International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(1):1988-93. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.127

Original Research Article

A DESCRIPTIVE STUDY ON THE BRANCHING PATTERN AND COURSE OF POSTERIOR TIBIAL ARTERY IN ADULT HUMAN CADAVERS

Jeyanthi C Gnanadeepam [1], Anjana TSR *[2], T Preethi Ramya [3].

[1,3] Associate Professor, Department of Anatomy, Government Kilpauk Medical College, Kilpauk, Chennai, Tamil Nadu, India.

[2] Assistant Professor, Department of Anatomy, Government Kilpauk Medical College, Kilpauk, Chennai, Tamil Nadu, India.

ABSTRACT

Background: In the background of increased incidence of vascular diseases affecting lower extremities in diabetics and smokers, arterial revascularization procedures are performed to obtain maximal perfusion to the foot, thereby restoring normal arterial pressure to the target area. Hence knowledge of the branching pattern and course of posterior tibial artery bears much clinical relevance.

Materials and Methods: The study material consists of twenty adult human cadavers (14 males and 6 females) at the Institute of Anatomy, Madras Medical College, Chennai, Tamil Nadu, India.

Results: In 85% of specimens, the posterior tibial artery arose from the popliteal artery at the lower border of popliteus. In 5% of specimens, the artery was replaced by peroneal artery. In 87.5% of specimens, three to five perforator branches arose from the posterior tibial artery. Mostly the perforators were located in the middle quarters of the leg and the last branch was located at an average of 8.9cm from the medial malleolus.

Conclusion: The knowledge of the course and branching pattern of posterior tibial artery is essential for achieving successful wound healing and avoidance of amputation in pathologies involving lower extremities. Also, the location of perforator helps in retrieval of fasciocutaneous flaps in treating an infected wound.

KEY WORDS: Posterior Tibial Artery, Branches, Wound healing.

Address for Correspondence: Dr. Anjana TSR, Department of Anatomy, Government Kilpauk Medical College, Kilpauk, Chennai-600010, Tamil Nadu, India. **E-Mail:** tsranjana@gmail.com

Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.127

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 30 Jan 2016 Accepted: 12 Feb 2016
Peer Review: 31 Jan 2016 Published (O): 29 Feb 2016
Revised: None Published (P): 29 Jan 2016

INTRODUCTION

The posterior tibial artery arises as one of the terminal branches of popliteal artery [1]. It starts at the level of lower border of popliteus muscle and ends at the distal border of flexor retinaculum [2,3]. At the lower border of the popliteus, it lies at the interval between tibia and fibula, then passes downwards and medially on the back of the leg. During the course, it then lies successively upon tibialis posterior, flexor digitorum longus, tibia and the back of ankle joint [2]. Along its course, the vessel is accompanied by two venae comitantes which are in turn interconnected by numerous transverse communications [3]. It is related to the tibial nerve which lies at first on its medial side, but soon crosses it superficially and is in the greater part of its course on its lateral side [4]. Under the flexor retinaculum, the artery passes between flexor digitorum longus tendon

medially and flexor hallucis longus tendon laterally.

At the distal border of flexor retinaculum, it terminates by dividing into medial and lateral plantar arteries [5]. The course may be marked on the surface by a line drawn from the center of popliteal region to a point midway between medial malleolus and calcaneus [6]. The pulsation can be felt at its termination, midway between medial malleolus and medial tubercle of calcaneum [7]. It gives off the following branches including circumflex fibular artery, peroneal artery, nutrient artery of the tibia, muscular branches, communicating branch, medial malleolar branches, perforator branches and medial calcaneal branches before dividing into terminal branches medial and lateral plantar arteries [1, 8].

The following variations may be encountered in the origin, course and modes of termination and level of bifurcation of posterior tibial artery. The origin of the posterior tibial artery may either lie above or below the usual site of origin which is at the lower border of popliteus. The high division of popliteal artery is often associated with origin of peroneal artery from the anterior tibial artery rather than posterior tibial artery [9]. According to Adachi (1928), the division of posterior tibial artery above the middle of the posterior surface of the popliteus is considered to be a high division [10].

Sometimes the posterior tibial artery may be absent or much reduced in length or caliber. In such cases, the peroneal artery takes over its distal territory. The true absence of peroneal artery has never been reported [11]. The embryological basis of that is as follows. The lower limb vessels arise from two sources, the primary axial artery which is a branch of the umbilical artery and the femoral artery, a continuation of external iliac artery. The popliteal and peroneal arteries arose from the axial artery. Being a derivative of axial artery, the peroneal artery is constant and hence its true absence has hitherto not been reported [12].

The nutrient artery was found to arise in the upper third of the leg in majority of specimens. The level of termination may also vary from being under the flexor retinaculum or beneath the origin of abductor hallucis. Apart from the afore mentioned branches, the posterior tibial artery gives off perforator branches which are of utmost clinical significance. The fasciocutaneous flaps based on the perforator branches of posterior tibial artery can be used for reconstruction of soft tissue defects involving the lower limb [2]. Hence the present study aims to give a detailed observation on the course, branching pattern and termination of posterior tibial artery.

MATERIALS AND METHODS

The study material consisted of twenty adult human cadavers (14 males and 6 females) at the Institute of Anatomy, Madras Medical College, Chennai. A longitudinal incision on the back of the leg from the middle of popliteal fossa to the heel was made and from there on extended till the level of middle toe. Skin, superficial fascia and deep fascia were reflected. The flexor retinaculum was exposed posteromedial to the medial malleolus. Both the bellies of gastrocnemius were reflected downwards and the soleus was separated from its tibial attachment and reflected laterally along with the intermuscular septum. The lower border of popliteus was identified. After removing the fascia covering the lower part of popliteal vessels, the terminal branches of popliteal artery namely the anterior and posterior tibial artery were identified. Then the posterior tibial artery was dissected up to its termination under the flexor retinaculum [13]. Then the following parameters that are of clinical importance were studied in detail.

1. Origin of posterior tibial artery in relation to popliteus muscle.
2. Course and mode of termination of posterior tibial artery.
3. Level of bifurcation of posterior tibial artery.
4. Perforating branches – number, origin and the distance of the last perforator from the medial malleolus.
5. Nutrient artery to tibia.

RESULTS

The following observations were made in relation to the origin, course, branching pattern and mode of termination of posterior tibial artery and the results were tabulated from Table 1 to 5.

Table 1: Origin of Posterior tibial artery.

S no	Origin of posterior tibial artery	Number of specimens (Total specimens = 40)	Frequency (percentage)
1	At the lower border of popliteus	34	85%
2	Above the lower border of popliteus	3	7.50%
3	Below the lower border of popliteus	1	2.50%
4	At the lower border of popliteus but extending laterally	2	5%

Table 2: Course and Mode of Termination.

S no	Course and mode of termination(based on the description in the introduction section)	Number of specimens (Total specimens = 40)	Frequency (percentage)
1	Normal course	34	85%
2	More medial course and termination at a higher level	2	5%
3	Terminate by joining the peroneal artery	2	5%
4	Replaced by peroneal artery	2	5%

Table 3: Level of Bifurcation.

S no	Level of bifurcation	Number of specimens (Total specimens = 40)	Frequency (percentage)
1	Under flexor retinaculum	32	80%
2	Replaced by peroneal artery	2	5%
3	Terminated proximal to flexor retinaculum	2	5%
4	Termination by joining with peroneal artery	2	5%
5	Under abductor hallucis	2	5%

Table 4: Origin of Peroneal Artery.

S no	Origin of peroneal artery	Number of specimens (total = 40)	Frequency (percentage)
1	From posterior tibial artery	38	95%
2	From popliteal artery	2	5%

Table 5: Perforating Branches.

S no	Number of perforator branches	Origin	Number of specimens (total = 40)	Frequency (percentage)
1	Three	Peroneal artery	2	5%
2	Three to five	Posterior tibial artery	35	87.50%
3	Five or more	Posterior tibial artery	3	7.50%

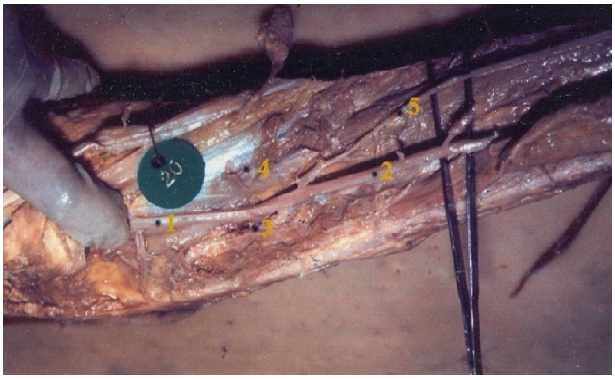
The distance of the last perforator branch from the medial malleolus was measured. When the number of branches varied between three to five, the average distance of the last perforator was found to be around 8.9 cm to 12.2 cm from the medial malleolus in thirty seven specimens. The mean $\pm$ standard deviation of the distance was found to be 10.55 $\pm$ 2.33. In three specimens where there were five or more perforators, the average distance of the last perforator from the medial malleolus was found to range from 2.4cm to 4.8cm.

Nutrient Artery: In 35 specimens (88%), the nutrient artery to tibia arose from the posterior tibial artery at a distance of 1.5 to 3.5cm below the lower border of popliteus in the upper third of tibia. Then it passed through the substance of tibialis posterior and entered into the nutrient foramen on the posterior surface of tibia. In 3 specimens (7%), the nutrient artery entered the tibia in the middle third and in 2 specimens (5%), the nutrient artery arose from the peroneal artery.

Fig. 1: Showing high origin of posterior tibial artery.

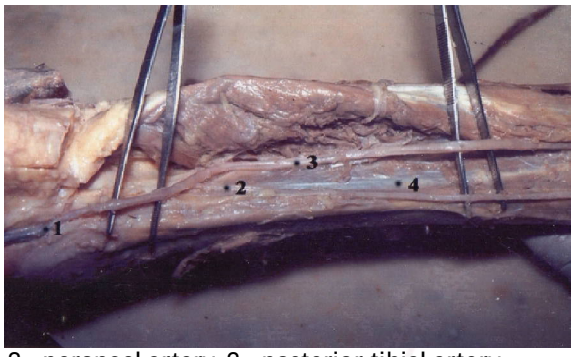
1) popliteal artery 2) posterior tibial artery
3) anterior tibial artery 4) popliteus.

Fig. 2: Showing small sized posterior tibial artery.



1) popliteal artery 2)peroneal artery 3)anterior tibial artery 4) popliteus 5) posterior tibial artery.

Fig. 3: Showing termination of posterior tibial artery by joining peroneal artery.

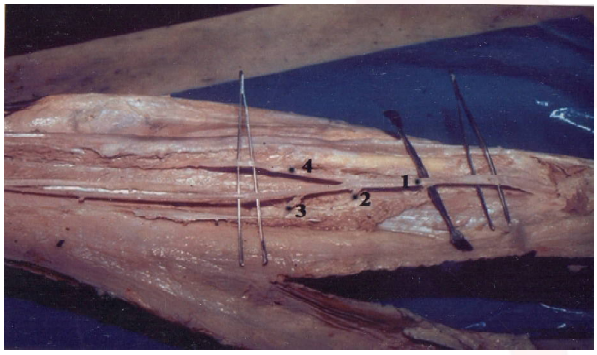


1,3 - peroneal artery, 2 - posterior tibial artery.
4 - tibialis posterior artery.

Fig. 4: Showing peroneal artery arising from popliteal artery and absent posterior tibial artery.

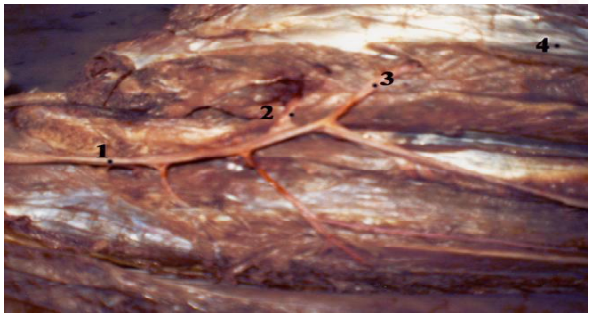
1)popliteal artery 2)peroneal artery 3)circumflex fibular artery 4)muscular branch 5)tibial nerve.

Fig. 5: Showing the origin of nutrient artery to tibia from posterior tibial artery.



1) posterior tibial artery 2) circumflex fibular artery 3) nutrient artery to tibia 4) peroneal artery.

Fig. 6: Showing the origin of two perforator branches from posterior tibial artery.



1) posterior tibial artery 2,3) perforating branches 4)soleus muscle.

DISCUSSION

The present study on the origin, course and branching pattern was compared with those of the previous studies.In the present study, the posterior tibial artery arose from the popliteal artery at the lower border of popliteus in 85% of specimens and it coincides with studies by various authors including Henry Gray (1858)[2], Keith L. Moore (1980) [14] and Hollinshead W. H (2001)[15].

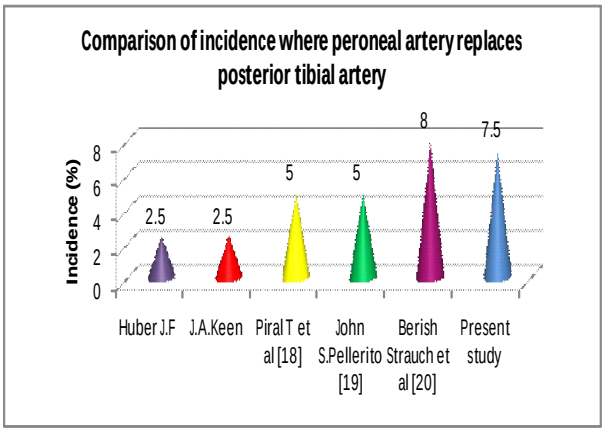
Table 6: Comparison of the Origin of Posterior Tibial Artery above the Lower Border of Popliteus.

Author	Adachi B et al. 1928 [10]	William J.Zwiabel 2000 [16]	J.A.Keen 1961 [17]	Parson. F. G and Robinson A 1898 [9]	Present study
Incidence	2.80%	4%	5%	8.20%	7.50%

As far as the origin of posterior tibial artery above the lower border of popliteus muscle, the incidence varied between 3% and 8% among various authors. In the present study, the incidence was 7.5%. The knowledge of variations in the level of origin help the radiologists during interventional procedures.

The following chart demonstrates the difference in incidence of the condition where the posterior tibial artery is replaced by peroneal artery.

Graph 1: Comparison of incidence where the posterior tibial artery is replaced by peroneal artery.



Course and Mode of Termination: The posterior tibial artery took a normal course as described in the introduction section in 85% of specimens. In 5% of specimens, the posterior tibial artery is replaced by peroneal artery. And it coincides with those of Piral T et al and John S Pellerito (Graph 1).

In the remaining 10% of specimens, the posterior tibial artery either terminated at a higher

level or by joining with peroneal artery. The detailed course and variation in the mode of termination alerts the vascular surgeons in considering the choice of a vessel during reconstructive procedures. The peroneal artery is an important vessel to consider in limb salvage operations in the absence of suitable popliteal or tibial artery. In the present study, the level of bifurcation was under the flexor retinaculum in 82% of cases and this observation coincides with those of J.C.B.Grant, John V.Basmajian, Keith L.Moore and Richard Snell [21].

Apart from the aforementioned parameters, the perforator branches were studied in detail with reference to their origin, number, location and the distance of the last perforator branch from the medial malleolus. The perforators were located in the middle two quarters of leg in 92.5% of specimens .The presence of three to five perforating branches help plastic surgeons in choosing skin flaps based on them for wound closures. The perforator flaps provide the advantage of rapid dissection, flap elevation and reliable skin territory. As no special equipment is needed to retrieve such flaps, they can be replicated in smaller centres also [22].

CONCLUSION

The knowledge of variation in the level of origin and mode of termination helps radiologists and vascular surgeons during revascularization procedures for foot salvage. With the advent of femoral-tibial artery bypass for peripheral arterial disease, limb preservation has improved greatly. The perforating branches help the plastic surgeons in procuring refined lower extremity free flaps for reconstructive procedures. The main principle of arterial reconstruction in the treatment of diabetic foot is to obtain maximum perfusion to the foot and to restore normal arterial pressure to the target area. The knowledge of variations in the course and branching pattern of posterior tibial artery must be borne in mind by orthopaedicians, surgeons and radiologists during knee arthroplasty, operation for correction of aneurysm of popliteal artery, surgical release of clubfoot [23], angiographic studies, embolectomy and catheterization procedures. Accessibility to the leg arteries is a critical factor in achieving successful revascularization. Hence this study of origin, course, branching pattern and termination of posterior tibial artery helps surgeons and radiologists in their respective fields.

Conflicts of Interests: **None**

REFERENCES

[1]. Boileau Grant J C, Basmajian J V. Grant's method of Anatomy. Seventh edition. Baltimore: The Williams and Wilkin's company; 1965: 366-367.
[2]. Standring S. Gray's Anatomy. Thirty ninth edition. London: Elsevier Churchill Livingstone; 2005: 1502-1503.
[3]. Thomas Walmsley. A manual of practical anatomy: A guide to the dissection of human body. Part I. second edition; London: Longmans, Green & company; 1922: 320-322.
[4]. Frazer J E and Robbins R H. Manual of Practical Anatomy: vol 1. London: Bailliere, Tindall & Cox; 1937: 624-627.
[5]. Morris Human Anatomy. Eleventh edition; Newyork: The Blakiston Division/McGraw-Hill Book company; 1942: 736-740.
[6]. George Arthur Piersol's Human Anatomy. Philadelphia: J.B.Lippincott company; 1936: 834-840.
[7]. Boyd J D. Textbook of Anatomy. Michigan: Macmillan; 1956: 365.
[8]. Russel T Woodburne. Essentials of Human Anatomy. London: Oxford University Press; 1961: 566-567.
[9]. Parson F G and Robinson A. Eighth report of the committee of collective investigation of the Anatomical Society of Great Britain and Ireland for the year 1897-98. November 1898; 33(1): 189-203.
[10].Adachi B. Anatomie der Japaner I. Das Arteriensystem der Japaner. Aorta thoracalis e Arcus plantaris profundus. Bd II., Kyoto, Verlag der Keiserlich-Japan Univ. 1928; 215–241
[11]. Senior H D. Abnormal branching of the human popliteal artery. American Journal of Anatomy. 1929; 44: 111.
[12]. Jiji P J, et al. Hypoplastic posterior tibial artery and the enlarged peroneal artery supplying the posterior crural region: a rare variation. J Vasc Bras. 2008; 7(3): 272-274.
[13]. Romanes G J. Cunningham's manual of practical anatomy. 15th ed. Newyork: Oxford University Press; 1986: 910-911.
[14]. Keith L Moore. Clinically Oriented Anatomy. Philadelphia: Williams & Wilins; 1980: 528-529.
[15]. Hollinshead W H. Anatomy for Surgeons. Second edition. Newyork: Harper and Row; 1965: 803-808.
[16]. William J Zwiebel. Introduction to vascular ultrasonography. Fourth edition; St.Louis: Saunders; 2000: 265-266.
[17]. Keen J A. A study of the arterial variations in the limbs. American Journal of Anatomy. May 1961; 108: 254-256.

[18]. Huber J F. The arterial network supplyng the dorsumof the foot. The Anatomical Record. 2005; 80(3): 373-391.
[19]. Piral T, Germain M, Princ G. Absence of the posterior tibial artery: Implications for free transplants of the fibula. Surg Radiol Anat. 1996; 18(2): 155-8.
[20]. Berish Strauch, Han-Liang Yu. Atlas of Microvascular Surgery: Anatomy and Operative Techniques. Second edition. Stuttgart: Thieme Medical Publishers; 2011: 218,219,264.
[21]. Richard S Snell. Clinical Anatomy for medical students. Fifth edition. Boston: Little Brown & Co; 1995: 563, 564, 606.
[22]. Ramesh S, Mohd Ali MZ, HJ Basiron N, Ajik S(2013). Propeller Flaps in Lower Limb Reconstruction: case series. Anaplastology S1: 003. Doi: 10.4172/2161-1173.S1-003.
[23]. Maria A, Georgi PG and Lazar J. Intriguing variations of the tibial arteries and their clinical implications. International Journal of Anatomical Variations. 2011; 4: 45-47.

How to cite this article:

Jeyanthi C Gnanadeepam, Anjana TSR, T Preethi Ramya. A DESCRIPTIVE STUDY ON THE BRANCHING PATTERN AND COURSE OF POSTERIOR TIBIAL ARTERY IN ADULT HUMAN CADAVERS. Int J Anat Res 2016;4(1):1988-1993. **DOI:** 10.16965/ijar.2016.127