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Dorsal Digital Artery Island Flap is an Effective Technique for Coverage of Finger Defect

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Abstract **Original Research Article**

Background: Reconstruction of soft tissue defects in fingers is a challenging problem and continues to evolve. A variety of flaps for reconstructing small-to-moderate defects have been described, but none is beyond drawbacks. The purpose of this study is to report and to evaluate the efficacy of the use of dorsal digital island flaps (DDIF) for the reconstruction of finger defects. ***Materials and Methods:*** The study was conducted from January 2020 to September 2021 in the Burn and Plastic Surgery Department at Rajshahi Medical College Hospital. A total of 10 DDIF, based on either proximally or distally, were done in 9 patients. Most of the causes of defects were electrical burns. All flaps survived with minimal complications to the donor finger. ***Results:*** Among 10 digits, the mean defect size was 4.24 (±2.34) cm2, ranging from 1.92 to 5.95 cm2. Defects were observed: 4 in middle fingers, 3 in thumb, 2 in ring fingers, and one in index finger. 6 fingers were in right hand. DDIF covered the defects on volar (5 cases), dorsal (4 cases), and both (1 case) surfaces. According to site, one case had defect on proximal phalanx with 3rd web space, 4 instances had on proximal phalanx, defect involving on both proximal and middle phalanx was in one case and rest 4 cases had defect on distal phalanx. Among 10 DDIF, 7 (70%) flaps were survived without any loss. Rest 3 (30%) cases had marginal necrosis (less than 2 mm loss) but did not require further procedure. ***Conclusion:*** DDIF is a reliable and effective option for finger defect coverage.

Keywords: DDIF; finger defect; donor site morbidity.

INTRODUCTION

To keep the hand's dynamicity, good covering is essential for finger defects. Reconstruction of soft tissue defects in fingers continues to be challenging [1-3]. Since, knowledge regarding vascularity of hand is enriched, local or regional flaps are becoming more preferable for the reconstructive surgeons [2, 4-10]. Dorsal digital artery island flap (DDIF) is such type of local flap for coverage of small to moderate size defect in both volar and dorsal aspect of fingers [1]. The aims of the study is to determine the effectiveness of DDIF in terms of operating time, defect size and site of fingers, viability of flap; arc of rotation, donor site complications.

MATERIAL AND METHODS

DDIF covered a total of 10 finger defects in 9 individuals. Between December 2019 and November 2021, this procedure was done in Rajshahi Medical College Hospital. 5 of the 9 patients were male and four were female, ages ranging from 10 to 56 years, with a mean (SD) age of 27.11 (±15.68) years. Most of defects (5 cases out of 9 cases) were caused by electrical burn and other 4 cases were due to Machinery and sharp cutting weapon injury. In all cases, either flexor tendons or bones (with or without interphalangeal joint) were exposed.

Vascular Anatomy

Barga- Silva *et al*., [11] showed that the position and number of dorsal branches of the digital artery proper are relatively conostant in their anatomical study. The dorsal digital arteries, which originate from the dorsal metacarpal arteries, anastomose with the vascular system at the proximal phalanx [12]. The anastomosis of the subdermal vascular networks of the branches of the dorsal artery was also demonstrated in Kostopoulos *et al*., [13] study.

The dorsal digital artery supplies blood to the proximally based DDIF, while the distally based DDIF is supplied by the subcutaneous dorsal vascular networks.

Surgical Technique

Patients under the age of 15 were operated on under general anesthesia, while those above 15 were operated on under brachial block. For both wound excision and flap harvesting, a digital tourniquet was applied in each digit. Following wound excision, flap was designed 0.2- 0.3 cm larger than the defect. Proximally based DDIF (Fig 1) was used to cover deficiencies on the proximal phalanx and proximal portion of the middle phalanx, whereas distally based DDIF (Fig 2) was used to cover abnormalities on the distal portion of the middle phalanx and the distal phalanx. Flaps were harvested at subcutaneous layer just superficial to extensor aponeurosis. For greater mobility and arc of rotation, pedicle was narrowed but not less than 1 cm. Donor site was covered with split thickness graft and splint was applied for 2 weeks.

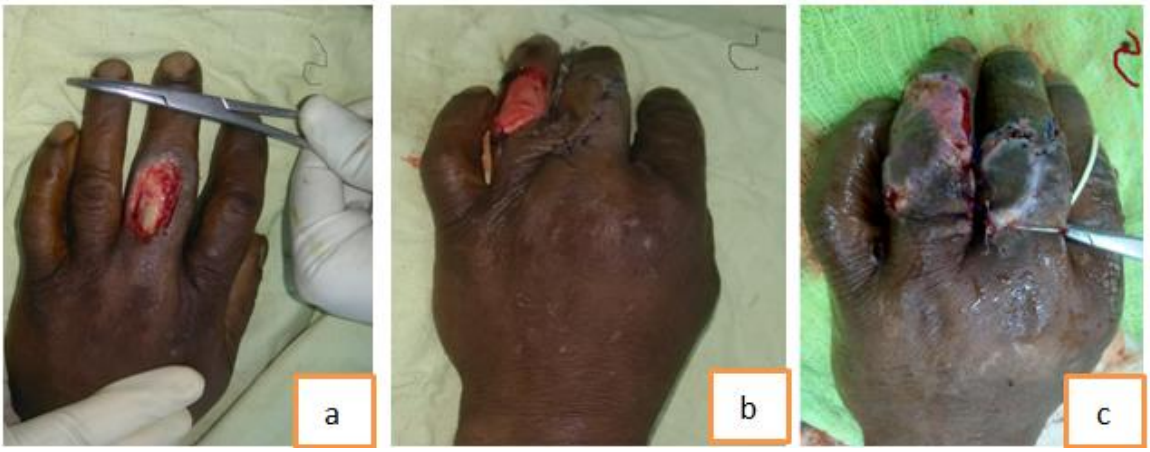

Fig 1: Proximally based DDIF a. Post infective soft tissue defect on dorsum of left middle finger with exposed proximal phalanx b. Flap harvesting from adjacent ring finger and inset to defect, c. After flap division (18 days later 1st stage)

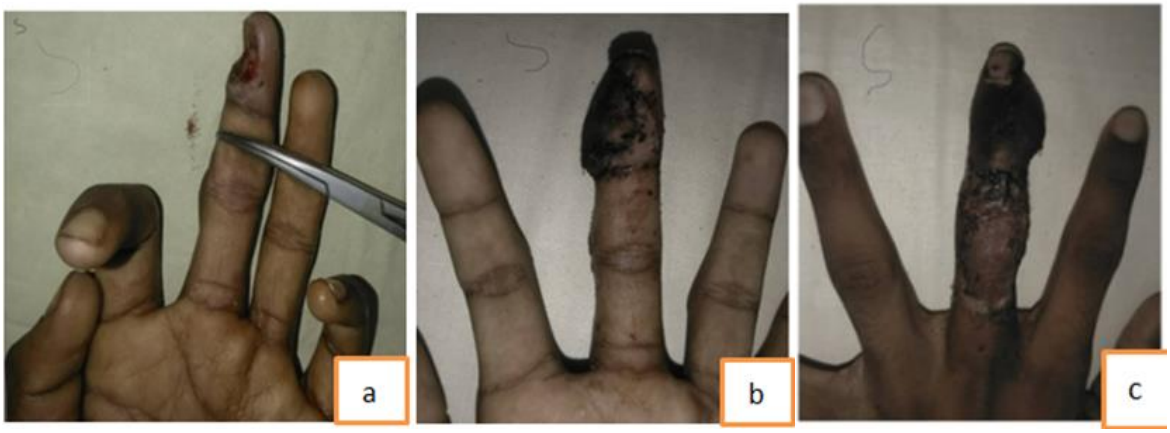

Fig 2: Distally based DDIF: a. Soft tissue defect of left middle finger on distal phalnax with exposed bone after electrical burn. Flap harvested from same finger. 14th post operative day photo b. volar aspect, c. dorsal aspect

RESULTS

Among 10 digits, the mean defect size was 4.24 (±2.34) cm^2, ranging from 1.92 to 5.95 cm^2. Defects were observed: 4 in middle fingers, 3 in thumb, 2 in ring fingers, and one in index finger. 6 fingers were in right hand. DDIF covered the defects on volar (5 cases), dorsal (4 cases), and both (1 case) surfaces. According to site, one case had defect on proximal phalanx with 3rd web space, 4 instances had on proximal phalanx, defect involving on both proximal and middle phalanx was in one case and rest 4 cases had defect on distal phalanx. Among 10 DDIF, 7 (70%) flaps were survived without any loss. Rest 3 (30%) cases had marginal necrosis (less than 2 mm loss) but did not require further procedure. Only case had wound

dehiscence which was healed secondary intention. In all cases skin graft of flap donor site was taken fully. During the follow-up phase, active movement of the donor finger's interphalangeal joints was monitored in the first and third months following the procedure. Only 10 degree restriction in flexion at PIPJ in 2 cases and 1 case developed 20 degree flexion restriction at DIPJ without deterioration of hand grip function. Table 1 showed the characteristics of flaps. In 5 score satisfaction level was measured in 3 months follow up period and was labeled as Excellent (scored 5/5); Good (scored 4/5); Fair (scored 3/5); Acceptable (scored 2/5); Poor (scored 2/5). Among 9 cases, Excellent was in 3 cases; Good in 4 cases (Fig. 3). The case summary was shown in Table 2.

Table 1: Characteristics of defects and flaps (n= 10)

Variables		
Measurement of defects	Range (cm^2)	1.92 – 5.95 cm^2
	Mean (SD)	4.24 (±2.34) cm^2
Measurement of Flaps	Range	2.94 – 7.61 cm^2
	Mean (SD)	5.22 (±2.31) cm^2
Arc of rotation	Range	45^0 – 180^0
	Mean (SD)	103^0 ($\pm 16.89^0$)
Pedicle of flap	Proximally based	6 (60%)
	Distally based	4 (40%)
Operating time	Mean (SD)	58 (± 11.66) min
Stage of surgery	Single stage	8 (80%)
	2- stage	2 (20%)

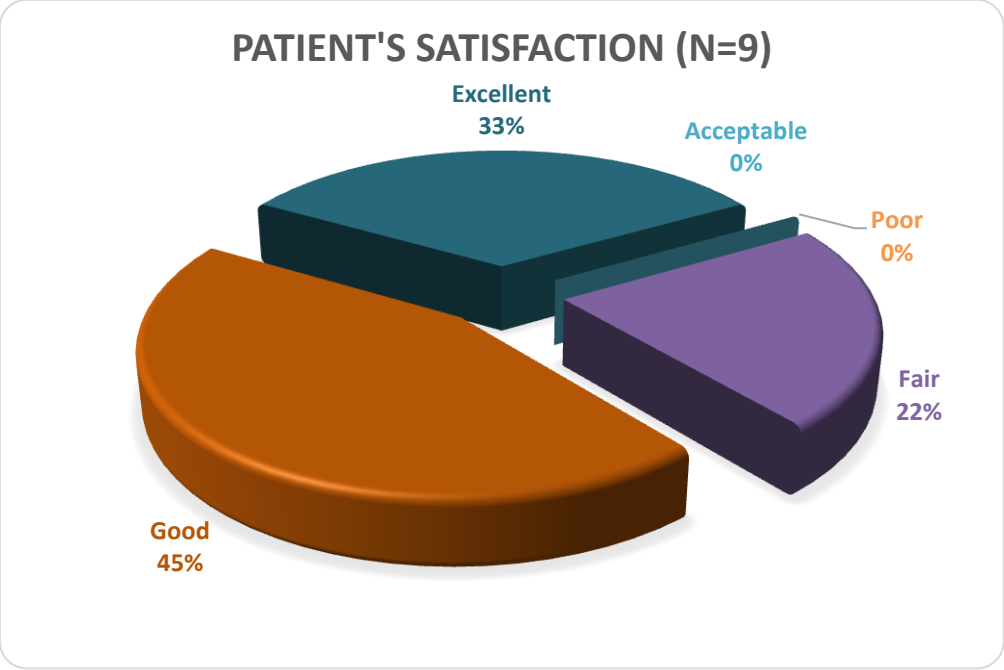

Fig 3: Level of Patients' satisfaction

Table 2: Case summary (n=09)

Case no	Age (year)	Sex	Aetiology	Side	Dorsal/ Volar	Injured Finger	Site	Exposed structure	Measurement of defect (cm2)	Flap measurement (cm2)	Pedicle	Stage of surgery	Flap survivability	Donor TAM	STSG
1	16	Male	Machinery	Left	Volar	Middle	DPX	Bone	2.1X 1.8	2.5 X 2	Distally	Single	Survive	None	No Loss
2	21	Male	Machinery	Right	Dorsum	Middle	PPX	Bone	3.2X 2.8	3.5X 2.6	Distally	2 stage	Marginal	None	No Loss
3	10	Male	Electrical Burn	Left	Volar +Dorsum	Middle	DPX radial half	DIPJ	1.6X 1.2	2.1X 1.4	Distally	Single	Survive	20 d. flexion restriction at DIPJ	No Loss
4	18	Female	Electrical Burn	Right	Volar	Ring	PPX + 3rd web	Flexor tendon	2.5X 1.7	2.8X 2	Proximally	Single	Survive	10 d. flexion restriction at PIPJ	No Loss
5	56	Female	Electrical Burn	Right	Volar	Index	PPX	Flexor tendon	2.1X 1.6	2.5X 1.8	Proximally	Single	Survive	None	No Loss
					Dorsum	Thumb	PPX	None	1.8X 0.7	2X 1	Proximally	Single	Survive	None	No Loss
6	24	Female	Sharp weapon	Left	Volar	Thumb	PPX	MCPJ	2.8X 2.4	3X 2.5	Proximally	Single	Survive	None	No Loss
7	32	Male	Sharp weapon	Right	Dorsum	Thumb	DPX	Loss of nail bed; DPX	2X 1.6	2.5X 1.5	Proximally	Single	Marginal	None	No Loss
8	49	Female	Electrical Burn	Right	Volar	Middle	PPX; MPX	flexor tendons	3.5X 1.7	3.8X 2	Proximally	2 stage	Marginal	20 PIPJ	No Loss
9	18	Male	Electrical Burn	Left	Dorsum	Ring	DPX	DIPJ	2X 1.5	2.2X 1.5	Distally	Single	Survive	None	No Loss

TAM: Total Active Movement; PPX: Proximal Phalanx; MPX: Middle Phalanx; DPX: Distal Phalanx; MCPJ: Metacarpo Phalangeal Joint; PIPJ: Proximal Interphalangeal Joint; DIPJ: Distal Interphalangeal Joint.

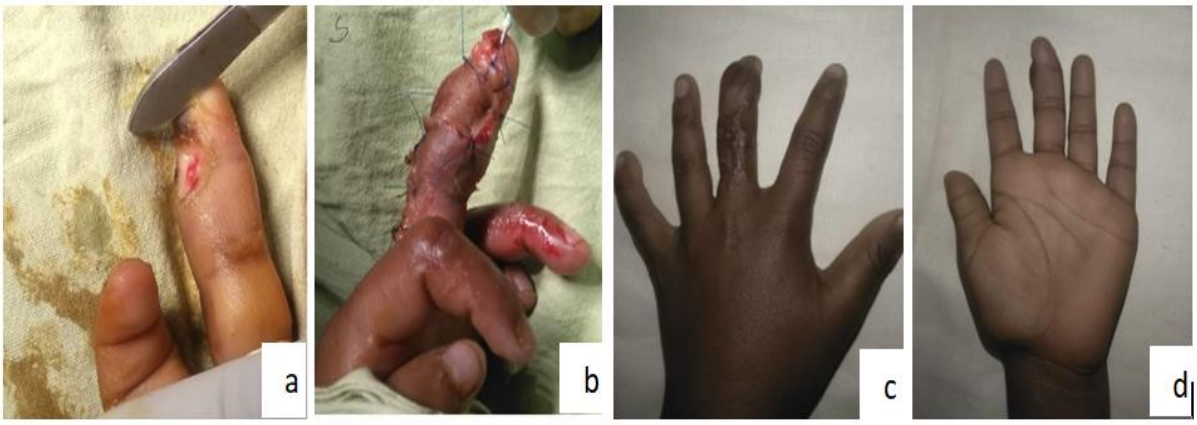

Fig 3: Case 3: a. Soft tissue defect on left middle finger with exposed distal phalngeal joint after machinery injury, b. immediate postoperative view after distally based DDIF harvesting from same finger. 6 week later flap coverage c. dorsal view d. volar view

Fig 4: Case 5: a. Post electrical burn defect on volar aspect of right index, little fingers and thumb. B. Proximally based DDIF done for index and thumb and cross finger flap for little finger. 3 months after 1st stage surgery c. volar view and d. dorsal view

DISCUSSION

Soft tissue defect coverage in the fingers is evolving [1]. A number of procedures are applicable ranging from local flaps to distant flaps for coverage. Another alternative is free flap, but it needs special instrument facility and experienced manpower. Distant (abdominal; groin) flaps are simple to harvest and do not demand the use of delicate equipment. But, keeping the hand to donor site for a certain period of time is cumbersome to both patient and surgeon. To overcome these problems, local flaps or regional flaps from hand is now increasingly preferable. DDIF is an option of local flap that may cover both volar and dorsal defects on the same or neighboring finger. Harvesting procedure is easy, not difficult like other digital perforator flaps. DDIF has wide arc of rotation even up to 180 degree to cover the defect of same fingers. Because the proximally based flap pedicle possesses a continuous dorsal digital nerve [1], these flaps are sensate and can cover the web space to the middle phalanx. In this study, distally based flaps were employed to cover the distal phalanx to the distal half of the middle phalanx. The fasciocutaneous flap pedicle was at least 1 cm wide and in distally based pedicle, narrow skin strip was retained up to circulating vessels for prevention of pressure and venous congestion. It can be applied as a single stage surgery for coverage of neighboring finger. Morbidity from active movement of a joint at the donor site is minimal. Three of the ten DDIF cases had flexion restriction of the interphalangeal joints of less than 20 degrees without impairing normal hand function. Though the above-mentioned flap can only cover small to moderate-sized finger lesions, it has several advantages such as no major artery sacrifice, ease of harvest, a wide range of arc of rotation, and the versatility to be harvested proximally or distally with minimal donor site morbidity.

CONCLUSIONS

DDIF is a reasonable option for covering small to moderate-sized defects in any finger.

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