD (mm)
Length of defect	11-25	17	43.48%	27.10 \pm 10.35
	26-40	09	43.48%	
	>40	04	4.35%	
Width of defect	6-15	15	30.43%	15.43 \pm 5.21
	16-25	14	39.13%	
	>25	01	26.09%	

Table V: shows that Maximum length of the soft tissue defect was 50 mm and minimum length 12 mm, mean length 27.10 (\pm 10.35). The Maximum width was 30 mm and minimum width 7 mm, Mean width 15.43 (\pm 5.21)

Table VI: Dimension of the flap among study cases (n-30).

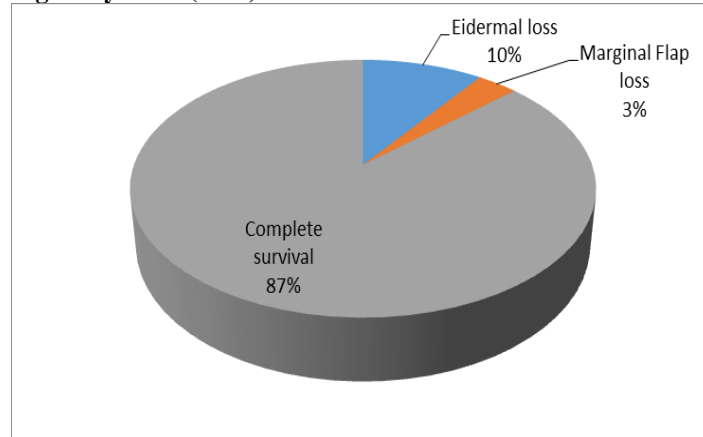
Dimension of the Flap	Variables (mm)	Frequency (n)	Percentages (%)	Mean \pm SD (mm)
Length of flap	11-25	17	43.48%	28.20 (\pm 9.69)
	26-40	09	43.48%	
	>40	04	4.35%	
Width of Flap	6-15	15	30.43%	15.57 (\pm 4.67)
	16-25	14	39.13%	
	>25	01	26.09%	

Table VI: shows the size of the flap. The maximum length of the flap was 52 mm and minimum was 14 mm, with mean length 28.20 (\pm 9.69). The maximum width of the wound was 25 mm and minimum was 8 mm with mean width 15.57 (\pm 4.67).

Table-VII: Method of donor site closure of FDMA flap among study cases (n-30)

Method of donor site closure	Frequency (n)	Percentage (%)
STSG	02	6.67%
FTSG	27	90.00%
Fillet	01	3.33%
Total	30	100%

Table VII shows donor site of maximum 27 (90.00%) cases were covered with FTSG.

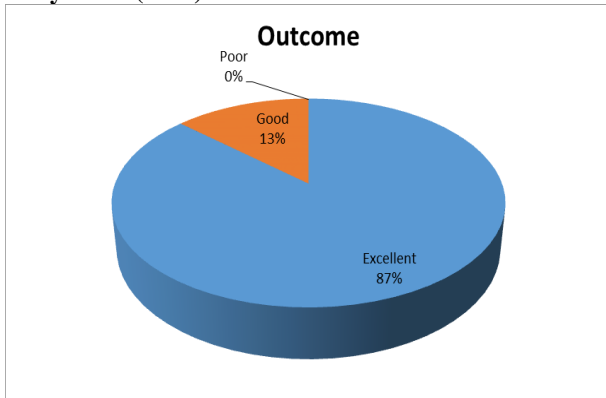
Overall Flap survival among study cases (n-30)

Pie Chart IV: shows among 30 cases, 04 cases had different types of complication shown in table VIII. There were epidermal flap loss in 03 (10%) cases and 01 case (3.33%) had marginal flap loss.

Table VIII: Management of Postoperative Complications among study cases (n-30).

Case no.	Post-operative complications	Management
Case - 10	Marginal flap loss	Conservative management
Case - 16	Epidermal loss	Conservative management
Case - 20	Epidermal loss	Conservative management
Case - 22	Epidermal loss	Conservative management

Table VIII shows the description of the management of complications of the 04 cases which had post-operative complications.

Final Outcome of flap based on preset criteria among study cases (n-30)

Pie Chart V: shows the outcome of flap according to preset criteria. 26 (86.67%) cases were very good and 04 (13.33%) cases were good.

DISCUSSION

The thumb is used in almost all human hand functions. Therefore, thumb injuries have much more significant impact on the normal daily life activities than do other digits injuries.^[2] Reconstruction of complex soft tissue defects of the thumb, with exposure of the underlying structures, is challenging to hand surgeons due to limited local soft tissue availability and the requirements for pliable, durable and sensate skin coverage to preserve the thumb function which is of paramount value to the usefulness of the hand.^[9] This study included 30 cases. The mean age of total cases was 26.16 years (age range:

08- 48 years). In a previous study Cheng C et al study in 2004, the age range was 20-56 years and average age was 33 years. In the study of Waheduzzaman et al the mean age was 26.23(SD±8.78) year.^[17]

Among 30 cases, 28 (60.87%) were Male and 02 (39.13%) were Female. Male female ratio was in this study 14:1. In a study of Samir et al, 2018 Male and female ratio 6.5:1.^[12] Mahesh AT et al, (2016) 5 were male and 3 were female.^[14,16] Waheduzzaman et al, shows out of 31 patients 28 were male and 3 were female; male female ratio is 9:1.^[17] Among 30 cases, 10(33.34%) were day labor, 09 (30.00%) were student. They were followed by service holder 08 (26.67%), businessman 04 (17.39%) and 02 (6.67%) were housewife. But occupation was not included in any other study.

In this study, burn was the cause of defect in maximum cases 16 (53.33%) followed by trauma 14 (46.67%). The type of burn was electric burn in 15 cases and flame burn in one case. In the study of Waheduzzaman et al, most common cause of injury was electric burn, 24 (77.4%), next was due to machinery injury 6 (19.4%), only one case was due to wax burn.. In the study of Thomas Muyldermans et al 4 patients presented with trauma, 2 patients with defects after tumor resection, and one patient with infection of the thumb.^[13] The most common cause due to electric burn among our study population indicates their unprotected nature in their working environment and as electric burn causes deep burn with exposure of tendon or bone so they needed flap cover for their reconstruction and was included in our study.

In this study, Left hand was involved hand in maximum 17(56.67%) cases. Regarding the site volar aspect of thumb was the affected area in 13 cases, followed by dorsum and lateral. The number was 05 (16.67%) in both sites; Most of the injury occurred on thumb of dominant hand, 19 (61.3%) compared to not non-dominant hand, 12 (38.7%) and most of the patient was right hand dominant, 27(87.1%). In the study of Thomas Muyldermans et al dominant hand in 6 patients among 7 patients and all are volar defect.^[13]

In this study flaps were transferred through open subcutaneous tunnel to prevent any kind of external pressure on pedicle from tissue edema and tightness. In Samir et al study, the flap was transferred through a subcutaneous tunnel into the defect of the thumb by gentle traction.^[12] The tunnel was tight in seven (46.7%) patients and had to be laid open then sutured primarily after flap in setting among the fifteen patients. The flap was then passed through a subcutaneous tunnel to the defect area and sutured. thumb defect was left open for monitoring. The donor site was grafted over the dorsum of the proximal phalanx index finger and the rat tail defect over the dorsum of the second metacarpal was closed primarily.^[9]

Among 30 patients, bone exposed in 7 patients, tendon exposed in 6 patients, both bone and tendon exposed in 4 patients, implant exposed in 1 patient and no vital structure exposed in case of 12 patients. Among this 12 patients 7 patients had volar palp defect and 5 over joint so flap coverage done. In the study Ibrahim Ahmed et al, out of 23 patients, 18 had both exposed tendons and bones while 5 had exposed tendons only.^[16] In the study of Waheduzzaman et al, exposed bone 12 (38.7%) cases, exposed tendon 9 (29%) cases, pulp 7(22.6%) cases, stump cover 2 (6.5%) cases, exposed joint 1 (3.2%) cases.^[17]

In this study, defects mean length was 27.1 (12-50) mm and mean width is 15.43 (7-30) mm. The dimensions of the flap mean length is 28.2 mm (14 mm - 52 mm) and mean width is 15.57 mm (8 mm -25 mm). In the study of Shun-Cheng et al, flap size ranged from 3 x 1.5 cm to 5 x 3 cm.^[7] In the study of Samir et al, the mean flap size was 33.3×17.7 mm.^[9] In the study of Waheduzzaman et al, mean flap length was 35.25 mm and breadth was 28.21mm.^[17]

Out of 30 cases, flap donor site were covered by STSG in two cases. FTSG was done in 28 cases taken from arm or wrist. In Samir et al, all cases were covered by FTSG taken from groin^[12] and Waheduzzaman et al, all 31 donor site covered by FTSG.^[17] There was no complication of donor site observed. All skin grafts take 100% and the fillet flap survived completely.

Regarding outcome of the study, according to pre-set criteria among 30 cases, 26 (86.67%) cases were excellent, 04 (13.33%) cases were good. There was no

case of satisfactory or poor outcome according to pre-set criteria. Overall post-operative complication rate was 13.34%. Among them, epidermal loss was found in 3 cases and marginal necrosis in one case. That may be due to the flaps were compromised due to venous congestion. Complication was found mostly on the cases of electric burn wound. All the cases were managed conservatively by secondary intension healing. Mahesh MD et al, (20014) described in their study, among the eight cases one patient had tip necrosis which was managed by secondary intension healing.^[14] Cheng et al described no flap loss or any other complication. Only complaint from the patients was graft discoloration.^[7] In the study of Waheduzzaman et al, 9 flap have minor complication with 6 flap had epidermis loss and rest 3 had marginal tip necrosis of about 1 mm which healed secondarily and did not required any further intervention.^[17]

CONCLUSION

First dorsal metacarpal artery flap offers a reliable coverage for small to moderate sized thumb defects. Moreover, it provides good functional outcomes with no donor site morbidity. It is a simple, effective and uncomplicated surgical technique.

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