e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(10); 625-629

Original Research Article

A Prospective Evaluation of the Effectiveness of Ad Hoc Posterior Tibial Vessels Perforator-Propeller Flaps for the Reconstruction of Small and Medium Sized Soft Tissue Defects in the Lower Third Leg

Pranav Kumar

Senior Consultant and H.O.D, Department of Burn & Plastic Surgery, ESIC Medical College and Hospital, Bihta, Patna, Bihar, India

Received: 16-07-2023 Revised: 20-08-2023 / Accepted: 28-09-2023
Corresponding author: Dr. Pranav Kumar
Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to assess the effectiveness of ad hoc posterior tibial vessels perforator-propeller flaps for the reconstruction of small and medium sized soft tissue defects in the lower third leg.

Methods: A prospective study was conducted in the department of plastic and reconstructive surgery, over a period of 12 months (January 2022 to December 2022). All patients with small to large sized soft tissue defects affecting lower third of tibia were included in the study. A total of 20 flaps were used for the coverage of defects localized at the lower third of the leg.

Results: Among the affected areas that required coverage of soft tissues of the leg, lower third leg was involved in all the patients. Flap dimensions ranged from 12 to 156 cm^2, with an average size of 50 cm^2 with interquartile range of 30 and 60 cm.2 The flap rotation was 180 degrees in 16 cases (80%), 140 degrees in 2 cases (10%), and 160 degrees in 2 cases (10%). The flaps were based on a single perforating vessel of the posterior tibial artery in 10 cases (50%) of the cases; on the anterior tibial artery in 8 cases (40%), and in 2 cases (10%) the peroneal artery was chosen. Complications were present in 20% of the flaps. These included 3 partial necrosis less than a 15% of the flap, which were all based in the posterior tibial artery, and 1 case with an epidermolysis of the flap based in the anterior tibial artery without a statistical difference with respect to the artery used to base the flap. Primary closure of the donor site was performed in 14 cases (70%).

Conclusion: Based on the results obtained in our study, we consider that the perforator-based propeller flaps are ideal in reconstructing small-medium defects of the lower third of the leg with the advantage of being safer options, replacing the defect with tissues similar in texture and thickness, flap can be elevated easily with lower incidence of donor-site morbidity.

Keywords: Ad hoc posterior tibial vessel propeller flaps; exploratory non-delineating incision; extensile steps of skeletoniszation of perforator

Introduction

Lower third leg soft- tissue defects are challenging the skills of reconstructive surgeon. Pathological constraints are degloving injuries in this region, which mars the prospectus of all perforator/propeller flaps and distally based pedicled flaps. The post-traumatic vascular disease (PTVD) [1] of chronic wound renders the local and regional vessels poor recipients for the microvascular reconstruction which are considered as the first choice for reconstruction of lower third leg soft-tissue defects. All these anatomical and pathological constraints prevailing in the lower third leg soft-tissue defects narrows the reconstructive armamentarium of the surgeon to very few choices. Conventional or flow-through free flap for the delayed primary reconstruction of acute wounds and free flaps with cross-leg construct or microvascular loops for chronic wounds are worn- down choices. But later, envisage microvascular anastomotic expertise.

On the other hand, in the lower third leg small- and medium-sized soft-tissue defects without any degloving injury, the perforator propeller flaps are the authors preferred choice. These are basically islanded fascio cutaneous flaps have unique versatility that it has two unequal blades which can rotate about the dissected cutaneous single best perforator – the pivot point through 180° in such a way that large blade fills the primary defect. The secondary defect is partially covered by the small blade of the propeller flap. So initially, these perforators have to be explored by posterior non-delineating incision and then choose the single best perforator, which is going to be the pivot point

of these propeller flaps. Then, the final dimensions of the flaps are designed according to the bio geometry of the propeller flaps based on the single-best perforator. Therefore, these flaps are aptly (cut as you go) called ad hoc posterior tibial propeller flaps. [2]

Reconstruction of defects in the foot and distal lower leg, with exposed tendons, bone, and/or hardware continues to be challenging, and they generally need flaps coverage. [3-5] In the absence of specific knowledge of the pattern or reliability of the blood supply, the flaps were used initially as random pattern flaps constrained by length-to-width ratios to ensure viability. [6] These flaps are unreliable in the lower leg because of their small dimensions and restrictions in mobility. [7] Moreover, Almeida et al [8] found a random pattern flap necrosis in 25% of cases. The post-traumatic vascular injury in the lower extremities makes the local and regional vessels poor candidates for the microvascular reconstruction, usually a preferred choice for reconstruction in lower third of leg. Due to all these constraints, the armamentarium of the reconstructive surgeons has narrowed down to very few choices. There are options like conventional or flow- through free flap and free flaps with cross-leg construction or microvascular loops for the coverage of chronic wound, which require the microsurgical expertise.

The aim of the present study was to assess the effectiveness of ad hoc posterior tibial vessels perforator-propeller flaps for the reconstruction of small and medium sized soft tissue defects in the lower third leg.

Materials and Methods

A prospective study was conducted in the department of plastic and reconstructive surgery, ESIC Medical College and Hospital, Bihta, Patna, Bihar, India over a period of 12 months January (2022 to December 2022) All patients with small to large sized soft tissue defects affecting lower third of tibia were included in the study. A total of 20 flaps were used for the coverage of defects localized at the lower third of the leg. All the details of the patient were recorded; various findings during pre-operative, intra-operative, postoperative and follow up periods were collected and analyzed. The patients were explained about the nature of the defect and the various flap options available. The proposed procedure was explained to the patient in detail including its merits and demerits. Informed and written consent was obtained from the patient. The detailed proforma of the study was submitted before the institution ethical committee and approval obtained.

Patients in the age group of 10-60 years, who were having defect with exposed tibia in lower extremities where primary skin grafting cannot be done and needing reconstruction as one stage procedure, were included for the study. Whereas, patients with peripheral vascular diseases, in cases where advancement, transposition perforator flap and free style free flap possible, patients with extensive tissue defects that cannot be covered with fascial flaps and patients with Gustillo-Anderson type 3B open fracture tibia were excluded from study.

Preoperative Preparation

All patients who needed wound care were admitted and advised limb elevation. Thorough debridement of wound done on day one and appropriate antibiotics were given according to culture and sensitivity, if needed. All co-morbidities (including type 2 DM) were treated beforehand. Smokers were planned after a two weeks period of complete abstinence of smoking. A hand-held Doppler ultrasound with 8 to 10 MHz frequency probe is used to mark the dominant perforator.

Preoperative Flap Planning

The propeller flap is identified as a local island fasciocutaneous flap based on a single dissected perforator. It has a design similar that of a propeller with 2 blades of unequal length with the perforator forming the pivot point so that when the blades are switched, the long arm comfortably fills in the defect. The flap has an ability to rotate any angle up to 1800. A proximally based fasciocutaneous flap is unable to get enough healthy tissue into the defect and it tends to expose either the subcutaneous border of the tibia or the Achilles tendon. The propeller flap avoids these problems. In doing so it simultaneously transfers the secondary defect to an easily grantable area over proximal muscle bellies.

When the rotation is needed only up to 90o it may not matter if more than one pedicle is kept, when the flap is needed to rotate 180o it is actually safer to divide all perforators except one.

Operative Procedure

All patients were operated under general/ regional anesthesia under the loupe magnification. Patients were positioned according to the defect and flap. A tourniquet was applied. Flap design was drawn, with the perforator as the pivot point of the flap. First, the distance was measured between the perforator and the distal edge of the defect. To this value, 1 cm is added is then added and then it is transposed proximally along the vascular axis, measured from the perforator, to form the proximal limit of the flap. Next, the width of the flap was determined approximately similar to the width of the defect.

First incision was made at one side of the marked flap retracted to locate the marked perforators. A subfascial approach was made to visualize the pedicle.

With this initial incision, the best perforator was chosen based on its position and size and by micro-clamping to ascertain the flap perfusion.

When the decision was made, the perforator that was finally chosen for the flap and with the best pedicle chosen, the design of the flap was completed and, if necessary, adjusted. We ensured that the proximal edge of the flap should reach the distal margin of the defect comfortably and would not place the perforator under any tension. Particular attention was paid to the fascial strands around the venae comitantes which were divided carefully to avoid extrinsic compression once the flap is rotated into position. Then the flap was completely islanded, it was left in its donor area and the tourniquet was released and hemostasis was secured.

Topical lignocaine was instilled around the perforator. Once the flap perfusion was confirmed, the flap was carefully lifted and pivoted around its pedicle to cover the defect. First the flap was turned clockwise into the defect and was positioned to look for any sign of extrinsic compression of venae comitantes by residual fascial strands. Then we turned the flap counterclockwise and examined the pedicle. The direction of rotation where venae comitantes were safer was selected.

Then the flap was secured in position with the first 2 skin sutures placed on either side of the axis of the pedicle. Then the inset of rest of the flap was done. The donor defect was closed either primarily without excessive tension or with skin graft. Sterile loose dressing was done.

Post Operative Care

Immobilization of the operated region was done with appropriate splint. Limb was kept elevated. Flap was monitored once in four hours for the first 48 hours and then once daily. Complete sutures were removed by 12th POD. POP immobilization continued for 2 weeks. The patient was allowed to ambulate once the flap and graft settled well. Follow up was done up to 6 months.

Results

Table 1: Intra and post operative findings

Variables	No	Percentages(%)	
Location of defect			
Lower third	20	100	
Degree of rotation			
180º	16	80	
140º	2	10	
160º	2	10	
Origin of perforating vessels			
Posterior tibial artery	10	50	
Anterior tibial artery	8	40	
Peroneal artery	2	10	
Complications of flap			
Complications offlap	**Origin of perforator**	**Sex of patient**	**No.of cases**
Epidermolysis	Posterior tibial artery	Female	1
Partial flap necrosis	Posterior tibial artery	Female	3
Donor-site closure			
Primary closure	14	70	
STSG	6	30	

Among the affected areas that required coverage of soft tissues of the leg, lower third leg was involved in all the patients. Flap dimensions ranged from 12 to 156 cm^2, with an average size of 50 cm^2 with interquartile range of 30 and 60 cm.2 The flap rotation was 180 degrees in 16 cases (80%), 140 degrees in 2 cases (10%), and 160 degrees in 2 cases (10%). The flaps were based on a single perforating vessel of the posterior tibial artery in 10 cases (50%) of the cases; on the anterior tibial artery in 8 cases (40%), and in 2 cases (10%) the peroneal artery was chosen. Complications were present in 20% of the flaps. These included 3 partial necrosis less than a 15% of the flap, which were all based in the posterior tibial artery, and 1 case with an epidermolysis of the flap based in the anterior tibial artery without a statistical difference with respect to the artery used to base the flap. Primary closure of the donor site was performed in 14 cases (70%). The registered complications of partial necrosis and epidermolysis of the flaps were among the group in which the primary closure of the donor site was treated with a

partial thickness skin graft, which had 100% integration.

Discussion

The middle and lower limb and ankle contain a limited amount of soft tissue and have poor skin elasticity. Traumatic injuries to these regions often result in the exposure of bones and tendons, and it is difficult to directly close these defects, even for small defects. Therefore, flap covering is often required. In traumatic cases, the soft tissue coverage in this area is often further reduced due to extensive soft tissue destruction and the multiple incisions required for complex internal fixation. Moreover, the anatomical region of the internal fixation has limited soft tissue relaxation, which further increases the demand for soft tissue coverage. These factors often limit the use of traditional local flaps. The main advantages of the propeller flap for the treatment of calf defects include a short operation time, shortened hospital stay, reduced patient costs, and location of the flap sites adjacent to the defect sites. [9-11]

Covering a soft-tissue defect over the tibial crest possess a challenge to reconstructive surgeon. Reconstruction of defect in leg has number of anatomical constraints such as paucity of loose tissues in the vicinity; abundance of subcutaneous bone and its prominences results in devitalization of fracture fragment easily because of periosteal stripping; tendinous nature of muscles in this region, which may result in the exposure of the tendons with pedicled flaps which can also lead to unstable scar after skin grafting of donor site); there is also reduced blood supply here; the circumference of the lower third leg is relatively smaller which may easily compromise lymphatic drainage, and poor wound healing; and lastly, the distal ankle and foot regions are considered as high pressure zones which make these regions as poor donor sites. Among the affected areas that required coverage of soft tissues of the leg, lower third leg was involved in all the patients. Flap dimensions ranged from 12 to 156 cm^2, with an average size of 50 cm^2 with interquartile range of 30 and 60 cm.2 The flap rotation was 180 degrees in 16 cases (80%), 140 degrees in 2 cases (10%), and 160 degrees in 2 cases (10%). Local flaps are the preferred options for coverage of proximal thirds of the leg, whereas, free flaps are reserved as options for the distal third of the leg and foot, with lack of local tissues to base locoregional flaps. [12-14] However, the use of fasciocutaneous local flaps based upon fascial plexus in the 1980s by Pontén and Hallock, introduced newer options for the reconstruction of the defects of the lower extremity. [15]

The flaps were based on a single perforating vessel of the posterior tibial artery in 10 cases (50%) of the cases; on the anterior tibial artery in 8 cases (40%), and in 2 cases (10%) the peroneal artery was chosen. Complications were present in 20% of the flaps. These included 3 partial necrosis less than a 15% of the flap, which were all based in the posterior tibial artery, and 1 case with an epidermolysis of the flap based in the anterior tibial artery without a statistical difference with respect to the artery used to base the flap. Primary closure of the donor site was performed in 14 cases (70%). The registered complications of partial necrosis and epidermolysis of the flaps were among the group in which the primary closure of the donor site was treated with a partial thickness skin graft, which had 100% integration. Among the 21 angiosomes [16] described in the lower limb, uniquely at the lower third leg region, there exist short and straight perforators directly overlying the source posterior tibial vessels. Therefore, the routine pre-operative marking of the perforators is not practical here because the Doppler acoustic signals of perforators cannot be distinguished from the source vessels. Hence, the perforator flaps based on the posterior tibial vessels in this region are named as ad hoc perforator propeller flaps, wherein the perforators are first exposed by exploratory posterior non-delineation incision and then single best perforator was selected.

Another possible described factor that may be associated with partial necrosis of the flaps is the inclusion of scar tissue in the flap design, or excessive tension in the closure of the defect. [17] This is why sometimes recommended the split thickness skin graft for the donor site of the flap, which will always become a more common option as the defect is more distal, due to the lack of displacement of the tissues in the leg. The flap can be redesigned with trans operative confirmation of the position of the perforators, as we did in 3 occasions when we had modified the original design, extending proximally to achieve adequate coverage. [18,19]

It has been found that the perforator propeller flaps used to preserve the major vascular axes of the limb and underlying structures, thereby obviating the need for a microsurgical anastomosis and at the same time provides the benefit of tissue-like covering. These flaps provide a consistent and predictable blood supply, comprising of at least 1 perforating vessel with size more than 0.5 mm, which is long enough for the needed transposition, and also help in closure of the donor site in a primary fashion. The benefits of the propeller perforator flap involve lower rate of donor site morbidity with primary closure in majority of the cases, reduced functional deficit, versatile flap design, and sparing of underlying muscles.

Conclusions

Based on the results obtained in our study, we consider that the perforator-based propeller flaps are ideal in reconstructing small-medium defects of the lower third of the leg with the advantage of being safer options, replacing the defect with tissues similar in texture and thickness, flap can be elevated easily with lower incidence of donor-site morbidity.

References

1. Mambally SR, Santha KK. Utility of arteriovenous loops before free tissue transfer for post-traumatic leg defects. Indian Journal of Plastic Surgery. 2015 Jan;48(01):038-42.
2. Waterston SW, Quaba O, Quaba AA. The ad hoc perforator flap for contracture release. Journal of plastic, reconstructive & aesthetic surgery. 2008 Jan 1;61(1):55-60.
3. Byrd HS, Spicer TE, Cierney III G. Management of open tibial fractures. Plastic and Reconstructive Surgery. 1985 Nov 1;76 (5):719-28.
4. Godina M. Early microsurgical reconstruction of complex trauma of the extremities. Plastic and reconstructive surgery. 1986 Sep 1;78(3): 285-92.
5. Ninkovic M, Mooney EK, Ninkovic M, Kleistil T, Anderl H. A new classification for the standardization of nomenclature in free flap wound closure. Plastic and reconstructive surgery. 1999 Mar 1;103(3):903-14.
6. McGregor IA, Morgan G. Axial and random pattern flaps. British journal of plastic surgery. 1973 Jul 1;26(3):202-13.
7. Rad AN, Singh NK, Rosson GD. Peroneal artery perforator-based propeller flap reconstruction of the lateral distal lower extremity after tumor extirpation: Case report and literature review. Microsurgery: Official Journal of the International Microsurgical Society and the European Federation of Societies for Microsurgery. 2008;28(8):663-7 0.
8. Almeida MF, da Costa PR, Okawa RY. Reverse-flow island sural flap. Plastic and Reconstructive Surgery. 2002 Feb 1;109(2):58 3-91.
9. Sisti A, D'ANIELLO CA, Fortezza L, Tassinari J, Cuomo R, Grimaldi L, Nisi G. Propeller flaps: a literature review. In Vivo. 20 16 Jul 1;30(4):351-73.
10. Bekara F, Herlin C, Somda S, De Runz A, Grolleau JL, Chaput B. Free versus perforator-pedicled propeller flaps in lower extremity reconstruction: what is the safest coverage? A meta-analysis. Microsurgery. 2018 Jan;38(1):1 09-19.
11. Tos P, Innocenti M, Artiaco S, Antonini A, Delcroix L, Geuna S, Battiston B. Perforator-based propeller flaps treating loss of substance in the lower limb. Journal of Orthopaedics and Traumatology. 2011 Jun;12(2):93-9.
12. Ger R. The technique of muscle transposition in the operative treatment of traumatic and ulcerative lesions of the leg. J Trauma. 1971;11(6):502-10.
13. McCraw JB, Dibbell DG. Experimental definition of independent myocutaneous vascular territories. Plast Reconstr Surg. 197 7;60(2):212-20.
14. Manchot C. The cutaneous arteries of the humanbody. New York: Springer-Verlag; 198 2: 105-114.
15. Filatov VP. Plastic procedure using a round pedicle. Vestn Oftalmol. 1917;34:149.
16. Geddes CR, Tang M, Yang D, Morris S. Anatomy of the integument of the lower extremity. Perforator flaps: anatomy, technique & clinical applications. St. Louis: Quality Medical Publishing, Inc. 2006:541-78.
17. Manchot C. Die Hautarterien cles Mensch lichen Korpers. Leipzig, FCV Vogel. 1889.
18. Ponten B. The fasciocutaneous flap: its use in soft tissue defects of the lower leg. Br J Plast Surg. 1981;34(2):215-20.
19. Salmon M. Arteres de la peau. Paris: Masson. 1936.