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Original Article

Arteria Dorsalis Pedis Free Flap for Dorsal Hand Defects: A Viable Reconstructive Option

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Abstract

Background: The arteria dorsalis pedis (ADP) flap has been widely described in reconstruction of soft tissue loss over dorsum of hand. However, some details require refinement to improve functional results.

Methods: From August 2018 to July 2020, 20 patients (13 males and 7 females), mean age 29 years (range, 18-48 years) with soft tissue loss over dorsum of hand were treated with ADP Free Flap. Fasciocutaneous flaps were used for patients with only soft tissue defects. All flaps were sensate. After reconstruction of the defects, functional outcomes were evaluated with the Quick DASH scale.

Results: One flap was lost. 19 (95%) flaps survived. Average flap thickness of 4.9 mm underwent innervation by an end-to-end neurorrhaphy. On basis of methodology parameters, flap reconstruction was exhibited 65% excellent, 30% good and 05% poor. QuickDASH scale was used for motor function evaluations and the average percentage of disability was found 19.73%. Average 09 months follow up, perception of pain and touch was present in all patients. Temperature in 84.22% patients on the entire flap and two-point discrimination was showed 16.42±5.04 mm in the proximal half and 18.52±4.35 mm in the distal half of flap. No patient experienced difficulty walking.

Conclusions: Simultaneous thinning and innervation of the ADP flap led to a good functional outcome with a low percentage of disability, which could result in minor surgical procedures and better recovery of motor and sensory function.

Keywords: Soft Tissue Loss, Dorsum of Hand, Arteria Dorsalis Pedis flap, Free Flap, QuickDASH scale

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Introduction

Hand is the most familiar region of the body as it is frequently on display, rarely covered and is a source of familiarity through interpersonal communication and physical interaction.[1] Dorsum of the hand has also proved to be of value for such purposes and features that have been investigated include variation in knuckle skin crease patterns, pigmentation distribution and superficial vein patterns.[2] Traumatic soft tissue defects of hand and upper extremities are common. In UK, each year over 20% of patients attending Accident and Emergency departments have a hand injury, of which 5% will require surgery.[3] Dorsum of hand defects

following trauma, burn, infections, scar contractures and tumor excision are associated with exposure of underlying structures such as the tendons, nerves, bones, and joints [4]. Although these defects are rarely lethal, they are invariably resource demanding and a source of significant long-term disability [5]. Several reconstructive procedures have been described to cover the soft tissue loss over dorsum of hand, including skin graft, local/regional, distant flap and free flaps. In the era of microsurgery, the reconstructive elevator rather than the reconstructive ladder may be more appropriate when treating soft tissue defects of the hand. The dorsalis pedis free flap is an ideal for the reconstruction of the combined defect of the dorsal hand skin and multiple extensor tendons [6] and also attractive option for free tissue transfer because of its thinness, reliability, long vascular pedicle and also provide a gliding surface for tendons function. So, the aim of this study was to assess the survival and functional outcome of soft tissue loss over dorsum of hand by arteria dorsalis pedis free flap.

Material and Methods

This prospective observational study was conducted in the Department of Burn and Plastic Surgery, Dhaka Medical College Hospital, Dhaka from 1st August 2018 to 30th July 2020. A total number of 20 patients who presented with soft tissue defect over dorsum of hand were included in this study by inclusion and exclusion criteria. Data were collected from patients and attendants by using a pre tested and pre designed structured data collection form. All the data were checked and edited after collection. Then the data were entered into computer and statistical analysis of the results was obtained by using windows-based computer software Statistical Packages for Social Sciences (SPSS-24) (SPSS Inc., Chicago, IL, USA).

Functionality was evaluated by the Spanish validated version of the QuickDASH scale [7, 8], which assesses motor functions of the upper extremity using a simple questionnaire of 11 items, such as Jar open, Heavy household, Carrying shopping bag, Wash your back, Cut your food, Recreational activities, Social activities, Regular activities, Pain, Tingling & Sleep. Each response score from 1(no difficulty) to 5 (Unable) then these value was converted to a score of 0 to 100 using the formula described within the scale. This questionnaire was answered by the patient or, in the case of infants, a parent or guardian.

Operative technique

Allen's test was done for all patient. Arteria dorsalis pedis flap is marked on basis of dorsalis pedis first dorsal metatarsal vascular axis which was tracing by clinically and Doppler examination. Flap was designed according to the template of defect. Maximum dimension of flap was approximately 12x12 cm. Dissection begins distal to proximal, from 1st web space. The first dorsal metatarsal vessels and deep peroneal nerve were identified. Artery was divided and included in the flap. Whole flap was dissected superficial to paratenon. For sensate flap superficial peroneal nerve were incorporated with flap. After proper identification of perforators lateral dissection of flap including dorsal venous arch and long saphenous vein were included with flap. Then medial dissection, careful ligation of perforator area, extensor retinacular incision were done for proximal dissection to gain the pedicle length. Now, capillary refill and dermal bleedings were evaluated before ligation and division of the pedicle. Recipient site vessels were dissected out, while the flap was harvested allowing a two teams approach and thus saving anesthesia time. The anterior tibial artery and one of its venaecomitans were anastomosed with radial artery and one of its venaecomitans respectively. Long saphenous vein was anastomosed with cephalic/basilic vein around wrist area. 8/0 prolene was used for all anastomosis. For sensate flap the superficial peroneal nerve was anastomosed to a branch of the superficial radial nerve. Hand was kept in functional position by posterior splint. Donor site was closed by intermediate thickness skin graft. Flap was monitored according to schedule.

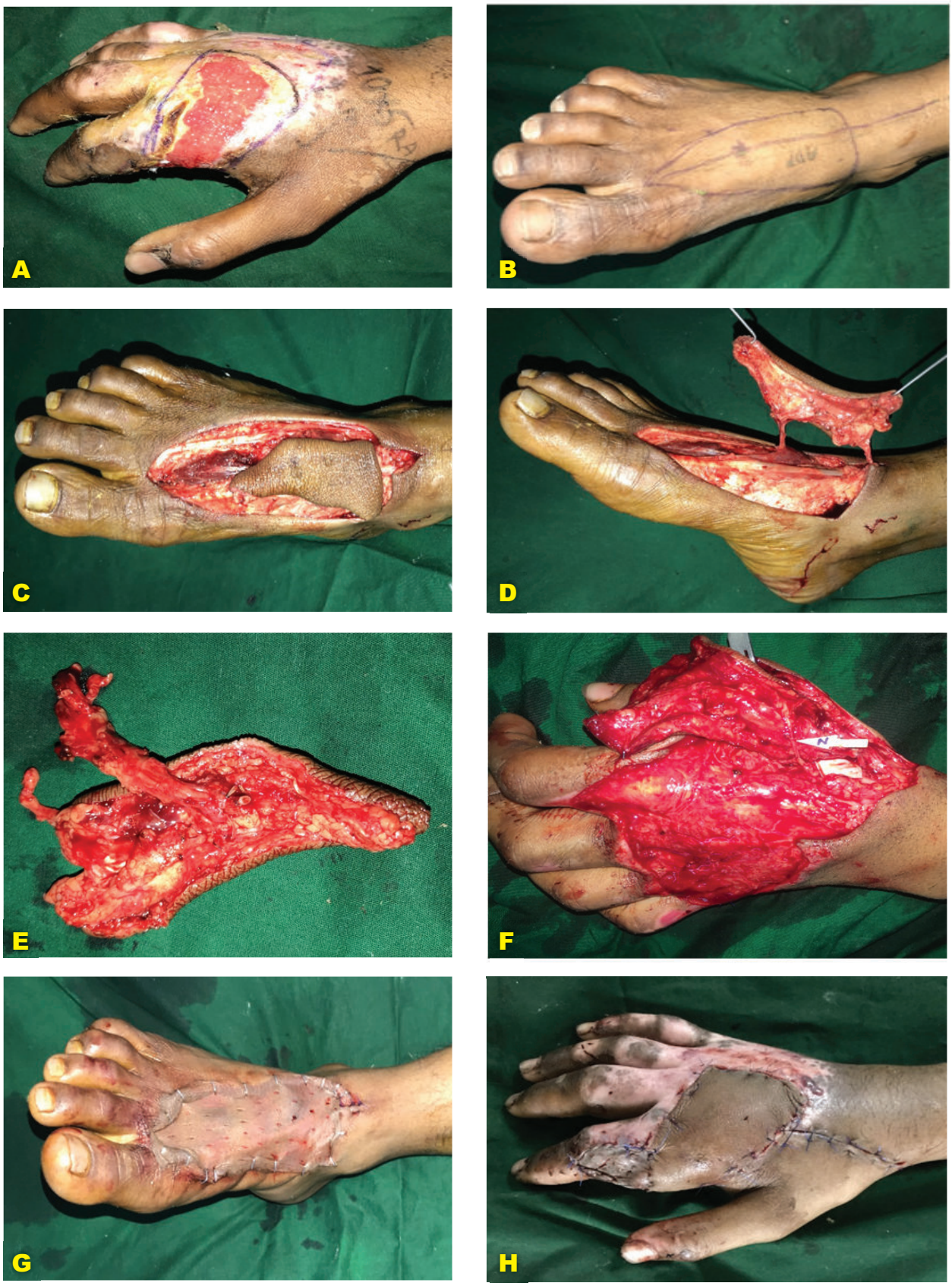

Figure 1: A. Pre-operative, B. Marking of flap, C to H. Peroperative. I to L. Postoperative follow up.

Figure 1 (cont) : I to L. Postoperative follow up.

Results

According to the patients analyzed, 13 were male (65%) and 07 were female (35%), with a mean age of 29±9.04 SD years with a range of 18 to 48 years. Etiology of injury demonstrates 13 (65%) patients were due to burn defect, 05 (25%) patients were from post-traumatic and rest of the patients are due to infection (10%). Mean transverse and longitudinal dimensions of the defects were 6.73 ±1.46 SD cm and 9.68 ±2.92 cm respectively. Largest soft tissue defect size was 15x10 cm. Mean length and width of the flap was 9.45 ±1.46 SD cm and 7.64±1.38 SD cm, respectively and mean thickness was 4.9 ±0.16 SD mm.

Table 1. *Per operative variation of vascular axis.*

Per operative findings		Frequency (n)	Percentage (%)
Dorsalis Pedis Artery Origin	Anterior Tibial Artery	19	95%
	Peroneal artery perforator	01	5%
Anastomotic site	Anatomical snuff box	17	85%
	Wrist	03	15%
Length of pedicle (cm)	Mean(±SD)	7.57±1.18	
	Range	6.5-10	

Table 2: *Outcome of reconstruction.*

Result	Criteria	Frequency (n)	Percentage (%)
Excellent	Complete flap survive Excellent flap adhesion No infection	15	75
Good	Flap Survive Good flap adhesion Mild infection Marginal flap necrosis healed by secondary procedure	03	15
Poor	Partial or total flap loss Alternative procedure may be needed	02	10

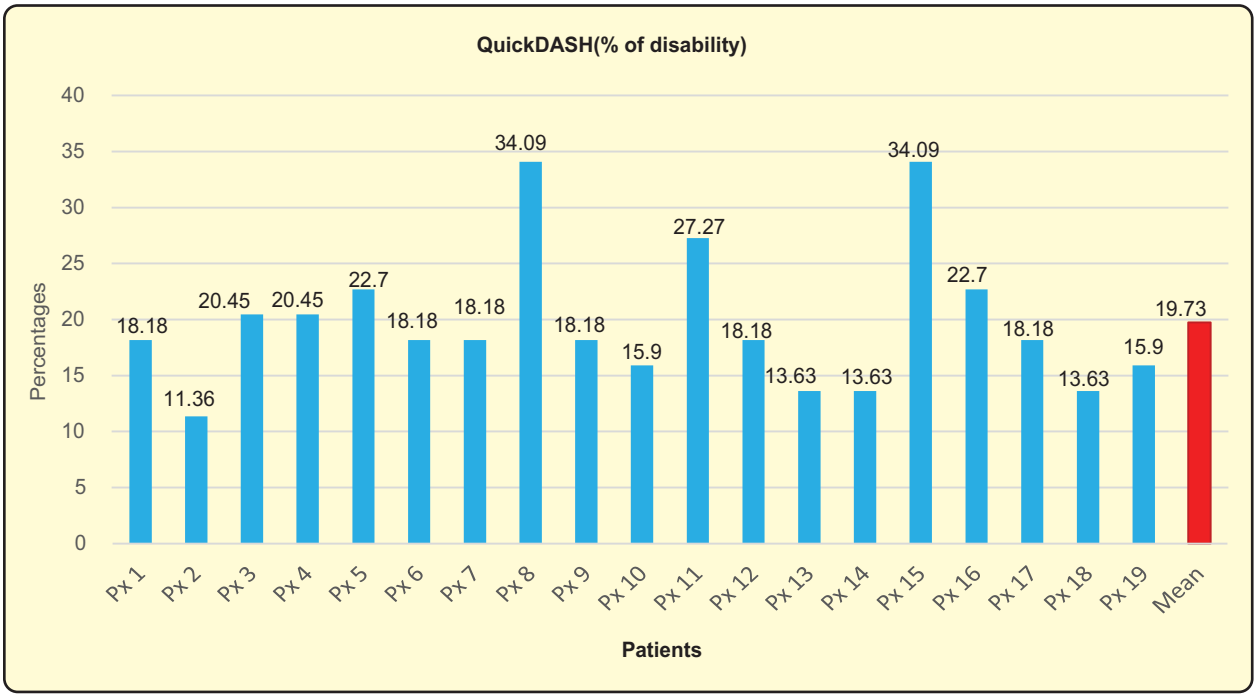

Figure 2: *Functional Evaluation by QuickDASH Scale (% of disability) n=19*

Table 3: *Functional evaluation (n=19)*

Function	Parameter	Min/Max	Mean
Motor	Quick DASH (% of disability)	11.36/34.09	19.73
Sensory	Touch	+	
	Pain	+	
	Temperature (hot/cold)	+ (3 EB Patients distal portion absent)	
	2 point disc. Proximal (mm)	10/30	16.42±5.04
	2 point disc. Distal (mm)	14/30	18.52±4.35

Functional evaluation table shows, the mean, 19.73% [(CI (95%): 16.69–22.76)] was evaluated by the QuickDASH scale. Perception of pain and touch was present in 100% of patients. The temperatures (cold and heat) were positive in 84.22% patients on the entire flap. But in three (15.78%) electric burn patient's perception of both cold and heat was absent in the distal half of the flap. Two-point discrimination was

showed a mean of 16.42±5.04 mm (CI (95%): 13.98–18.85) in the proximal half of the flap and a mean of 18.52±4.35 mm (CI (95%): 16.43–20.62) in the distal half.

Discussion

Thin arteria dorsalis pedis free flap was described by McCraw and Furlow[9] in 1975. In the study of Evagelos et al[10] the flap thickness was ranged from 5.0- 5.5mm and pedicle length in 7-8cm. In our series, we achieved minimum and maximum thickness of 4.8 mm and 5.2 mm, respectively. Mean thickness of flap was 4.9±0.16 SD mm. The pedicle length was ranged from 6.5-10 cm and mean pedicle length was 7.57 cm. In this study, 13 (65%) cases the wounds over dorsum of hand were found on right hand and rest of the wounds 7 (35%) cases were occurred over left dorsum of hand. As this hospital is a burn and plastic surgery center, majority of patients were victims of accidental burn injuries 13 (65%) 05 (25%) patients were from post-traumatic and rest of patients from infection (10%). All patients were treated with fasciocutaneous flap. The dorsalis pedis artery was a continuation of anterior tibial artery in 85% case and might be absent or very small diameter dorsalis pedis artery in 15% patient and in 5.3% cases dorsalis pedis artery was raised from anterior perforating branch of peroneal artery.[11] In this 20 cases study, 95% cases dorsalis pedis artery was the continuation of anterior tibial artery and in one patient (05%) the artery was raised from continuation with a very small caliber anterior tibial artery that was misguided with palpation and Doppler examination. The prominent supply was observed from a perforating peroneal artery that was harvested as a pedicle of that arteria dorsalis pedis flap. Mean pedicle length was 7.57 cm

In 17(85%) patients arteria dorsalis pedis free flaps were transferred to dorsum of hand and anastomosis were carried out between the dorsalis pedis artery and radial artery at the anatomical snuff box and in case of 03 (15%) patients the anastomosis were done in wrist area as end to end manner with radial artery due to presence of injury over anatomical snuff box area, venaecomitans and great saphenous vein were made anastomosis with venaecomitans of radial artery and the cephalic vein subsequently. Superficial peroneal nerve in the dorsalis pedis flap was anastomosed with the superficial branch of the radial nerve to make the flap sensate in all patients.

One (05%) flap was total lost. Venous thrombosis was occurred on 2nd postoperative period and reanastomosis was performed but unsuccessful. 03(15%) patients developed flap marginal necrosis and were managed by excision and secondary suturing. One patient (05%) developed partial flap loss and was managed by excision and split thickness skin graft. Total flap loss was treated by two staged groin flap. Eo et al[11] described, among 20 patients, one had partial necrosis of the distal part of the flap and this was successfully treated by debridement and split thickness skin grafting. In this study, Donor sites developed variable size graft loss. 3(15%) patients had less than 01 cm graft loss was treated with regular dressing and antibiotics, less than 02 cm graft loss was managed be repeat split thickness skin graft and more than 02 cm graft loss over ankle area was managed by local transposition flap of foot. Usually, complications with the dorsalis pedis flap donor site could occur immediate postoperatively and over the short-term postoperative period. There were delayed donor-site healing and minimal residual deficit, and above all, patients of this study believed that the overall benefits of the procedure outweigh the donor-site morbidity. Swelling of the foot continued for 1 or 2 months in all patients. Hypertrophic scarring occurred in all patients, however, this improved with time. None of our patients had any ulcerations at time of examination, and all were able to walk normally. In the study of Adani et al[6] among 12 patients, partial skin graft loss at donor site of ADP flap harvesting was occurred in 06 patients treated with repeat Skin grafting.

In this study, 75% flaps survived completely. Maximum dimension of flap was 12x10 cm. Only 15% patients had marginal flap necrosis and 05% patients had partial flap loss. Another 05% patients had total flap loss. Result of the study shows, 75% of the patients exhibited excellent outcome due to complete flap survive, excellent flap adhesion and no infection. 15% patient were considered good because flap Survive, good flap adhesion, mild infection and marginal flap necrosis were healed by secondary procedure. 10% patient, the outcome was poor due to partial or total flap loss and were managed by alternative procedure like split thickness skin graft or another flap like groin flap. As this outcome of the study was considered as per parameters set in the methodology, and this could not be compared with other studies. In this study, the interval from injury to operation was ranged from 17-

49 days, with an average of 27.85±07.58 days and after operation, patient was stayed in hospital ranged from 17- 30 days, with an average of 20.65±03.20 days. In the study of Jihui et al[12] was shown the length of hospital stay ranged 11-23 days.

The innervation of the ADP flap had been widely studied. Innervation was heavily reliant on the superficial peroneal nerve and terminoterminal neurorrhaphies, decreasing the reinnervation time. After average 09 months follow up period perception of pain and touch were present in 100% patient. The temperatures (cold and heat) were positive in 85% patient on the entire flap and in 15% electric burn patients (03) the perception of both cold and heat were absent in the distal half of the flap. Two-point discrimination showed a mean of 16.42±5.04 mm (CI (95%): 13.98–18.85) in the proximal half of the flap and a mean of 18.52±4.35 mm (CI (95%): 16.43–20.62) in the distal half. In Jihui[12] reported an average two-point discrimination in the transferred flaps of 25 mm. In the study Eo et al[11] described the two-point discrimination in the flap 12 mm.

From the functional point of view, our assessment was made by the validated scale QuickDASH, which was a shortened version of the DASH scale to measure the degree of disability of the upper extremity (for its acronym in English, Disability of the Arm, Shoulder and hand). This scale did not measure the degree of disability as mild, moderate, or severe. Instead, the result was expressed as a percentage of disability. According to the article published by Kovacs et al[13] which was the largest series so far studied, with 118 patients, he performed a comparative analysis of the injured reconstructed limb with the healthy contralateral limb.

According to these reports, we observed that the scale measured a diminishing result as the patient adapted to the conditions of his injured limb and was still able to perform more tasks as time passed, even without rehabilitation exercises. According to the average result in our study in the QuickDASH scale of 19.73%, with a mean follow-up of 09 months, we found a very low disability percentage in our patients, compared with those described in the international literature, and it was even better than those assessed by Kovacs[13], who concluded that the average rating of the DASH scale before 3 years after the injury was of 28.7% and is of 20.2% after 3 years.

Conclusion

The arteria dorsalis pedis free flap is a versatile option for reconstruction soft tissue defect over dorsum of hand which provides motor and sensory concept and significant improvement in color and texture on the reconstructed site. So, it is a viable coverage for soft tissue defects over dorsum of hand.

Conflict of interest statement: None declared

Ethical approval: Internal Review Board (IRB) approval was obtained from the Ethical Committee of Dhaka Medical College.

Consent: Informed written consent was obtained from the patients.

Clinical photography permission: Obtained from patients.

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