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Original Research Article

Outcome of perforator propeller flap for the coverage of soft tissue defects over middle and distal part of leg

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ABSTRACT

Background: Plastic surgery is a constant battle between blood supply and beauty. The end result of a reconstructive procedure is primarily attributable to the stability of the vascular component, which is fundamental in that it ensures survival and proper functioning of tissues that have been transferred to the recipient site. The aim of the study was to evaluate the clinical outcome of perforator propeller flap for coverage of soft tissue defects in middle and distal legs.
Methods: This was a prospective observational study and was conducted in the Department of Plastic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh during the period from September 2018 to February 2020. The study population includes the total of 30 patients having soft tissue defects of the middle and distal thirds of leg necessary for flap coverage in the Department of Plastic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh.
Results: In total 30 patients maximum 11 (36.7%) were in 31-40 years age group. Majority 27 (90%) were male and 3 (10%) were female in our study. Out of 22 flaps in distal leg necrosis occurred in 4 (18.19%) and among 8 flaps in middle leg necrosis occurred in 1 (12.5%).
Conclusions: This study observed that that perforator propeller flaps are ideal in reconstructing soft tissue defects of the middle and distal third of the leg, being safe, easy to perform, providing similar tissue in texture and thickness of damaged tissues, with low donor site morbidity.

Keywords: Distal leg, Flap viability, Perforator propeller flap, Soft tissue defects, Surgical technique

INTRODUCTION

In plastic surgery, there exists a perpetual balance between ensuring adequate blood supply and achieving aesthetic outcomes. The success of a reconstructive procedure largely hinges on the viability and reliability of the vascular component. This vascular stability is pivotal as it guarantees the survival and functionality of the tissues transplanted to the recipient site.[1] The challenge of providing soft tissue coverage to the middle and distal portions of the leg stems from various factors related to the lower limb. These include limited availability of soft tissues, prominence of bony structures, diameter variations, and biomechanical considerations. A simple defect can turn into a major challenge, for which several therapeutic options have been described.[2-4] The strategy for soft tissue coverage depends on several factors including the size and location of the wound, level of contamination, types of tissues affected, and functional needs. Other considerations include the extent and

location of the injury, dimensions and vascular integrity of the flap if it's a free flap, potential complications at the donor site, method of bone fixation, and desired aesthetic results.[5,6] Local options for reconstruction and coverage of defects in the middle and distal third of the leg are limited. The cross-leg flap popularized by Stark was used in his time with much popularity; however, today it is performed rarely because of its high morbidity of the donor site and the necessary immobilization of both lower extremities.[7] Though free flaps have been the first choice for reconstruction of distal leg, there are some local flaps that may be of choice in some cases, providing adequate coverage of cutaneous defects. The widespread adoption of free flaps in reconstructive surgery has spurred innovation and technical advancements, particularly in lower extremity procedures.[8] This evolution has led to the development of flaps tailored for the lower limb, such as perforator-based flaps or freestyle flaps. The increased availability and improved understanding of the leg's vascular anatomy, its relationship with muscle groups, and reduced morbidity have encouraged the use of perforator flaps. Techniques derived from anatomical studies on perforator flap dissection have expanded the range of pedicle flap designs. According to the Gent consensus, perforator flaps consist of skin and subcutaneous fat nourished by perforators originating from deep vascular systems. These perforators traverse predominantly through muscle and intermuscular septa to reach the skin surface.[9,10] Although perforator flaps technique requires microsurgical dissection, it does not require vascular suturing and can thus be defined a microsurgical non microvascular flap as reported by Georgescu et al.[11] Perforator flaps are highly appealing due to their versatility, boasting over 500 perforating vessels as potential resources. In the upper limb, there are an average of 48 perforators from 15 vascular territories, and in the lower limb, we can find 93 from 21 territories.[12] The perforator propeller flaps are versatile in our therapeutic armament, initially described by Hyakusoku et al., to define a method in which a flap with a length exceeding its width is rotated 90 degrees on its central axis based on a central subcutaneous pedicle.[13] Teo, T.C. refined the technique to achieve a greater degree of rotation by fully releasing the perforating vessel as a single pedicle. This advancement resulted in its subsequent definition and classification.[14,15]

This study aimed to evaluate the clinical outcome of perforator propeller flap for coverage of soft tissue defects in middle and distal legs.

METHODS

This was a prospective observational study and was conducted in the Department of Plastic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh during the period from September 2018 to February 2020. The study population includes the total of 30 patients having soft tissue defects of the middle and distal thirds of leg necessary for flap coverage in the Department of Plastic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh.

Figure 1: (A) Post traumatic defect back of lt. ankle and marking of perforator; (B) Flap elevation based on distal most peroneal artery perforator, (C) After wound excision and flap dissection; (D) Immediate postoperative period after inset of flap and graft over donor area; (E) Follow up after 48 hrs; (F) Follow up after 7 days; (G) Follow up after 1 month; and (H) Follow up after 3 months.

Inclusion criteria

Wound reconstruction in middle and distal leg trauma: addressing challenges from electric burns, flame burns, tumor excision, and exposed bones, tendons, vessels, and implants through flap coverage were included.

Exclusion criteria

Patients with potential injuries to the pedicle of donor site due to previous trauma or surgery. Too large wound that cannot be covered with local tissue. Patients with significant major co-morbid medical conditions. Patients with poly trauma and other life-threatening injury that causes delayed resuscitation were excluded.

Data collection

Findings of observation and interview with the patient and attendants were recorded on prescribed data collection sheet that was fulfilled by the investigator.

Prior to commencement of the study, the respective authority was approved the research protocol. All the patients included in this study were informed about the nature, risks and benefits of the study. Confidentiality was maintained. Proper permission was taken from the department and institution concerned for the study.

Statistical analysis

After collection of data, all data were compiled in a master table first. Data was processed and analyzed using SPSS (22) for windows software. Qualitative data presented on categorical scale was expressed as frequency and corresponding percentage. Quantitative data was presented as mean and standard deviation (SD). P value was measured by paired t test (one tailed) and less than 0.05 is taken as significant.

RESULTS

Table 1 shows that among 30 patients maximum 11 (36.7%) were in 31-40 years age group, 7 (23.3%) were in 41-50, 6 (20.0%) were 21-30 respectively.

Table 1: Distribution of patients according to age (n=30).

Age group (years)	Number	Percentage (%)
10-20	2	6.7
21-30	6	20.0
31-40	11	36.7
41-50	7	23.3
>50	4	13.3
Mean age (Yrs.) ±SD	37.51±10.92	

Figure 2 shows majority 27 (90%) were male and 3 (10%) were female.

Figure 3 shows the commonest aetiology were trauma 19 (63.3%) then burn 8 (26.7%) and skin malignancy 3 (10 %).

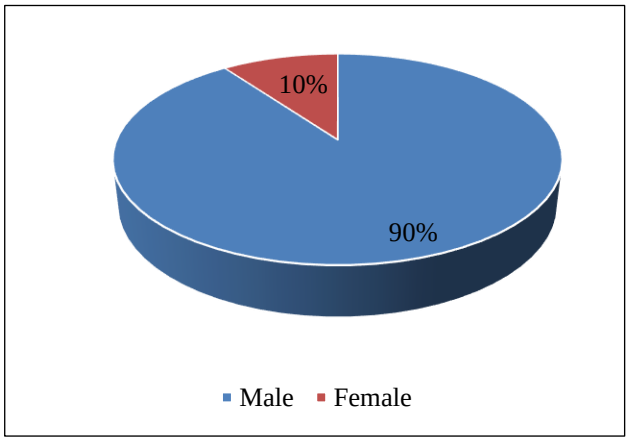

Figure 2: Distribution of sex among the cases (n=30).

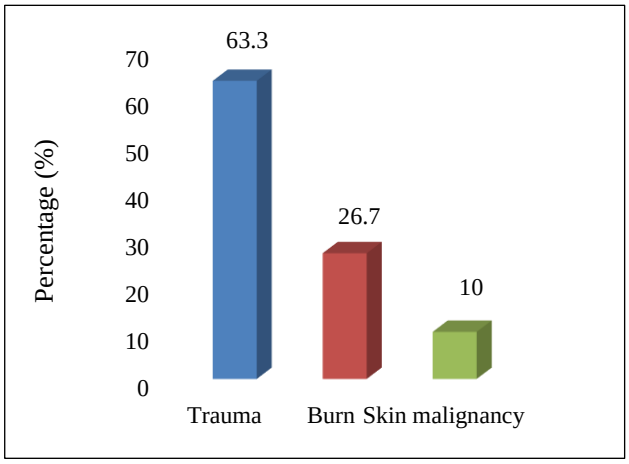

Figure 3: Distribution of defects according to aetiology (n=30).

Table 2 shows majority 22 (73.35%) were distal leg and 8 (26.7%) were middle leg.

Table 2: Site of soft tissue defect of the study subjects (n=30).

Site of soft tissue defect	Frequency	Percentages (%)
Distal leg	22	73.3
Middle leg	8	26.7

Table 3 shows minimum length of the wound is 4 cm and maximum length is 9 cm, minimum width of wound is 3 cm and maximum width is 7 cm. Minimum length of the flap is 6 cm and maximum length is 16 cm, minimum width of flap is 3 cm and maximum width is 7 cm.

Table 3: Length and width of wound and flap (n=30).

Variable		Mean (cm)	Minimum (cm)	Maximum (cm)
Wound	Length	6.49±1.67	04	09
	Width	4.52±1.21	03	07
Flap	Length	11.30±2.21	06	16
	Width	5.83±1.13	04	08

Table 4 shows minimum dimension of the wound is 12 cm^2 and maximum dimension is 63 cm^2. Minimum dimension of the flap is 24 cm^2 and maximum dimension is 128 cm^2.

Table 4: Dimension of the soft tissue wound and flap among the study population (n=30).

Variable	Mean dimension (cm^2)	Maximum dimension (cm^2)	Minimum dimension (cm^2)
Soft tissue defect	27.81±11.29	63	12
Flap	67.35±15.21	128	24

Table 5 shows 14 (46.7%) were posterior tibial artery perforator flap, 10 (33.3%) were peroneal artery perforator flap and 6 (20%) were anterior tibial artery perforator flap.

Table 5: Distribution of vessel in propeller flap (n=30).

Vessel in propeller flap	Frequency	Percentages (%)
Posterior tibial artery perforator flap	14	46.7
Peroneal artery perforator flap	10	33.3
Anterior tibial artery perforator flap	6	20.0

Table 6 shows out of 22 flaps in distal leg necrosis occurred in 4 (18.19%) and among 8 flaps in middle leg necrosis occurred in 1 (12.5%).

Table 6: Outcome in relation to site of soft tissue defect (n=30).

Site of soft tissue defect	No. of cases	No flap loss (%)	Flap necrosis (%)
Distal leg	22	18 (81.81)	4 (18.19)
Middle leg	8	7 (87.5)	1 (12.5)

Table 7 shows that majority 25 (83.3%) patients were found good, 3 (10%) were satisfactory and 2 (6.7%) were poor outcome.

Table 7: Final outcome of flap (n=30).

Outcome	Frequency	Percentages (%)
Good	25	83.3
Satisfactory	3	10.0
Poor	2	6.7

DISCUSSION

Soft tissue defects of the lower extremities especially the distal leg continues to present a difficult reconstructive challenge to the plastic surgeon. The ideal soft tissue reconstruction of the leg should be versatile, relatively simple to accomplish, provides similar skin texture to the missing ones, with minimal donor site morbidity.[16] Propeller perforator flaps are a reliable option for a stable coverage of mid-distal third defects of the leg, where the design of the flap is based on perforators, in relation to the localization and size of the defect. This prospective observational study was done to evaluate the clinical outcome of perforator propeller flap for coverage of soft tissue defects in middle and distal legs. The present study findings were discussed and compared with previously published relevant studies.

The mean age of the study cases was 37.51±10.92 years. Among the study cases maximum 11 (36.7%) patients were in 31-40 years age group. This finding is nearly similar to the finding of Mendieta and his colleague, Singh and Bal. They found the mean age 32.8 years and 33.4 years.[17,18] In this present study there was male preponderance, the percentage of male patient was 90% and female patient was 10%. In the study there was-male preponderance among patients who had suffered trauma, because males were more exposed to outdoor activities and involved in motor vehicle accidents and sports activities. Therefore, the findings of the study are in well agreement with the findings of the other research works.[16-19]

This study was conducted in a specialized center for burn and trauma. Trauma was found as the commonest cause of soft tissue defects among the cases. Among 30 cases 19 cases had soft tissue defects due to trauma (63.3%), 8 (26.7%) cases had soft tissue defects due to burn and 3 (10%) cases had soft tissue defects due to skin malignancy. Study conducted by Hifny et al, found trauma as the commonest cause of soft tissue defects in lower limb in their respective study.[16] Another study Singh and Bal, they found trauma 15 cases (75%), post burn contracture (PBC) 3 cases (15%), third degree thermal burns 1 case (5%), infection 1 case (5%).[18]

In present study among the study cases 73.3% had defects in the distal leg and 26.7% had defects in the middle leg. According to Mendieta et al and associates, they found among the affected areas that required coverage of soft tissues of the leg, in order of frequency, the middle third represented 18 cases (64.3), and in the distal third 10 cases (35.7%). Another study Hifny et al, they found the

site of soft tissue defects were in the distal third in 9 cases (81.8%) and 2 cases (18.1%) present in the middle third.[16,17] Middle and distal third of the leg, as has been reported in other series.[15,20]

In this study, maximum wound length of 09 cm and maximum wound width of 7 cm were covered with the peroneal artery perforator flap. Mean length of the wound was 6.49±1.67 cm and the mean width was 4.52±1.21 cm and the maximum dimension of the wound was 63 cm^2. This finds consistent with previous studies.[16,17] According to Lu and associates maximum dimension of successfully reconstructed wound was 64 cm^2 which is nearly similar to our study. The mean length of the flap was 11.30±2.21 cm, mean width of the flap was 5.83±1.13 cm and mean dimension of flap was 67.35±15.21 cm^2. The maximum length of flap was 16 cm, maximum width of flap was 08 cm and maximum dimension of flap was 128 cm^2. According to Lu and associates maximum dimension of flap to reconstruct wound in this area was 160 cm^2 which is consistent with our study.[21]

In this study at our institution, we have been using propeller-based perforator flap in 30 patients to cover soft tissue defect with exposed bones and ligaments in the middle and distal third of the leg. Flap dimensions were ranged from (24 cm^2 to 128 cm^2) with average of 67.35 cm^2. This finding consistent with Gir et al, they found average flap dimensions were of PAP and PTAP was 69.3cm^2 and 62 cm^2, respectively.[20] This study is also very much similar with the Shin et al. of 63.8 cm^2, we could elevate most of our flaps (86.7%) based on one perforator without complication or vascular compromise with good healing potential.[22] Moreover, Koshima et al, could use perforator flap size of up to 19x13 cm^2 based on single perforator from posterior tibial artery, while Rad et al reported a flap size of 22x8 cm^2 which is based on single peroneal artery perforator.[23,24] In this study, although we could use propeller posterior tibial artery perforator flaps measuring up to 16x5 cm^2 without any complication. On the other hand, we could elevate peroneal artery perforator flap measuring up to 16x6 cm^2, but these cases showed vascular compromise complications in form of partial necrosis and significant necrosis.

In this study at final follow up good outcome was observed in 25 (83.3%) cases, satisfactory outcome was observed in 3 (10%) cases and poor outcome was observed in 2(6.7%) cases. This study shows that the perforator-based propeller flap covers soft tissue defects of middle and distal leg with minimal complications in most of the cases. Therefore, this study reveals perforator-based propeller flap as a reliable option for reconstruction of wound in lower limb. Similar study Mendieta et al. indicated that the advantages of the propeller perforator flap include lower morbidity of the donor site, primary closure in most cases, versatility in flap design, and muscle preservation with less functional deficit of the leg. [17]

The limited number of participants may affect the generalizability and statistical power of the findings, potentially limiting the ability to draw robust conclusions. A short duration of observation may not capture long-term outcomes or variations in treatment effects over time. This could restrict the understanding of the intervention's effectiveness and its impact on the studied population. Conducting the study in a single center may limit the diversity of patient populations, treatment approaches, and healthcare settings, potentially reducing the applicability of the results to broader populations or different healthcare contexts. Additionally, it may introduce institutional biases that could influence the study outcomes.

CONCLUSION

This study observed that that perforator propeller flaps are ideal in reconstructing soft tissue defects of the middle and distal third of the leg, being safe, easy to perform, providing similar tissue in texture and thickness of damaged tissues, with low donor site morbidity. Overall functional outcome was also good following surgery.

Recommendations

Therefore, perforator propeller flaps could be used for coverage of soft tissue defect in middle leg and distal leg. Locating perforator and estimating perforator size preoperatively are essential steps in flap design and help avoid partial flap necrosis and/or flap necrosis. The goal is to identify the most dominant perforator relative to the surrounding and/or contralateral perforators. A large-scale, multicenter study could be initiated.

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