

Vascular basis of Retrograde Fasciocutaneous Flap based on Lower Two Posterior Tibial Artery Perforators

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ABSTRACT

Introduction: Throughout its course, the posterior tibial artery supplies numbers of perforators to the skin. This study is an attempt to find the anatomical location of the perforators related to posterior tibial artery in fresh cadaveric dissection as it is one of the main sources of artery having many septocutaneous or musculocutaneous perforators. Fasciocutaneous flaps can be harvested based on perforator arising from posterior tibial artery of lower limb and are used in lower limb defects. Retrograde fasciocutaneous flap was performed in total ten cases with different variety of lower limbs defects based on lower two perforators arising from posterior tibial artery.

Material and methods: The present study was carried out in the department of Anatomy in collaboration with department of Plastic surgery, Assam Medical College and Hospital, Dibrugarh, during the period from July 2015 to June 2016. A total number of 15 adult cadavers (30 lower limbs) of either sex were included in the study. Total ten cases of fasciocutaneous flap were performed for a variety of defects in lower limbs.

Results: We observed two distal perforators lie within 4-7cm from the tip of medial malleolus. Fourteen legs were dissected after injecting methylene blue dye through the lower two perforators of posterior tibial artery (posterior tibial artery was ligated just proximal to the perforator at 7cm). We found the reach of dye was about 19cm (mean) through the lower two perforators a point 7 cm proximal to the tip of the medial malleolus.

Conclusion: The present study illustrates that the sizeable perforators of posterior tibial artery are found in the leg from knee to ankle and has a reliable vascular territory for harvesting retrograde fasciocutaneous flap based on lower two perforators. We found that retrograde flaps are very useful and a simple solution for various difficult defects of the distal third of the leg, ankle, heel, midsole, malleolus and dorsum of the foot. However, in clinical practice, local and systemic factors should always be considered before planning of flap.

Keywords: Vascular basis of Retrograde, Fasciocutaneous Flap, Lower Two Posterior Tibial Artery Perforators

INTRODUCTION

The posterior tibial artery is the largest terminal branch of the popliteal artery, begins at the lower border of the popliteus between tibia and fibula, deep to gastrocnemius and extends obliquely downward to the medial aspect of the leg. Arterial perforators are the vessels that leave the muscle and intermuscular septa and pass through the deep fascia, upon whose superficial surface they give off three to six small radiating branches that anastomoses with superficial

plexus.^{1,2}

Achieving adequate and aesthetically satisfactory skin and soft tissue cover for lower limb defects is a challenge in the field of plastic and reconstructive surgery. Perforator based flaps are typically harvested with sparing of underlying muscle tissue and minimal trauma; there use is said to reduce post operative pain; donor site morbidity and functional loss.¹ The clinical development of the lower leg fasciocutaneous flap and the subsequent understanding of its underlying anatomical vascular basis help surgeons to develop better technique of fasciocutaneous flap in treatment of lower leg defects.³

This study is an attempt to find the anatomical location of the perforators related to posterior tibial artery in fresh cadaveric dissection as it is one of the main sources of artery having many septocutaneous or musculocutaneous perforators. Retrograde fasciocutaneous flaps are perforator based flaps, use in lower limb defect are arising from posterior tibial artery of lower limb.

The current research aimed to study the location, number and distance between the different perforators of the posterior tibial artery which are usually used for fasciocutaneous flap for lower limb reconstruction and to study the two distal perforators of Posterior tibial artery to know the dimension of retrograde fasciocutaneous flap which is usually used for lower third defect of the leg.

MATERIAL AND METHODS

The present study was carried out in the department of Anatomy in collaboration with department of Plastic surgery, Assam Medical College and Hospital, Dibrugarh, during the period from July 2015 to June 2016. A total number of 15 adult cadavers (30 lower limbs) of either sex were included in the study. Total ten cases of fasciocutaneous flap were performed for a variety of defects in lower limbs. Permission

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How to cite this article: Partha Sarathi Barooah, Anup Tanti, Jyotirmayee Lahon, Dhruvajyoti Deka, Ajanta Hazarika, Pradip Kumar Tiwari. Vascular basis of retrograde fasciocutaneous flap based on lower two posterior tibial artery perforators. International Journal of Contemporary Medical Research 2017;4(9):1929-1933.

from the institutional ethical committee (Human) taken before initiation of study.

Specimen selection

Fresh adult cadavers provided in the department of Anatomy, Assam Medical College and Hospital, Dibrugarh for academic purpose after fulfillment of all required official formalities.

Exclusion criteria

- Formalinised body
- Cadavers with leg deformity or trauma

Fresh adult cadaveric dissection was performed on fifteen bodies (30 lower limbs). In 16 legs 50% Methylene blue dye was injected in the popliteal artery to locate the perforators of posterior tibial artery. Whereas in another 14 lower limbs 50% methylene blue dye was injected from the lower two perforators of PTA to ensure the safe dimension of retrograde flaps. The study was done in two parts.

RESULTS

Group:-A –Dye study to locate the perforators of posterior tibial artery.

Steps

- (1) Dissect and isolate the popliteal artery at popliteal fossa
- (2) Ligation of popliteal artery in popliteal fossa.
- (3) 30ml of methylene blue dye was injected in popliteal artery - distal to the ligature through a cannula /feeding tube No-6.
- (4) First incision was made from middle of the popliteal crease to mid malleolar point over Tendoachilles.
- (5) Two horizontal incision were made over medial side of the limb, one upper and one lower end point of the first incision.
- (6) Now fasciocutaneous flap was harvested from the underlying muscle.
- (7) During dissection sub fascial plexus and perforators were observed containing the dye.
- (8) Measurement of the distance of the perforators of posterior tibial artery from tip of the medial malleolus for their location. The sizable perforators were observed at every 3 -4 cm interval.

Group:-B - Dye study to know the maximum dimension of fasciocutaneous flap based on lower two perforators of posterior tibial artery.

Steps

- (1) Dissect and isolate the posterior tibial artery at the level, posterior to the medial malleolus and ligated.
- (2) Identify the lower two perforators of posterior tibial artery within 7cm (in our study) from tip of medial malleolus.
- (3) The posterior tibial artery was again ligated proximal to the distal two perforators.
- (4) 15ml of 50% methylene blue dye was injected within the ligated segment of posterior tibial artery.
- (5) We have to confirm it that the flow of dye will pass through the perforators only.
- (6) A fasciocutaneous flap was elevated by one proximal

and two horizontal incisions.

- (7) Observe the reach of the dye under surface of the flap which indicate the safe limit of the flap based on lower two perforators of posterior tibial artery.
- (8) We found the reach of dye was about 19cm (mean) i.e. the average length of the retrograde fasciocutaneous flap based on lower two perforators of posterior tibial artery.

In Group A: (Figure-1)

Perforators of posterior tibial artery

There were nine sizeable vessels, which were the branches of the posterior tibial artery. They were measured from the medial malleolus as well as from a reference line joining the tibial tuberosity to mid-malleolar point. Thus if a line is drawn 4.5 cm medial and parallel to the reference line, it will indicate the vascular axis for the medial flap.² We observed distal six perforators were located mostly in the distal 3rd and middle 3rd of the leg; traversing between the flexor digitorum longus and medial border tibia anteriorly and Tendoachilles and soleus posteriorly.

In the 16 limbs (both right and left) we found a total number of 130 perforators, mean 8 (7-9) per leg from medial malleolus to knee. Basically two types of perforators were found (at an average distance of 2.5 to 7cm) i.e., septocutaneous and musculocutaneous perforators. We observed septocutaneous perforators [*supply the overlying skin by traversing through an intermuscular septum before they pierce the deep fascia*] were located mostly in the distal 3rd and middle 3rd of the leg. Whereas musculocutaneous perforators [*supply the overlying skin by traversing through muscle before they pierce the deep fascia*] coming out through the soleus and medial gastrocnemius muscle, found in middle and proximal 3rd of the leg. In our study out of 130 perforators, 99 (76.2%) were septocutaneous whereas 31 (23.8%) were musculocutaneous. We measured the distances in between the perforators and observed that there are sizeable perforators at 2.5-7 cm interval.

In Group B: (Table 1)

We found two distal perforators lie within 4-7cm from the tip of medial malleolus. 14 legs were dissected after injecting methylene blue dye through the lower two perforators of posterior tibial artery (after ligating the main vascular trunk at 4cm and at 7cm from medial malleolus). We found the reach of dye was about 19cm (mean) through the lower two perforators a point 7 cm proximal to the tip of the medial malleolus.

Clinical Study (Figure 2,3 and 4)

Total ten cases were performed for a variety of defects in lower limbs. All the cases were evaluated for one year of my study. Majority of the patients were between 20-40 years of age of group. Youngest patient in this series was 13 years old and oldest was 48 years. Most of the cases were due to RTA. One case was chronic diabetic ulcer and one case was due to domestic accident. Most of the defects were located at lower 1/3rd of leg. Out of all lower 1/3rd of leg defect two had over Tendoachilles and one had defects over medial malleolus. One defect was over both lower and middle 1/3rd of leg and

Cadaveric No.	Limb		Reach of the dye from lower two perforators (in cm)	
	Right	Left	Right	Left
1	Male (n=6) 42.86%	Male (n=6) 42.86%	17	17.5
2			22	21.5
3			18.5	19
4			19.8	19
5			18.5	18
6			16.5	17
7	Female (n=1) 7.14%	Female (n=1) 7.14%	17.8	18.5
Total (N=7)	7	7	18.58 ± 1.854	18.64 ± 1.463

Table-1: Reach of dye in distal perforator based fasciocutaneous flap

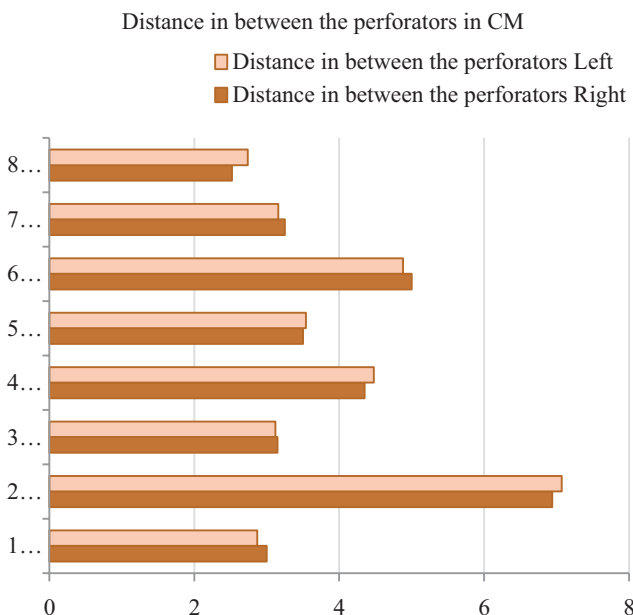


Figure-1: Distance between the perforators

partly upper third of leg. In all the defects, bone/ tendon or both were exposed. In majority of cases bone was exposed. Two defects had the exposed tendon and one defect had exposed both bone and tendon.

In all ten cases posterior tibial artery perforator based fasciocutaneous flaps were done. All the cases of perforator based fasciocutaneous flaps; vascular axis of posterior tibial artery was identified and marked preoperatively. A reference line is drawn by joining the tibial tuberosity and the mid-malleolar point and vascular axis lies approximately 4.5cm medial and parallel to this line or 1.5 cm from the medial border of the tibia.² Perforators of posterior tibial artery were identified and marked preoperatively using hand held Audio Doppler. The perforators were usually found 1 to 1.5 cm away from the vascular axis.

The size of the defect ranged from 2.5cm to 6cm of width and 3cm to 17cm of length. The dimensions of the flap ranged from 3cm to 8cm of width and 5cm to 21cm of length. Largest flap size of our study was 21 x 8 cm. Which was performed to cover a defect involving both middle and lower 3rd following RTA. In all the cases, the grafted donor site healed without any complication except for one case where the donor site scar became hypertrophied and was treated accordingly.



Figure-2a and b: Cadaveric dissection and dye test

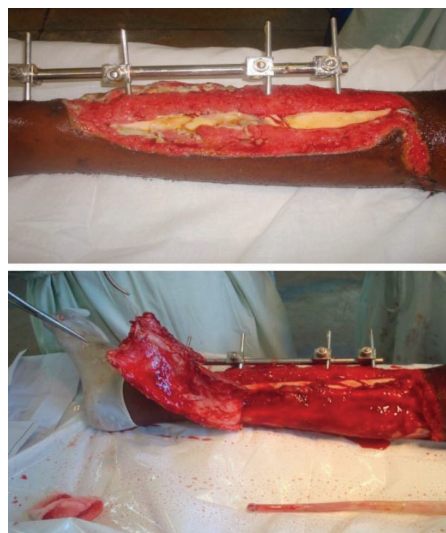


Figure-3a (preoperative) and b: Dissecting retrograde fasciocutaneous flap based on lower two perforators



Figure-4: Post-operative picture

In all the cases the donor site healed with a skin graft scar. There was no necrosis of skin flaps at the donor site. In one case donor site scar becomes hypertrophied and was treated with adjuvant therapy.

No complications related to the flap was observed except in one diabetic case wound infection had occurred. Majority of cases were discharged within 2-3 weeks. In

one diabetic case with wound infection hospital stay was extended for more than one month and in one case with skin graft scar managed conservatively with adjuvant therapy. All cases were regularly followed up after discharge 2 weekly for one and half month, monthly for three month, and then advised three monthly after one year. In every follow up flap site was evaluated for any unstable scarring, sinuses, ulceration, restriction of movement of underlying tendons and none of the patient developed these complications. Donor site skin graft scar was also evaluated and in one case patient developed hypertrophic scarring over donor site. Reasonable protective sensations develop between six to twelve months in majority of the patients.

DISCUSSION

Ponten B³ introduced fasciocutaneous flaps for management of soft tissue defects of lower limb. After this study different research work have been carried out for understanding their vascularity.

Hong et al. reported the use of a reverse pedicled posterior tibial artery flap in four patients. He also described that such flap can reach any part of the foot⁴

Chuenkongkaew et al reported that the reverse-flow posterior tibial fasciocutaneous flap can be successfully transferred to cover lower leg and foot defects in 2 patients.⁵

Amarante et al.⁶ described, a distally based flap on the medial side of the lower leg. In ten cadaver dissections two perforating arteries (located 4 and 6.5 cm proximal to the medial malleolus) from the posterior tibial artery were a constant finding in his study and a flap has been designed based on these perforating arteries successfully in four patients

Tolhurst et al. enumerated, advantages of fasciocutaneous and the blood supply of the deep fascia.⁷

Carriquiry et al.⁸, Cormack and Lamberty (1984)⁹, and Ismail AM (1997)¹⁰ performed a methylene blue dye study of the leg in cadavers, and they revealed that the septocutaneous vessels were an important source of skin circulation and were the basis for various fasciocutaneous flaps.

Bhattacharya et al.¹¹ performed 40 fasciocutaneous flap based on the lower perforators of posterior tibial artery. They observed that in the fasciocutaneous flap, the dye reached up to 20 cm from a point 8 cm proximal to the tip of the medial malleolus through the lower two sizeable perforators and found the safe haemodynamic territory of the fasciocutaneous perforator-based flaps (which was about 20cm) whereas in live patient they expected the actual safe territory should be 22 cm i.e. more about 2cm.¹¹

In our study, we also found distal two perforators lie within 4-7cm from the tip of medial malleolus. 14 legs were dissected after injecting methylene blue dye through the lower two perforators of posterior tibial artery. We found the reach of the dye was about 19cm (mean) through the lower two perforators. So we can consider the safe limit of retrograde fasciocutaneous flap perfused by distal two perforators is 19 cm from a point 7 cm proximal to the tip of the medial malleolus.

We have used fasciocutaneous flap in ten cases to reconstruct soft tissue defects of lower limb based on the perforators of posterior tibial artery. Majority of defect were due to RTA which was similar as mentioned in most of the studies in the literature, two were chronic diabetic ulcer and one had domestic accident. Out of the 10 cases 9 were male and 1 female. The location of the perforators was marked preoperatively by Audio Doppler satisfactorily. In our clinical study the location of the perforators were all most same as observed in the cadaveric dye study. Most of the defects of distal 3rd of the leg and foot were managed by perforator based fasciocutaneous flaps; Vascular axis of posterior tibial artery was identified and marked preoperatively by drawing a reference line joining the tibial tuberosity and the mid malleolar point. The vascular axis lies approximately 4.5cm medial and parallel to this line or 1.5 cm from the medial border of the tibia.² Perforators of posterior tibial artery was identified and marked preoperatively using hand held audio Doppler. All necessary investigation including blood parameters, x-rays etc. done preoperatively. In all the cases, the donor site healed smoothly, except for one case where hypertrophic scar occurred over the donor site of skin graft. In one case we encountered wound infection which was managed conservatively.

CONCLUSION

The present study illustrates that the sizeable perforators of posterior tibial artery are found in the leg from knee to ankle and has a reliable vascular territory for dissecting retrograde fasciocutaneous flap based on lower two perforators. We found that retrograde flaps are very useful and a simple solution for various difficult defects of the distal third of the leg, ankle, heel, midsole, malleolus and dorsum of the foot. However, in clinical practice, local and systemic factors should always be considered before planning of flap. Preoperative reference line and audio Doppler helps in identifying the perforators during flap dissection.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 25-08-2017; **Accepted:** 30-09-2017; **Published:** 08-10-2017