

A STUDY OF PLANTAR ARTERIAL ARCH WITH ITS SURGICAL PERSPECTIVE

Anupama K ^{*1}, Saraswathi G ², Shailaja Shetty ³.

^{*1} Assistant professor, Department of Anatomy, M S Ramaiah Medical College. Bangalore, Karnataka, India.

² Retired Professor, Department of Anatomy, J S S Medical College, JSS University, Mysore, Karnataka, India.

³ Professor and Head, Department of Anatomy, M S Ramaiah Medical College. Bangalore, Karnataka, India.

ABSTRACT

Introduction: In the present day scenario the advances in the field of plastic, reconstructive and microvascular surgeries of the foot has necessitated a thorough knowledge of variations in the formation and branching pattern of plantar arterial arch. The blood supply of the sole is rich and is derived from the branches of the plantar arterial arch formed by variable contributions of dorsalis pedis artery, lateral plantar artery and medial plantar artery.

Materials and Methods: 50 feet of the formalin fixed adult human cadavers were dissected and studied, in the Department of anatomy, JSS Medical College, Mysore.

Results: The formation of plantar arterial arch and the origin of plantar metatarsal arteries were noted. The plantar arterial arch was classified into six types based on the origin of plantar metatarsal arteries. Type A-10%, Type B- 4%, Type C- 26%, Type D- 36%, Type E- 20%, Type F- 4%. It was also classified into 3 types based on the contribution of the formative arteries. Type I – 40%, Type II – 36% and Type III – 24%.

Conclusion: The present study was undertaken due to its clinical importance in the field of reconstructive surgery, microvascular surgery and autograft transplantation.

KEY WORDS: Plantar arterial arch, Plantar metatarsal arteries, Reconstructive surgery; Microvascular surgery.

Address for Correspondence: Dr Anupama K, Assistant Professor, Department of Anatomy, MSRIIT Post, M S Ramaiah Medical College, Bangalore- 560054, India. Phone No: 9449249001

E-Mail: dranukodial@yahoo.co.in

Access this Article online

Quick Response code



DOI: 10.16965/ijar.2016.228

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

Received: 05 May 2016	Accepted: 16 May 2016
Peer Review: 05 May 2016	Published (O): 31 May 2016
Revised: None	Published (P): 31 May 2016

INTRODUCTION

The architecture of the skeletal and fibro muscular components of the foot is very nicely designed to support its function. The blood supply maintains the structural integrity of the structures [1]. The arteries of the sole are

derived from three source deep plantar branch of Dorsalis pedis artery (DPA), Lateral plantar artery (LPA) and Medial plantar artery (MPA). The plantar arterial arch (PA) is formed by the variable contribution of the Lateral plantar

artery and the deep branch of Dorsalis pedis artery [2]. The plantar arch gives off three perforating and four plantar metatarsal branches and an additional lateral digital branch to the fifth toe which is known as Fibular Plantar Marginal artery (FPMA) [3,4].

Variations in the branching pattern of plantar arterial arch have been described and are fairly common. This is due to variable contributions of dorsalis pedis artery and lateral plantar artery for the origins of plantar metatarsal arteries.

In the present study the variations in the formation and branching pattern of the plantar arterial arch was noted and it was classified based on the origin of plantar metatarsal arteries as described by Saraffian:

Type A: The arch was formed only by the deep plantar branch of dorsalis pedis artery and supplies all the plantar metatarsal arteries 1 to 4 and the fibular plantar marginal artery.

Type B: The point of union was located between the 4th plantar metatarsal artery and the fibular plantar marginal artery. The deep plantar branch of dorsalis pedis artery supplies the plantar metatarsal arteries 1 to 4.

Type C: The point of union was located between the 3rd and 4th plantar metatarsal arteries. The deep plantar branch of dorsalis pedis artery provides the plantar metatarsal arteries 1 to 3. The lateral plantar artery provides fibular plantar marginal artery and 4th plantar metatarsal artery.

Type D: The point of union was located between the 2nd and 3rd plantar metatarsal arteries. The deep plantar branch of dorsalis pedis artery provides the plantar metatarsal arteries 1 and 2. The lateral plantar artery supplies fibular plantar marginal artery, 4th and 3rd plantar metatarsal arteries.

Type E: The point of union was located between the 1st and 2nd plantar metatarsal arteries. The deep plantar branch of dorsalis pedis artery supplies only first plantar metatarsal artery. The lateral plantar artery supplies fibular plantar marginal artery, 4th and 3rd and 2nd plantar metatarsal arteries.

Type F: The plantar arterial arch was formed entirely by the lateral plantar artery and all the

plantar metatarsal arteries take origin from lateral plantar artery³. This study was undertaken because of its clinical importance in reconstructive surgery, vascular surgery, and autograft transplantation.

MATERIALS AND METHODS

50 feet (25 right and 25 left) from 25 embalmed adult cadavers (21 male and 4 female, 35-70 years of age) were dissected and studied in the Department of anatomy, JSS Medical College, Mysore. The structures of the foot were dissected carefully layer by layer. The oblique head of adductor hallucis was dissected to visualize the full course of lateral plantar artery and plantar arterial arch. The plantar metatarsal arteries were traced and its origin was noted. The presence of fibular plantar marginal artery and its origin was noted.

The contribution of dorsalis pedis artery and lateral plantar artery in the origins of plantar metatarsal arteries and fibular plantar marginal artery was noted to be variable. The length of the plantar arterial arch was measured from the point proximal to first metatarsal artery to the point distal to the last metatarsal artery. The length and the diameter were measured using a vernier caliper. Predominant artery contributing to the formation of plantar arch was determined by measuring the diameter of the arch at each commissure between the plantar metatarsal arteries in the entire course of the plantar arch. The commissure with the smallest diameter determined the point of anastomosis between the deep branch of dorsalis pedis artery and lateral plantar artery. Thus the origin of plantar metatarsal arteries was also determined.

The plantar arterial arch and its branches were then coated with acetone and quickfix solution, painted using synthetic enamel asian paints and photographed. The plantar arterial arch was then classified as described above.

OBSERVATIONS AND RESULTS

The plantar arterial arch was present in all 50 specimens. The classification of plantar arterial arch based on the contributions is shown in the table below.

Table 1: Typing based on the origin of plantar metatarsal arteries in the present study. (DPA= Dorsalis pedis artery, LPA= Lateral plantar artery, FPMA= Fibular plantar marginal artery).

Type of plantar arterial arch	Origin of Plantar metatarsal arteries from DPA	Origin of Plantar metatarsal arteries from LPA	No of specimens			Percentage
			Right	Left	Total	
Type A	1 to 4 Plantar metatarsal arteries+ FPMA.	-	2	3	5	10%
Type B	1 to 4 Plantar metatarsal arteries	FPMA	1	1	2	4%
Type C	1 to 3 Plantar metatarsal arteries	4 th Plantar metatarsal arteries + FPMA	4	9	13	26%
Type D	1 & 2 Plantar metatarsal arteries	3 & 4 Plantar metatarsal arteries + FPMA	9	9	18	36%
Type E	1 st Plantar metatarsal artery	2 to 4 Plantar metatarsal arteries + FPMA	8	2	10	20%
Type F	-	All plantar metatarsal arteries + FPMA	1	1	2	4%

Table 2: Showing measurements of Plantar arterial arch using a vernier caliper.

Mean length		Mean diameter	
Right	Left	Right	Left
4.62	4.74	0.41	0.39

Based on the amount of contribution from dorsalis pedis and lateral plantar arteries for the formation of plantar arterial arch it can be divided into three types.

Type I: Predominant contribution from Dorsalis pedis artery which was seen in 40% of the specimens.

Type II: Predominant contribution from Lateral plantar artery which was seen in 36% of the specimens.

Type III (Balanced type): Equal contributions of both Dorsalis pedis and lateral plantar arteries which was seen in 24% of the specimens.

Fig. 1: Showing Type A plantar arterial arch.

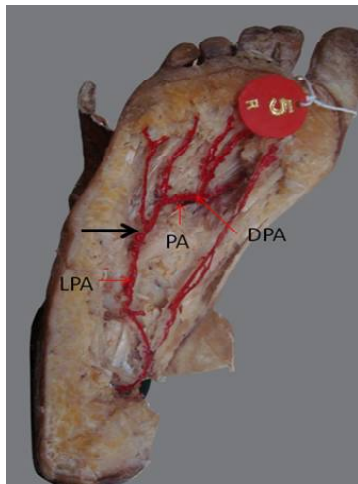


Fig. 2: Showing the Type B plantar arterial arch.

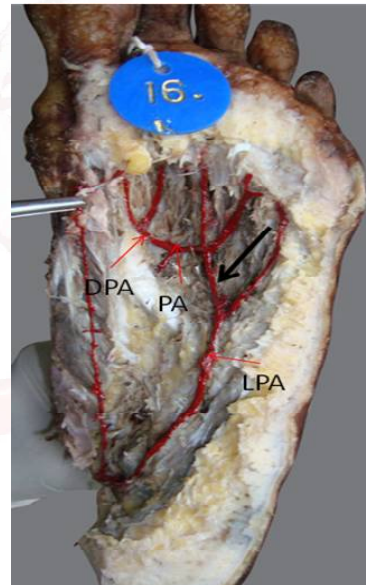


Fig. 3: Showing the Type C plantar arterial arch.

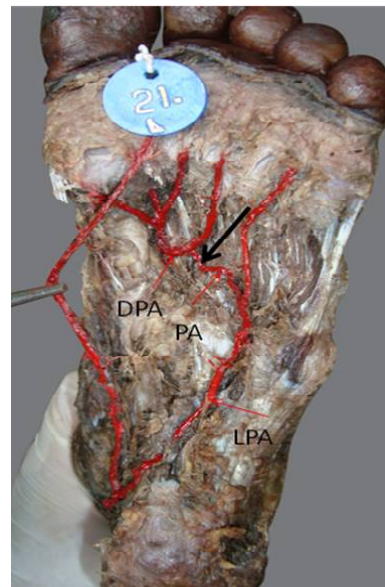


Fig. 4: Showing the Type D plantar arterial arch.

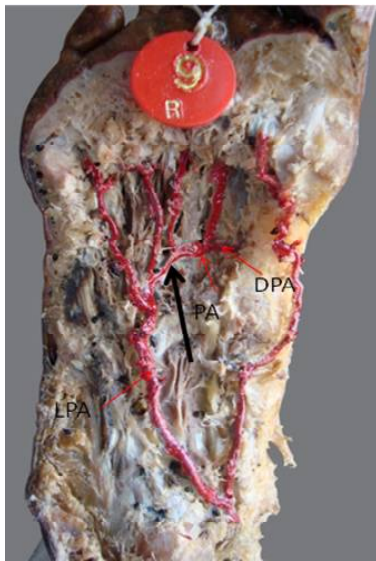


Fig. 5: Showing the Type E plantar arterial arch.

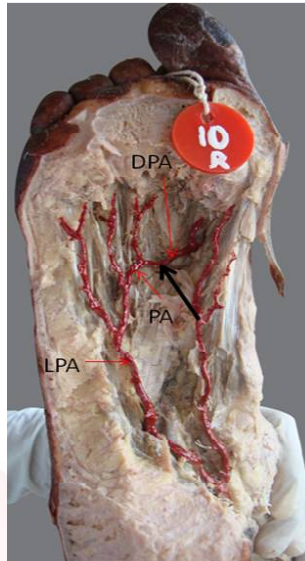
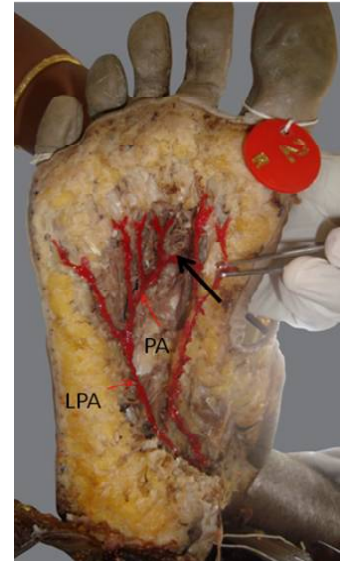


Fig. 6: Showing the Type E plantar arterial arch.



In all the above figures the black arrow represents the junction between dorsalis pedis and lateral plantar arteries.

DISCUSSION

Table 3: Comparison of incidence of different types of plantar arterial arch of our study with the other studies.

Type of plantar arterial arch	Kalicharan A et al. (40 feet)	Manno (66 feet)	Adachi (130 feet)	Present study (50 feet)
Type A	25%	48.40%	25.30%	10%
Type B	5%	51.60%	32.30%	4%
Type C	20%		14.60%	26%
Type D	24%		14.60%	36%
Type E	10%		6.10%	20%
Type F	21%	Nil	7%	4%

In the present study like Gabrielli et al and Ozer et al the plantar arch was classified into three types. According to Gabrielli et al Type I was found in 72%, Type II- 22% and Type III- 6%. The result of our study was similar to Ozer et al who found Type I plantar arch in 48%, Type II- 38% and Type III in 14% [1,6]. The mean length and diameter are similar to the study done by Kalicharan et al [5].

There are increased incidences of foot injuries caused by road traffic and industrial accidents and burns in the past few decades due to change in life style. A thorough knowledge of formation, branching and relations of plantar arteries help the vascular surgeons in successfully performing microvascular surgeries of the foot [6,7].

In patients with diabetes and peripheral arterial disease, the main occlusive process

involves the pedal arteries. In cases where either dorsalis pedis artery or lateral plantar artery is predominantly contributing to origin of all plantar metatarsal arteries; if it is involved in injury or occlusion then the amount of damage resulting due to it is extensive. The number of amputations has greatly reduced due to advances in vascular surgery wherein the vascularisation is restored by bypass surgeries in patients with critical ischemia of pedal arteries [8].

The dorsalis pedis artery was first used as the vascular basis for neurovascular flap by O'Brien et al. Almost simultaneously it was found that the plantar vascular system involving first and the second metatarsal arteries can also be used for such reconstructions. Since then a great variety of free composite tissue transfer from the foot such as: first web space neurovascular free flap, free toe to fingertip neurovascular flap, free dorsalis pedis flap including extensor tendons and others have been taken from the foot and used [7,9].

Similarity of the dorsal skin of the foot and hand are of great advantage in repairing defects of the dorsum of the hand as its first web space complements very satisfactorily. Hence neurovascular flaps from the foot are taken to repair the hand. The flap elevation not only requires technical skills, but also a thorough

knowledge of all anatomical details regarding the vascular supply in the area. Its long pedicle with relatively large vessels makes vascular anastomosis easy and safe [9,10].

Angiographic investigations especially Intraarterial digital arteriography and Contrast enhanced magnetic resonance angiogram not only help to identify the site of occlusion of the artery but also indicates the pattern of origin of plantar metatarsal arteries so that any procedures of the foot can be preplanned according to the anatomical basis [11].

CONCLUSION

The present study was undertaken due to its clinical importance in the field of reconstructive surgery, microvascular surgery and autograft transplantation such as:

1. Harvesting either the great toe or second toe to reconstruct thumb or any other digits of the hand.
2. Using neurovascular flaps for reconstructive purposes, as an autograft.
3. For vascular surgeons to perform arterial bypass grafting to prevent ischemic necrosis and hence to save the limb.

Conflicts of Interests: None

REFERENCES

- [1]. Gabrielli C, Olave E, Mandiola E, Rodrigues CFS, Prates JC. The deep plantar arch in humans. Constitution and topography. *Surg radiol anat.* 2001;23(4):253-258.
- [2]. Mahadevan V. Pelvis and lower limb. Chapter 84 in *Gray's Anatomy 40th ed.* Standring S. Churchill Livingstone. Elsevier; 2008:1455-1457.
- [3]. Sarrafian SK. Anatomy of the foot and ankle- Descriptive, topographic, functional. JB. Lippincott Company. Philadelphia; 1983:281-291.
- [4]. Anupama K, Saraswathi G, Jyothi K C, Shanmuganathan K. A Study of Fibular plantar marginal artery with its clinical perspective. *Int J Current research and review.* March 2014;06(06):71-74.
- [5]. Kalicharan A, Pillay P, Rennie C, Haffajee M R. The anatomy of the plantar arterial arch. *Int. J. Morphol.* 2015;33(1):36-42.
- [6]. Ozer MA, Govsa F, Bilge O. Anatomic study of the deep plantar arch. *Clinical anatomy.* 2005;18(6):434-442.
- [7]. Strauch B, Sharzer LA, Brauman D. Innervated free flap for sensitivity and coverage, chapter 14 in *Microsurgery for major limb reconstruction.* Urbaniak JR. Mosby publication; 1990:112-116.
- [8]. Hughes K, Domenig CM, Hamdan AD, Schermerhorn M, Aulivola B, Blattman S et al., Bypass to plantar and tarsal arteries: An acceptable approach to limb salvage. *Journal of vascular surgery.* 2004;40:1149-1157.
- [9]. Meyer. *Microsurgery and replantation.* Chapter 11 in *Surgery of musculoskeletal system.* Everts MC. Volume 1. Churchill Livingstone. New York;1983:244-229.
- [10]. Foucher G, Van FG, Morrison WA. Composite tissue transfer to the hand from the foot. Chapter 5 in *Recent advances in plastic surgery.* No 3. Jackson IT, Sommerland B C. Churchill Livingstone. New York;1985:65-81.
- [11]. Sebastien C, Douek P, Moulin P, Vaudoux M, Marchand B. Contrast-Enhanced MR Angiography of the Foot: Anatomy and Clinical Application in Patients with Diabetes. *American Journal of Radiology.* 2004;182:1435-1442.

How to cite this article:

Anupama K, Saraswathi G, Shailaja Shetty. A STUDY OF PLANTAR ARTERIAL ARCH WITH ITS SURGICAL PERSPECTIVE. *Int J Anat Res* 2016;4(2):2392-2396. DOI: 10.16965/ijar.2016.228