

A Study of Variations in the Origin and Branching Pattern of Popliteal Artery: A Cadaveric StudyMohammed Awais Ahmed¹, Aditya Moota^{2*}, Anitha T³¹Associate Professor, Department of Anatomy, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar^{2*}Associate Professor, Department of Anatomy, Father Colombo Institute of Medical Sciences, Warangal, Telangana State³Professor & Head, Department of Anatomy, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar

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Abstract:**Background:** The popliteal artery is a major blood vessel located in the posterior region of the knee joint in the human body. The incidence of normal branching pattern of popliteal artery ranges between 92 - 96%. Knowledge of branching pattern of popliteal artery is of immense help to surgeons.**Aim and Objective:** To understand variation in the origin, length, diameter and branching patterns of popliteal artery.**Materials and Method:** This study was under observational study, conventional dissection method, in which 45, embalmed human adult lower limb specimens were included in the study. Adult lower limb specimens were obtained from the embalmed cadavers allotted for routine dissection to the first year MBBS students at our Institute for the duration of two year.**Results:** Mean length of popliteal artery was 18.8 cm. (16.9cm-20.7cm). Mean diameter of PA was 7.65mm.(6.9mm- 8.4mm). 97.78% of the specimen showed normal branching pattern while only 1(2.22%) Originated of inferior genicular artery (ILGA) from ATA. Out of 45 specimens, 43 specimens showed normal pattern of terminal division of PA. In one specimen, high division of PA was observed. In another specimen, trifurcation of PA was identified.**Conclusion:** Origin of the popliteal artery is the continuation of femoral artery in all the specimens, unusual origin of inferolateral genicular artery from anterior tibial artery was documented in one specimen & Variations of terminal branching pattern of popliteal artery were observed which included, high division of popliteal artery, trifurcation of popliteal artery into anterior tibial, posterior tibial and peroneal arteries.**Keywords:** Popliteal Artery, Branching Pattern, Inferior Genicular Artery.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

The popliteal artery is a major blood vessel located in the posterior region of the knee joint in the human body. It is an extension of the femoral artery, which runs down the thigh, and it becomes the popliteal artery as it passes through the adductor hiatus, a small opening in the adductor magnus muscle.

The popliteal artery then descends down the back of the knee joint and continues into the lower leg. The primary function of the popliteal artery is to supply oxygenated blood to the structures in the lower leg and the foot.

As it travels down the leg, it gives off various branches that provide blood to different areas. Most knee joint surgeries are affected by popliteal artery anatomy [1] This artery is near the femur and tibia

in the knee [2]. This joint's fractures and dislocations often cause vascular damage. It also increases knee arthroscopy bleeding [3]. Poor popliteal artery musculotendinous connection can cause entrapment syndrome. Classical form [4]. Understanding popliteal artery development can help explain aneurysm and entrapment syndrome. [5] Exercise-induced gastrocnemius muscle hypertrophy may develop functional popliteal artery entrapment syndrome (PAES) [6]. Additionally, anticipate PAES difficulties. Both above and below-knee bypass grafts can use the popliteal artery [7]. Arthroscopy, vascular grafting, direct surgical repair, transluminal angioplasty, embolectomy, and arterial injury detection require knowledge of popliteal artery branching changes [6].

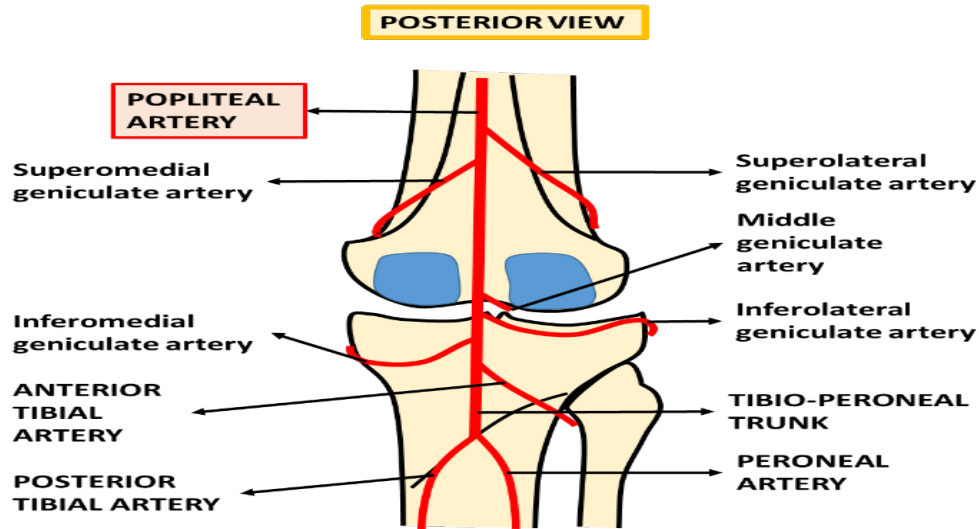


Figure 1 : Popliteal artery and its branching Patterns

Variations of the popliteal artery have been the subject of repeated study. The embryonic development determines the anatomic variability [8]. In young adults, especially athletes with anomalous anatomic relationship between the popliteal artery and the musculotendinous structures, serious disabilities may result. A variant artery may pass beneath the head of gastrocnemius or an aberrant band, causing occlusion of the artery and leading to popliteal entrapment syndrome.[9] The incidence of normal branching pattern of popliteal artery ranges between 92 - 96%. Variation of popliteal artery and its branching pattern may have clinical implications during vascular grafting, direct surgical repair, transluminal angioplasty, or embolectomy. Involvement of variant arteries during surgeries can lead to arterial complications like transection, fistula formation, pseudoaneurysms. Moreover differentiating occlusion or arterial injury from variation depends upon clinician's knowledge of variation [10]. Knowledge of branching pattern of popliteal artery is of immense help to surgeons, as this vascular component is also approached during bypass surgeries for revascularization of lower limb, to relieve popliteal entrapment syndrome, patellar surgeries and also repair of anterior cruciate ligament tear. [10]

Thus in the present study we tried to understand variation in the origin, length, diameter and branching patterns of popliteal artery.

Materials and Method

This study was under observational study, conventional dissection method, in which 45, embalmed human adult lower limb specimens were included in the study. Adult lower limb specimens were obtained from the embalmed cadavers allotted for routine dissection to the first year MBBS

students at our Institute for the duration of two year.

Method

Popliteal fossa was dissected as per the dissection steps given in Cunningham textbook of anatomy. A Transverse incision was made at the junction of middle and lower 1/3 of thigh and another transverse incision made at the junction of middle and lower 1/3 of back of leg. A vertical incision connecting the midpoints of the above two transverse incisions was made. Skin flap raised and the superficial fascia was stripped from deep fascia. Cutaneous structures were identified. After reflecting the deep fascia, the boundaries and contents of the popliteal fossa were defined. The two bellies of gastrocnemius were identified and separated from their attachment to the femur. Both bellies of the gastrocnemius were reflected downwards. The lower part of the popliteal vessels lateral, and the TN in the popliteal fossa were exposed. The soleus was separated from its tibial attachment and reflected laterally along with the intermuscular septum. The lower border of the popliteus was identified.

The fascia was removed from the popliteal vessels and the terminal branches namely the anterior tibial artery (ATA) and posterior tibial artery (PTA) were traced. ATA gives off at this level from popliteal artery and extends into the anterior compartment of leg. The PTA was traced up to the flexor retinaculum. The peroneal artery (PRA) was identified which arose from the PTA and traced along the back of the fibula undercover of flexor hallucis longus muscle. The large muscular branches of the PA were exposed and traced further. After removing the fat from the popliteal surface of the femur, the lateral, medial and middle

genicular branches were identified and traced. The following parameters were noted after dissection:

- The length of the PA was measured from its origin (hiatus of the adductor magnus) to the level of terminal division using a thread and scale.
- The diameter of the PA was measured using vernier callipers at the three different levels.(AH, level of bifurcation, midpoint)

- Variations in the terminal branching pattern of popliteal arteries were noted.

Observation and Results

In the study we have included 45 embalmed human adult lower limb specimens were included in the study. Adult lower limb specimens were obtained from the embalmed cadavers Of the 45 lower limb specimens dissected, in all the specimens (100 %) the PA was the continuation from Femoral artery

Table 1: Origin of Popliteal Artery

Origin of PA	Frequency	Percentage
From femoral artery	45	100
Other source of origin	0	0

The length of the PA is measured from adductor hiatus (AH) to the level of bifurcation into ATA and PTA. In the study we have observed that minimum length of PA among all study subjects was 16.9cm and maximum was 20.7 cm and mean length of popliteal artery was 18.8 cm.

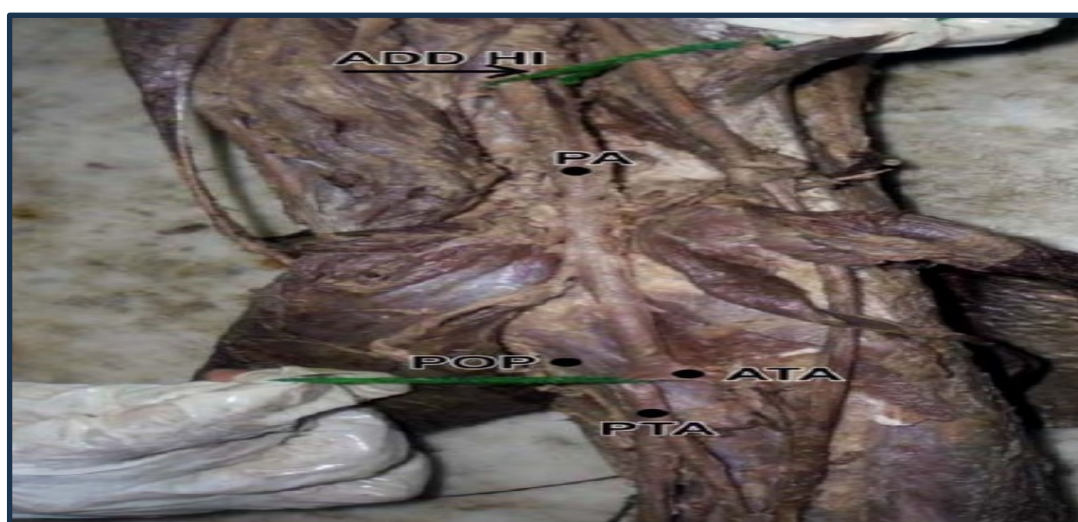


Figure 2: Normal Course of Popliteal artery

Table 2: Length of Popliteal Artery

Length of PA	In CM
Minimum	16.9 Cm
Maximum	20.7 Cm
Mean	18.8 Cm

Table 3: Diameter of Popliteal Artery

Diameter of PA	In mm
Minimum	6.9 mm
Maximum	8.4 mm
Mean	7.65mm

We have observed that minimum diameter of PA among all study subjects was 6.9mm and maximum was 8.4mm and mean length of popliteal artery was 7.65mm.

Table 4: Branches of the Popliteal Artery

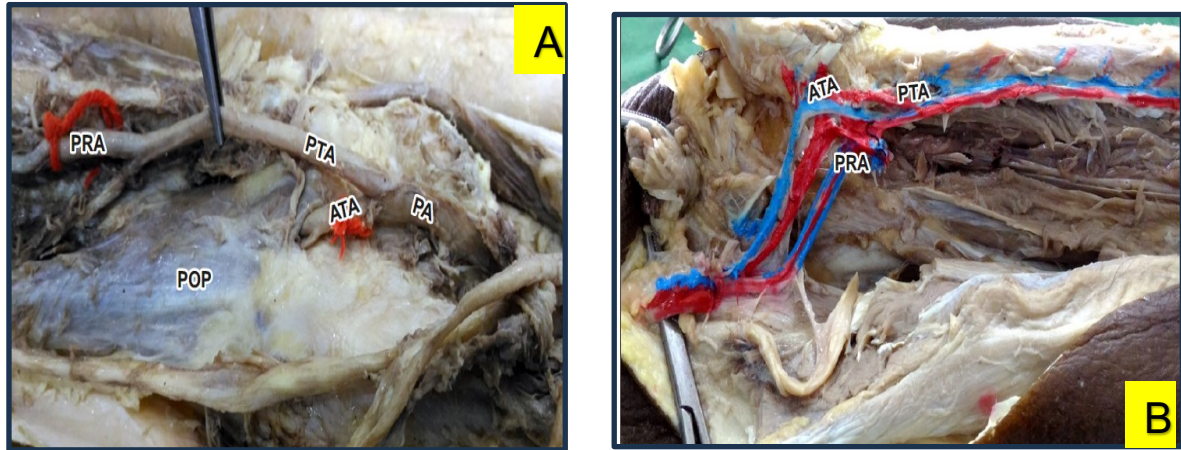
Branches of PA Specimen	Frequency	Percentage
Normal branching pattern	44	97.78
Origin of ILGA from ATA	1	2.22

Above table showed branches of the popliteal artery, out of all, 97.78% of the specimen showed normal branching pattern while only 1(2.22%) Originated of inferior genicular artery (ILGA) from ATA

Table 5: The Variations in the terminal division of Popliteal Artery

Termination of Popliteal artery	Number of Specimen	Percentage
Normal Termination of PA	43	95.6
High Division of PA	1	2.2
Trifurcation of PA	1	2.2

In the present study, out of 45 specimens, 43 specimens showed normal pattern of terminal division of PA. In one specimen, high division of PA was observed. In another specimen, trifurcation of PA was identified, shown in the table above and figures below.

**Figure A, B: High Division of Popliteal Artery and Trifurcation of Popliteal Artery**

Discussion

The popliteal artery which is the continuation of femoral artery is the main and prime arterial supply to the knee, to the leg and foot. Because of its situation, its branches are vulnerable for injuries and damage. The genicular arterial anastomoses form intricate anastomoses, superficial and deep and these are the sources of nutrition to the joints, articular capsule and synovial membrane. The single middle genicular artery is susceptible for damage during the use of arthroscopy.[11] The terminations of popliteal artery are of variable types and the importance of termination may alter the origin of peroneal and inferior set of genicular arteries.

In the present study all 45 embalmed human adult lower limb specimens, were dissected by using conventional dissection method that revealed normal origin, course and termination of popliteal artery. In our study all the lower limbs showed popliteal artery originated from femoral artery, which is in accordance with the study by D.K. Kadasne [12] (2009) stated that the PA runs as a continuation of FA beyond the opening of artery in adductor magnus. Another study by Richard S. Snell [13] (2010) quoted that the PA enters popliteal fossa through the opening in the adductor magnus, as a continuation of FA and ends at the level of lower border of popliteus by dividing into ATA and PTA. According to Gray's Anatomy [14] (2012), Susan Standring stated that PA is the continuation of FA. Sometimes it may arise as a

continuation of the sciatic artery which is a branch of inferior gluteal artery.

In our study 44 specimens showed usual branching pattern. In one specimen ILGA arose from ATA instead of PA. Perforators of PA and its branches are of two types' musculocutaneous and septocutaneous perforators. Study conducted by Billakanti et al [15] (2014) stated that IMGGA which is usually a branch of PA was found to be arising from ATA. Another study by Bettaiah et al [16] (2016) observed in 40 specimens, reported that common trunk for MGA, SLGA was nil, while common trunk for MGA, SLGA and SMGA was observed in 5% of the specimens.

Present study showed 95.6% of specimens showed normal pattern of terminal division of PA. In 2.2% of specimen, high division of PA and 2.2% of specimen trifurcation of PA was observed and these observations were consistent with studies conducted by Tindall AJ [17] (2006), Kim D et al [18] (1989) and Sanders RJ et al [19](1986). Another study by Susan Standring [14] (2012) stated that PA divides at distal border of popliteus in 90% of specimens. Ankit Khandelwal et al [20] (2014) reported 5% of HDEPA in 40 specimens. Oztekin et al [21] (2015) reported one case of dorsalis pedis artery (DPA) out of 495 extremities (0.2%). High origin ATA is surgically important as it is in direct contact with posterior surface of tibia. It has high risk of injury during knee arthroplasty, high tibial osteotomy and total knee replacement procedures. When a transverse tibial cut is made

through the tibial cortex using osteotomy drill, ATA is more prone to injury. The knowledge of variation of termination of PA is important during arthroscopic knee surgery to minimize the surgical complication. Sawant et al [22] (2013) studied 120 specimens and reported 5% trifurcation Oztekin et al (2015) reported trifurcation in 3 specimens out of 495 extremities (0.6%).

The popliteal artery is a commonly approached site for above- or below-knee bypass grafts. It is also frequently injured by penetrating and blunt trauma of the lower extremity. Exposure of this artery is therefore, often required in both emergency and elective vascular procedures. [23] Knowledge of the anatomic variability in this region may have clinical implications and are very essential during vascular grafting, direct surgical repair, transluminal angioplasty, embolectomy, other arterial injury. [24] Awareness of the anatomical variations in the branching of the popliteal artery is important because damage to its branches may result in limb disability or life threatening haemorrhage.

Conclusion

From the overall observation and discussion with the other studies we can conclude that, origin of the popliteal artery is the continuation of FA in all the specimens, unusual origin of inferolateral genicular artery from anterior tibial artery was documented in one specimen & Variations of terminal branching pattern of popliteal artery were observed which included, high division of popliteal artery, trifurcation of popliteal artery into anterior tibial, posterior tibial and peroneal arteries.

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