RESEARCH PAPER

Anatomical Variations Of Popliteal Artery & Its Terminal Branches – A Cadaveric Study

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ABSTRACT

Background - The popliteal artery is the major arterial supply to knee joint, leg and foot. Variations in its branching and termination patterns are clinically important during vascular, orthopedic and reconstructive procedures.

Aim - To study the morphology, branching pattern, termination and anatomical variations of the popliteal artery in cadavers and assess their clinical significance.

Materials and Methods - The observational cadaveric study was conducted in Department of Anatomy, Sharda School of Medical Sciences and Research, Sharda University on 60 lower limbs from 30 embalmed adult cadavers. Dissection of popliteal fossa was performed through the posterior approach. The origin, course, length, diameter, branching pattern and termination of the popliteal artery were studied. Variations were classified according to the Kim et al. classification system.

Results - In all 60 limbs, the popliteal artery continued from the femoral artery at the adductor hiatus and followed a normal course. The mean length and diameter of the artery were 18.4 cm and 8.1 mm respectively. Muscular and genicular branches were consistently present. One anomalous origin of the inferior lateral genicular artery from the anterior tibial artery (1.7%). The most common termination pattern was Type IA (80%), Type IB trifurcation (6.7%), Type IIIA (6.7%) and Type IIIB (6.7%).

Conclusion - The popliteal artery demonstrates considerable anatomical consistency in its origin, course and branching pattern; however, variations exist in its termination. Recognition of these variations is essential during angiography, bypass grafting, arthroplasty and trauma surgery to minimize vascular complications.

Keywords - Popliteal artery, Anterior tibial artery, Posterior tibial artery, Peroneal artery.

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INTRODUCTION

The popliteal artery is branch of the femoral artery beyond the adductor hiatus, is the main artery supply to the knee joint, leg and foot. It passes through popliteal fossa in close association with the popliteal vein and tibial nerve before terminating at the lower border of the popliteus muscle by dividing into the anterior tibial artery and the tibioperoneal trunk. The tibioperoneal trunk further divides into the posterior tibial and peroneal arteries.[1,2] This artery is deeply situated and so is intimately associated with other neurovascular structures, making it very significant both anatomically and clinically. Surgeons, orthopedic surgeons, vascular surgeons and radiologists should have knowledge of normal anatomy and branching pattern of popliteal artery. Unrecognized arterial variations may lead to vascular injury, hemorrhage, ischemia or operative complications, especially when handling procedures around the knee joint, or during traumatic situations like fractures and knee dislocations.[3,4] Anatomical variations of the popliteal artery are relatively common and include high division, trifurcation and hypoplasia or absence of terminal branches. These variations are due to persistence or regression of primitive vascular channels during embryological development. Such deviations could affect distal blood supply and they can make radiological interpretation and operative procedures more challenging.[5] Therefore, awareness of these patterns is

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essential for accurate diagnosis and safe clinical intervention. Cadaveric dissection remains one of the most reliable methods for studying vascular anatomy, as it allows direct visualization of the artery and its relation to adjacent structures. The present study was conducted to observe the branching pattern, level of termination and anatomical variations of the popliteal artery in cadavers, with emphasis on their clinical and surgical relevance.

MATERIAL METHOD

The present observational analytical cadaveric study was conducted in the Department of
Anatomy, Sharda School of Medical Sciences and Research, Sharda University over a period of 18 months (April 2024–November 2025). In this study 60 lower limbs from 30 well embalmed adult cadavers of the North Indian population were included. Cadavers with evidence of previous surgery, trauma or mutilation involving the knee and lower limb region were excluded. Dissection of the popliteal fossa was performed through the posterior approach using standard anatomical dissection techniques. The skin and superficial fascia were reflected and the popliteal fat was excised to expose neurovascular structures. The tibial nerve, common peroneal nerve and popliteal vein were identified and separated to visualize the popliteal artery. The artery was traced from the adductor hiatus to its terminal branches, namely the anterior tibial, posterior tibial and peroneal arteries. The course, branching pattern, level of termination, length, diameter and relation of the popliteal artery with surrounding structures were studied. The bifurcation or trifurcation of the artery was given special attention. The level of termination was noted in relation to the lower border of the popliteus muscle and intercondylar line of the femur. The digital Vernier caliper was used to take the measurements. Variations were categorized in accordance to the classification system of Kim et al. Photographic documentation was performed for all observed variations.

Ethical approval was obtained from the Institutional Ethics Committee prior to commencement of the study.

RESULT

Origin - In all 60 lower limbs (100%), the popliteal artery was observed as a direct continuation of the femoral artery at the adductor hiatus. No variation in origin was noted.

Course - The popliteal artery was normal in all specimens. It passed down from the adductor hiatus to the lower border of the popliteus muscle, deep to the popliteal vein and tibial nerve throughout its course.

Length -The length of the popliteal artery ranged from 16.2 cm to 21.0 cm, with an average length of 18.4 cm. Only slight variations in length were noted, with majority of specimens measuring 17cm – 19cm.

Diameter - The external diameter of the popliteal artery ranged from 6.4 mm to 10.2 mm, with an average diameter of 8.1 mm. The majority of the arteries were between 7–9 mm in diameter, and no narrowing or aneurysmal dilatation were observed.

Branching Pattern - In all the limbs, popliteal artery bore muscular branches along with five genicular branches. All specimens had the superior medial, superior lateral, middle and inferior medial genicular arteries (100%). In 59 limbs (98.3%), the inferior lateral genicular artery was a branch of the popliteal artery and in one limb (1.7%) it was a branch of the anterior tibial artery. No other anomalous branches were observed.

TERMINATION / BIFURCATION PATTERN OF THE POPLITEAL ARTERY

The terminal branching pattern of the popliteal artery was carefully evaluated and variants found were recorded and categorized based on Kim classification in all 60 dissected limbs.[6]

Table 1.1 - Distribution of terminal branching patterns of popliteal artery

Kim Classification	Number of Limbs	Percentage
Type IA	48	80.00%
Type IB (Trifurcation)	4	6.70%
Type IIIA	4	6.70%
Type IIIB	4	6.70%
Total	60	100%

Type IA pattern: Cadaveric dissection image illustrating the normal branching pattern. The popliteal artery (1)

bifurcates into the anterior tibial artery (2), and a common tibio-peroneal trunk subsequently divides into the posterior tibial artery (3) and the peroneal artery (4). In the present study, this pattern was observed in 48 out of 60 limbs (80%). **(Fig 1.1)**

Type IB pattern: Cadaveric dissection image illustrating a trifurcation pattern of the popliteal artery (1). Instead of the usual bifurcation, the artery directly divides into three terminal branches: the anterior tibial artery (2), posterior tibial artery (3), and peroneal artery (4), all at one level. This configuration eliminates the presence of a distinct common tibio-peroneal trunk. In the present study, this variant was observed in 4 out of 60 limbs (6.7%). **(Fig 1.2)**

Type IIIA pattern: Cadaveric dissection illustrating the popliteal artery (1) giving rise to a normal anterior tibial artery (2), while the posterior tibial artery is hypoplastic or absent. In this variant, the anterior tibial artery becomes the dominant distal vessel, and the peroneal artery (3) provides collateral supply to compensate for the reduced posterior tibial artery. In the present study, this pattern was observed in 4 out of 60 limbs (6.7%). **(Fig 1.3)**

Type IIIB pattern: Cadaveric dissections image illustrating the popliteal artery (1) giving rise to the posterior tibial artery (2) through the common tibio-peroneal trunk, while the anterior tibial artery is hypoplastic or absent. In this variant, the posterior tibial artery becomes the dominant distal vessel, and the peroneal artery (3) provides compensatory supply to the region normally supplied by the anterior tibial artery. In the present study, this pattern was observed in 4 out of 60 limbs (6.7%). **(Fig 1.4)**

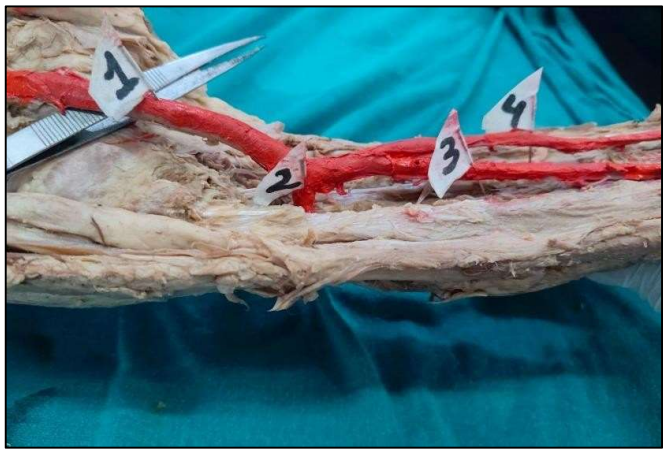

Figure1.1–Type IA pattern (1) Popliteal artery; (2) Anterior tibial artery; (3) Posterior tibial artery; (4)Peroneal artery.

Figure1.2- Type IB pattern (1) Popliteal artery; (2) Anterior tibial artery (3) Posterior tibial artery; (4) Peroneal artery

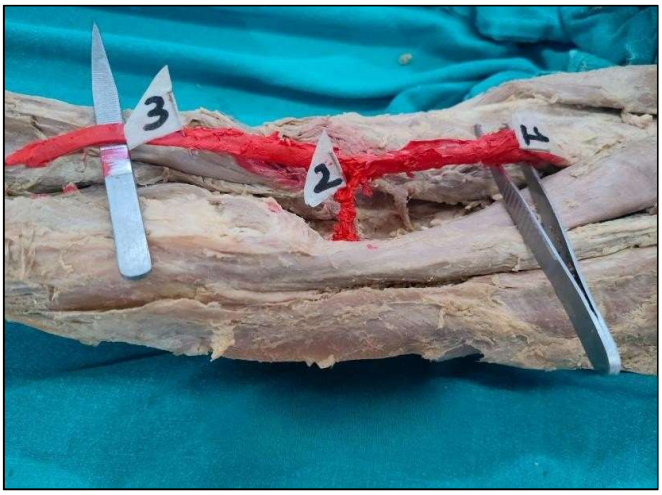

Fig 1.3–Type IIIA pattern (1) Popliteal artery (2) Anterior tibial artery (3) Peroneal artery.

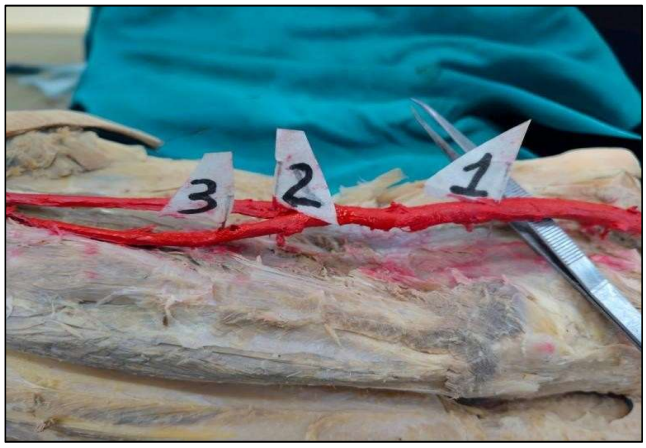

Fig 1.4–Type IIIB pattern (1) Popliteal artery (2) Posterior tibial artery (3) Peroneal artery.

DISCUSSION

The present cadaveric study was done to analyze the morphology, branching pattern and variations of the popliteal artery especially its terminal pattern as it is clinically important in vascular, orthopedic and reconstructive procedures.

The popliteal artery arose as a continuation of the femoral artery at the adductor hiatus in all 60 limbs studied and followed its normal course through the popliteal fossa. The artery remained deep to the popliteal vein and tibial nerve in almost all specimens, confirming the consistency of its anatomical relations. No abnormal origin or significant deviation in course was observed. These results coincide with those reported by cadaveric and imaging studies of the popliteal artery by Pinter et al. [7], and Rai et al. [8], which show a consistent origin and course of the popliteal artery.

The morphometric analysis revealed that the length of the popliteal artery ranged from 16.2–21.0 cm with a mean length of 18.4 cm, while the external diameter ranged from 6.4–10.2 mm with a mean diameter of 8.1 mm. These findings were comparable with previous studies by Mavili et al. [9], Tomaszewski et al. [10], and Singh et al. [11], indicating relatively stable arterial dimensions useful for vascular surgery and interventional procedures.

The branching pattern of the popliteal artery was largely consistent. Almost all specimens showed muscular branches, as well as all five genicular arteries. In one (1.7 %) of the specimens, the inferior lateral genicular artery originated from the anterior tibial artery in an abnormal manner and the other specimens had the usual origin. These results are consistent with the previous reports that the genicular branches are fairly stable and experience minor fluctuations at times.

The termination pattern showed the greatest variability. Type IA branching according to Kim's classification was the most common pattern, observed in 48 limbs (80%).

Type IB trifurcation was seen in 4 limbs (6.7%) and Type IIIA and Type IIIB each in 4 limbs (6.7%). The present study showed a relatively high prevalence of Type III variants as compared to previous studies. The Type IA has been reported as the predominant pattern in most studies conducted worldwide and locally in India. The frequency and distribution of variants differ among populations.

The present results show that the classical branching pattern of the popliteal artery is the most common, but there are significant variations that can be clinically important. The understanding of these variations is essential during angiography, bypass grafting, arthroplasty, trauma surgery and other vascular surgery procedures that are performed in the popliteal region.

Table 1.2 – Comparison of variation in popliteal artery with present study

Author	Year	Location	Type of Study	Sample Size	Type I A (%)	Type I B (%)	Type I C (%)	Type II A1 (%)	Type II A2 (%)	Type II B (%)	Type IIC (%)	Type III A (%)	Type III B (%)	Type III C (%)
Kim D[6]	1989	USA	Angiography	605	92.5	2.0	1.2	3.0	0.7	0.8	<0.2	3.8	1.6	0.2
Soumya P12	2017	Tamil Nadu	Cadaver	50	96	–	2	2	–	–	–	–	–	–
Bama N13	2018	Chennai	Cadaver	50	96	2	–	2	–	–	–	–	–	–
Jyothi S14	2019	Kannada	Cadaver	50	88	2	–	–	–	–	–	10	–	–
Angel15	2021	Punjab	Cadaver	30	96.7	–	–	3.3	–	3.3	–	–	–	–
Present study	2025	North India	Cadaver	60	80	6.7	–	–	–	–	–	6.7	6.7	–

CONCLUSION

The present study demonstrated that the popliteal artery shows considerable anatomical consistency in its origin, course, morphometry and branching pattern. However, significant variations were observed in its termination pattern, with Type IA bifurcation being the most common configuration. Trifurcation and hypoplastic or absent terminal branches were also identified, including bilateral occurrences, suggesting an embryological basis for these variations. These variations are clinically important as they may alter distal limb perfusion and complicate vascular, orthopedic and reconstructive procedures. Awareness of such patterns is essential during angiography, bypass grafting, arthroplasty and other interventions involving the popliteal region to reduce the risk of vascular injury and operative complications.

Scope for Future Study

Further large-scale cadaveric and radiological studies are required to determine the population prevalence of

popliteal artery variations and correlate anatomical findings with imaging and clinical outcomes. Advanced techniques such as CT angiography and 3D vascular reconstruction may improve understanding of the embryological basis and surgical significance of these variants.

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