

POSTERIOR TIBIAL ARTERY PERFORATOR BASED PROPELLER FLAP FOR RECONSTRUCTION OF SKIN AND SOFT TISSUE DEFECT AROUND ANKLE JOINT

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Abstract

Background: Soft tissue coverage of distal leg and ankle region represents a challenge and such defect usually requires a free flap. However, this needs facility of microsurgery, may lead to donor site morbidity and is time consuming. With the introduction of perforator flap, management of small and medium size defects of distal leg and ankle region is easier, less time consuming, and with minimal donor site morbidity. When local perforator flap is designed as propeller and rotated to 180 degree, donor site can be closed primarily and increases the distance crossed by flap, thus increasing versatility.

Objectives: To observe the outcome of soft tissue coverage of defects around ankle joint by posterior tibial artery perforator based propeller flaps.

Methods: This was a prospective type of observational study carried out on 20 patients with skin and soft tissue defects in and around ankle joint for a period of 14 months in the Department of Burn and Plastic Surgery, Dhaka Medical College and Hospital.

Results: Among 20 cases 17 were male and 3 female; age ranged from 11 to 60 years. Post operative outcome of flap were excellent in 11 cases, good in 6 cases, poor in 3 cases as per defined criteria. Uneventful outcome was observed in 14 cases and minor complications were observed in 5 cases; and total flap loss occurred in 1 case which required revision surgery.

Conclusions: Perforator flap provides adequate soft tissue coverage for small & medium size wound around ankle. It is an easy, reliable & effective procedure with reasonable outcome.

Key words: Posterior tibial artery perforator based propeller flap, ankle joint, soft tissue defect.

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Introduction:

One of the most important goals in the management of severe injury around the ankle is to obtain adequate soft tissue coverage. The application of Taylor's concept about body angiosomes, referred to tissue transfers, has meant that the development of the perforator flaps and muscles is no longer needed as a carrier of skin flap vascularity.¹

Reconstruction of defects in and around ankle joint, with exposed tendons, bone and/or hardware is challenging and generally need flap coverage.² There are a total of 93 perforators in the lower extremity with an average diameter of 0.7 mm and able to supply a flap 47 cm² in size.³ According to Gent consensus, perforator flaps are constituted by areas of cutaneous and subcutaneous tissue nourished by perforator

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branches originating from deep vascular axis with intramuscular or intraseptal course⁴.

Propeller flaps are elevated as island flaps with a pedicle at the centre allowing its rotation 180°. According to Zhang and colleague as cited by Geoffrey GH, David CR.⁵ A skin flap from medial leg based on posterior tibial artery and its cutaneous branches was first described by Zhang and colleague in 1983.

With introduction of propeller flaps, management of small and medium sized defects of lower leg and ankle region has become convenient, less time consuming and with minimal donor site deformity. An ideal resurfacing should be stable, thin enough to allow footwear and to obtain an anatomical contour, able to withstand shoe friction and providing a gliding surface for underlying tendon.⁷

Perforator based propeller flaps have several obvious advantages. The source artery, underlying muscles, and fascia are preserved. They are easy to approach and can be performed expeditiously for the management of soft tissue defects in the elderly, systemically compromised patients, and multiple injury patients. They are technically less demanding, and the need for microvascular anastomosis is avoided. The recipient site has a similar texture, thickness, pliability and pigmentation to that which has been lost. Additionally, pedicled perforator flaps limit scars and morbidity to one extremity.

Propeller flaps are perforator flap based on a skeletonized perforator vessel and rotated 180°.⁸ The direction of rotation depends on the angle between the proximal long axis of the flap and the defect.⁹ The posterior tibial artery supplies 10% integument of lower extremity (337±111cm²).¹⁰ Tibial posterior perforators seem to have an advantage over anterior tibial and peroneal artery perforators because they usually have a large caliber and better veins.¹¹

Rationale of the study

Soft tissue defect around lower leg and ankle joint is very much common in Bangladesh due to road traffic accidents, which cause high morbidity, long hospital stay, high expenses and loss of working hours and ultimately patient

becomes a national burden. Management of lower third of limb defects is a common challenge for the reconstructive surgeon due to lack of soft tissue in that anatomic area.

Microsurgical tissue transfer offer the solution to these problems but in developing countries the lack of availability of microsurgical equipments, surgeons with competence and training still restricts use of free flaps in most regions of the world.

Materials and Methods:

It is a Prospective type of observational study. The study was conducted in Department of Burn and Plastic Surgery, Dhaka Medical College and Hospital. Study period was 14 months (from July 2016 to September 2017). The study population included the patients admitted for procedures requiring reconstruction of ankle defect. 20 patients were taken for this study. Sampling was purposive

Surgical Procedure: Preoperatively perforators near the defect were marked with the help of hand-held Doppler probe and the most suitable perforator with relation to size and closeness to defect was chosen

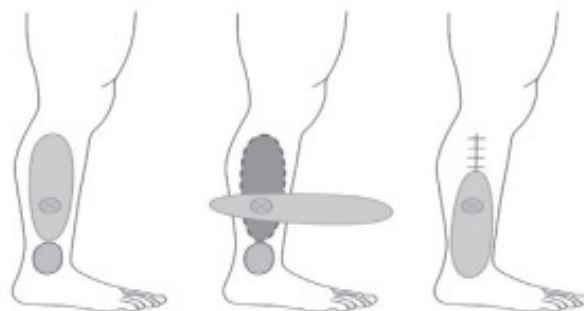


Fig. 1. Schematic diagram of the propeller flap (blue = traumatic defect of lower third of lateral leg; red = donor site, orange = propeller flap with unequal 'blades'; x = the perforating unit (of artery and vein) is the axis of rotation).

In this case the propeller rotates 180° and the donor site is partially covered by the minor blade and partially sutured. The defect is completely covered by tissue from outside zone of injury.

The flap is drawn adjacent to the defect around the perforator. Length of the flap is determined

1-2 cm more than the distance of perforator to the distal end of the wound along the vascular axis & width 0.5-1cm more than that of the wound. A tourniquet is inflated without prior exsanguinated. This maneuver facilitates identification of perforators as they remain filled with the blood. All flaps were dissected under loop magnification. An exploratory incision is given along posterior margin of the flap. The dissection started in subfascial plane, keeping in mind expected site of perforator. Once suitable perforator was found, dimension of flap confirmed or changed to the extent, as required. The propeller flap has two unequal blades with the perforator forming the pivot points so that when the blades are switched, the long arm fills the defect.

In this case the propeller rotates 180° and the donor site will be partially covered by the minor blade and partially sutured. The flap will be drawn adjacent to the defect around the perforator. Length of the flap determined 1-2 cm more than the distance of perforator to the distal end of the wound along the vascular axis & width 0.5-1cm more than that of the wound. The proximal large blade is a fasciocutaneous flap, whereas the distal smaller blade is a subdermal vascular plexus flap, preserving atleast a quarter area of adipofascial tissue intact around the perforator.¹³

Flap margins will be incised, so as to island it on selected perforator. Adequate release of all fascial strands around the perforator and dissection around the perforator in

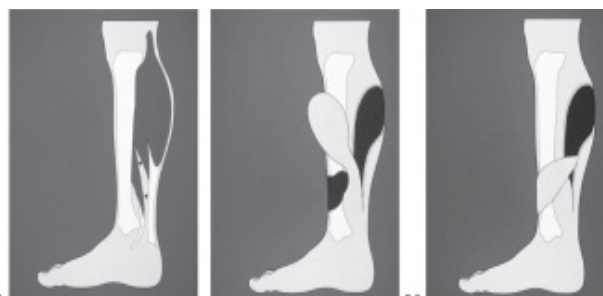


Fig 2: Posterior tibial perforator flap. Diagrammatic representation of (A) the approximate site of the two most commonly encountered septocutaneous perforators (8 to 12 cm above medial malleolus)(Quaba O, Quaba AA. Pedicled perforator flaps for the lower limb. *Semin Plast Surg.* 2006; 20:103-11)¹²

intermuscular or intramuscular plane to gain additional length will be carried out.

After deflation of the tourniquet, haemostasis will be secured and viability of flap evaluated & kept in place for 10-15 minutes. Finally rotation of the flap into the defect will be performed and position of the perforator rechecked to avoid kinking. The flap is inset and sutured into the defect. Proximal donor area partially covered with the distal flap or skin graft . Keeping a quadrant adipofascial tissue around distal pivot perforator to form a perforator adipofascial pedicle can preserve more venous return routes and relieve flap swelling.. The survival of the flap is based on subdermal vascular plexus.¹⁴ According to Hyakusoku et al as cited by Mateev MA, Kuokkanen HO, The term propeller flap was first described by Hyakusoku et al in 1991.¹⁵



Fig 3: Pre operative condition of soft tissue defect



Fig 4: Posterior tibial artery perforators



Fig 5: Flap elevation on single perforator
Peroperative:



Fig 6: Flap is rotated 180° to cover the defect



Fig 7: Propeller flap inset & donor site closure

Fig.-8: Post operative at 6 months follow up



Fig 9: defect at lateral aspect of ankle



Fig 10: Flap elevation



Fig 11: Propeller flap inset & donor site closed by S.T.S.G



Fig 12: Post operative picture at 2 weeks



Fig 13: After 6 months AP view



Fig 14: After 6 months lateral view

RESULTS:

Table I
Distribution of age (N=20)

Age Range (in year)	Number of cases	Percentage (%)	Mean age SD
11-20	4	20	34.4±15.57
21-30	5	25	
31-40	5	25	
41- 50	4	20	
51-60	3	15	

Table II
Distribution of sex (N=20)

Sex	Frequency (f)	Percentage (%)
Male	17	85
Female	3	15
Total	20	100

Table III
Causes of wound (N=20):

Causes of wound	Frequency (f)	Percentage (%)
Contact burn	2	10
Electric burn	7	35
Lacerated injury	7	35
RTA	4	20

Table IV
Location of defect (N=20)

Location of defect	Number of cases (n)	Percentage (%)
Distal $\frac{1}{3}$ rd of Tibia	2	10
Anterior	8	40
Anteromedial	5	25
Posterior	5	25

Table V
Dimension of wound and dimension of flap (N=20)

Variables (in cm)	Mean±SD (in cm)	Number of cases
Length of wound		
3-4		1
5-6	5.4±.51	10
7-8	7.4±.52	9
Width of wound		
2- 3	2.8±.44	5
>3-4	4±0	7
>4- 5	5±0	8
Length of flap		
7-9	8±0.81	7
10-12	11.77±0.52	5
13-15	13.5±0.75	8
Width of flap		
4-5	47.5±0.42	11
6-7	6.5±0.53	6
8-9	8.3±0.57	3

Table VI
Site of usable perforators of Posterior Tibial Artery (N=20)

Site	Number (n)
4-6 cm from medial malleolus	5
7-9 cm from medial malleolus	7
10-12 cm and above from medial malleolus	8

Table VII
Follow up on 5th POD

Site	Follow up events	Frequency (f)	Percentage(%)
Recipient site	Presence of infection at flap	1	5
	Marginal Necrosis	3	15
	Venous congestion of flap	4	20
Donor site	Seroma formation	2	10
	Partial graft loss	1	5

Table VIII
Evaluation 1 month after operation

Complication	Number (n)	Percentage(%)
Partial flap loss	4	20
Total flap loss	1	5
Partial graft loss	1	5

Table IX
Management of complications (N=20)

Management of post operative complications	Frequency (f)	Percentage (%)
Conservative treatment (healing by secondary intention)	3	15
Minor procedure(STSG)	2	10
Debridement & covered by alternative surgical methods (peroneal artery perforator flap)	1	5

Table-X
Post-operative flap survivality (N=20)

Outcome	Number of cases (n)	Percentage (%)
Complete flap survival	13	85
Marginal Flap necrosis	6	30
Total flap necrosis	1	5

Table XI
Donor site morbidity (N=20)

Donor site morbidity	Number of patients (n)	Percentage (%)
Broad scar	4	20
Infection	2	10
Acceptable scar	14	70

Table XII
Distribution of study group by final outcome (N=20)

Outcome	Number of cases (n)	Percentage (%)
Excellent	11	55
Good	6	30
Poor	3	15

Discussion:

This prospective observational study was carried out at Department of Plastic surgery and Burn unit at Dhaka Medical College Hospital, Dhaka. An aim to evaluate the outcome of management of soft tissue defect around ankle joint by perforator flaps, for this purpose a total number of 20 patients were selected for the study based on inclusion & exclusion criteria.

Age incidence in study population ranged from 11 to 60 years, with a mean age 34.4 (SD±15.57). In this study, out of 20 cases 17(85%) were male and 3(15%) were female giving male-female ratio of 17:3.

In this present study, most of the defect around ankle joint was caused by post burn wound, either contact or electric burn, in 9(45%) cases and trauma in 11(55%) cases. Shi-Min Chang in his study showed that most common cause of ankle defect was RTA 6(50%) and second cause was skin infection 4(33%).¹⁷

Georgescu AV stated that the posterior tibial artery propeller perforator flap is indicated for defects over the pretibial and medial aspect of the distal leg, heel, medial malleolus, calcaneum, Achilles tendon, and dorsum of the foot.¹² In this study, the largest flap is 15×8 cm² and smallest flap is 8×4 cm².

Durga found constant perforator of posterior tibial artery 9-10cm above the medial malleolus in 12 out of 14 cases.¹³ In this study, most of the perforators (80%) lie within 9 cm from transmalleolar line. Nearest perforator of posterior tibial artery is 4 cm from medial malleolus. The distal one is 12 cm and above from medial malleolus. According to Schaverien & Saint-Cyr the distal distribution of the perforators in the lower leg is in the 4 to 9 cm interval, perforators from both the anterior and posterior tibial arteries, but also 1-2 well represented perforators of the peroneal artery.²⁰

According to Peddi Manjunath, A constant perforator of posterior tibial artery was found 9-10 cm above the medial malleolus in 22 out of 26 cases.²

Follow up of the patients in this study on 5th post-operative day revealed 1 (5%) patient developed infection, 4 (20%) patients developed venous congestion. Marginal necrosis developed in 3 (15%) cases. Four patients ended up with partial flap loss later on. Flap donor site morbidity like partial graft loss, seroma formation occurred in 3 (15%) cases.

After 1 month of operation, follow up result showed that 04 (20%) patients had partial flap loss, 1(05%) patient had total flap loss, 1 (5%) patient had partial skin graft loss. Jakubietz RG, Jakubietz MG, Gruenert JG et al¹⁴ studied with 8 patients & his outcome was one partial flap loss, two superficial skin loss (epidermis). In present study, complete flap survival occurred in 13 cases, marginal flap necrosis in 6 cases and total flap necrosis in 1 case.

This study showed - out of 6 patients 3(15%) cases of flap site infection responded conservatively, regular dressing with antibiotic coverage healed wound infection. Two (10%) patient required minor procedure- STSG. One total flap lost patient had debridement and coverage by a second operation – peroneal artery perforator based flap coverage. Ramesha KT showed the venous congestion of the tip or of the entire flap was the most common complication, and was due to the insufficient flow in the perforator pedicle, either because of an inadequate selection of the perforator, or because of an insufficient dissection and

clearing of the vascular pedicle, especially around the vein.¹⁹

According to Manjunath P, A significant drawback can be cosmetic deficit related to donor site, which formally contraindicated this procedure in women. Another disadvantage is related to the fact that the perforator can be within the zone of injury, which can prejudice the viability of the flap.² In this study, 3 patients were female and among them 2 had no donor site morbidity and 1 patient had infection and healed by secondary intention.

In the study, outcome of donor site was acceptable scar (70%) in 14 patients. Only 4 patients developed broad scar (20%), infection in 2(10%) cases. No other study showed donor site outcome.

According to Tos P, Innocent M , Artiaco S, Antonini A, Delcroix L , Geuna S et al.,perforator artery selection before flap harvesting was based on vessel size and distance to the area of defect, the perforator arteries were septocutaneous in 19 cases and musculocutaneous in three.⁴ In this study, we used septocutaneous perforator in all cases and no musculocutaneous perforator.

Quaba stated that larger flaps can be raised on the medial side of the leg compared with the anterolateral aspect. This is due to the fact that perforators arising from the posterior tibial axis, although small in number, are of larger diameter than those from the anterior tibial and peroneal axes, where the converse holds true.¹²

In this study, 85% of patients had satisfactory outcome, while the rest 15% did not exhibit satisfactory outcome as there was partial flap loss that required interventions.

Conclusion

Perforator flaps are useful armamentarium for coverage of defects of distal 3rd of leg & ankle. It includes fasciocutaneous component of leg without interfering muscular activities and underlying neurovascular structures. With this surgical procedure more part of the flap can be used to cover the wound by like with like tissues. A satisfactory healed wound for lower extremity wound reconstruction can be achieved using this flap study.

Limitations of the study:

- Sample size was small for a representative data.
- Period of follow up was limited

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