Original Article

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Radiology Section

Multidetector Computed Tomography Angiographic Evaluation of Anatomical Variations in Popliteal Artery Branching: A Retrospective Study from Northern India

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ABSTRACT

Introduction: The popliteal artery branching pattern has multiple variations which have implications in the outcomes of various surgical procedures. Amongst cadaveric, Computed Tomography (CT) angiographic and Digital Subtraction Angiographic (DSA) studies, Multidetector Computed Tomography (MDCT) Angiography provides a comprehensive, quick and efficient evaluation of the popliteal arterial anatomy along with surrounding structures and related pathologies of the vascular and non-vascular structures.

Aim: To evaluate the patterns of popliteal artery division on MDCT angiography of lower limb in patients presenting to a tertiary medical institute in Northern India.

Materials and Methods: This retrospective descriptive study was conducted in the Department of Radiodiagnosis at Shri Guru Ram Rai Institute of Medical and Health Sciences, Dehradun, Uttarakhand, India (tertiary care medical institute of Northern India). Patients presenting for a period of one year from April 2021 to March 2022 were included in the study. The MDCT angiographic findings of 152 patients who were evaluated for various illnesses, including peripheral vascular disease, popliteal arterial aneurysms, and trauma were analysed. The branching pattern of popliteal artery was evaluated according to the classification system provided by Kim DU et al. Morphometric analysis of popliteal artery, including diameter was also done. The imaging based data was collected and analysed by two radiologists. Chi-square test was used for statistical analysis.

Results: The mean age of the patients was 54.18 years with male predominance of 110 (72.37%). Amongst the 304 limbs available for evaluation, the data from six limbs could not be assessed due to atherosclerotic blockage in four patients, extensive calcification in one patient and amputation in one patient. Hence, 298 limbs were evaluated on MDCT angiography for the pattern of branching of popliteal artery. Type IA was the most common pattern of division seen in 268 limbs (89.93%). Out of 298, 30 limbs showed variant anatomy, with unilateral variation in 18 patients and bilateral variation in six patients. Type III pattern (n=12, 4.03%) was more common than Type II pattern (n=11, 3.6%) in the study group.

Conclusion: The knowledge of variations of popliteal arterial division and meticulous evaluation is essential to provide a successful roadmap for therapeutic measures.

Keywords: Angiography, Anterior tibial artery, Geographical locations, Lower extremity

INTRODUCTION

The popliteal artery is a continuation of the superficial femoral artery and its branches form the major vascular supply of the leg. The popliteal artery branches below the knee into Anterior Tibial Artery (ATA) and the Tibioperoneal Trunk (TPT), which further divides into Posterior Tibial Artery (PTA) and Peroneal artery (PR), in most subjects. However, variation to this division system, in either pattern or location has its repercussions on the outcome of various surgical and endovascular therapeutic procedures around the knee joint. Thus, the knowledge and preoperative evaluation of popliteal artery variant anatomy is essential for both successful outcome and prevention of complications during surgery [1-3].

There have been many ways to document popliteal artery anatomy and its variants including cadaveric studies, Digital Subtraction Angiography (DSA) and Multidetector Computed Tomography (MDCT) angiographic studies. While cadaveric studies provide a clear visual analysis and hence the best judgement for anatomical variations, they lack the additional evaluation of arterial pathology. Moreover, cadaveric study evaluation of a variant arterial anatomy has no clinical implication for the subject. Digital subtraction angiography on the other end of the spectrum provides an excellent opportunity of both diagnosis and therapeutic intervention together, giving a meticulous evaluation of arterial anatomy and pathology. Multidetector CT angiography is the most comprehensive investigation of these options, providing a non-interventional, quick approach for evaluation of arterial anatomy, intraluminal pathologies as well as pathologies of the surrounding soft tissues and bones giving a wholesome roadmap to the clinician regarding treatment planning [1,2,4]. Multiple previous studies in the literature have previously presented the popliteal arterial division patterns in different ethnic groups with variation in patterns across geographical locations; this was the first such study in North Indian population [2-4].

The aim of the present study was to evaluate the patterns of popliteal artery division as demonstrated by MDCT angiography in patients presenting to a tertiary medical institute in Northern India, highlighting the percentage of variants in popliteal anatomy in the given region, thereby directing the clinicians regarding treatment protocols in the population of that particular region.

MATERIALS AND METHODS

This retrospective descriptive study was conducted in the Department of Radiodiagnosis at Shri Guru Ram Rai Institute of Medical and Health Sciences, Dehradun, Uttarakhand, India (tertiary care medical institute of Northern India). The study was based on imaging and hospital data of MDCT lower limb angiography patients in the Department of Radiodiagnosis collected in the month of April 2022 for scans done over a period of one year from April 2021 to March 2022.

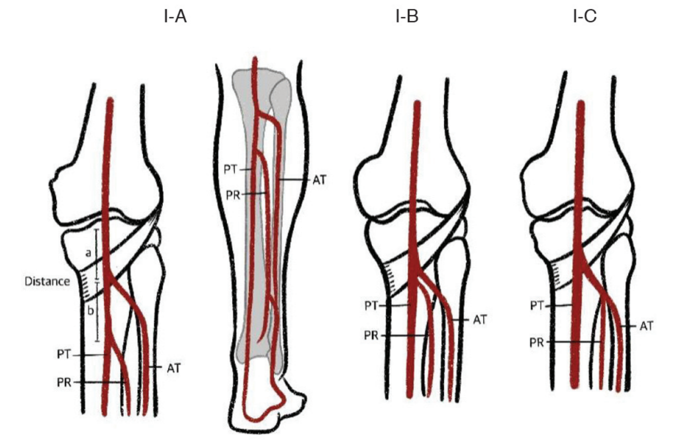
The clearance from the Institute's Ethical Committee was obtained (ECR/710/Inst/UK/2015/RR-21). A consent waiver was obtained since the patients had already undergone the required investigations for clinical requirements.

Inclusion criteria: All consecutive patients undergoing MDCT angiography of lower limbs for any indication (various illnesses including peripheral vascular disease, popliteal arterial aneurysms and trauma) were included in the study.

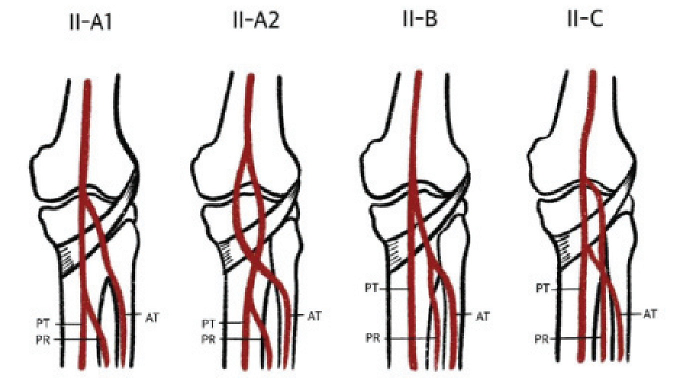
Exclusion criteria: Patients with severe below knee arterial disease which hampered evaluation of division of popliteal artery and its branches were excluded from the study.

Procedure

Two radiologists with more than five years of experience independently assessed and documented the anatomical features of popliteal artery and patterns of its division on MDCT angiography. In case of discrepancy, the senior radiologist's opinion was taken into account. The branching of popliteal artery was categorised under 10 groups according to the origin of the ATA in relation to the tibial plateau, as per the classification system provided by Kim DU et al., [Table/Fig-1-3] [5].



[Table/Fig-1]: Type I: Branching of popliteal artery below the tibial plateau. Type IA: Anterior Tibial Artery (AT) is the first branch followed by division into Peroneal artery (PR) and Posterior Tibial artery (PT). Type IB: The division of AT, PT and PR within a distance of 5 mm. Type IC: The division of PT as the first branch and the division of AT and PR as branches of Anterior Tibio Peroneal Trunk (ATPT).

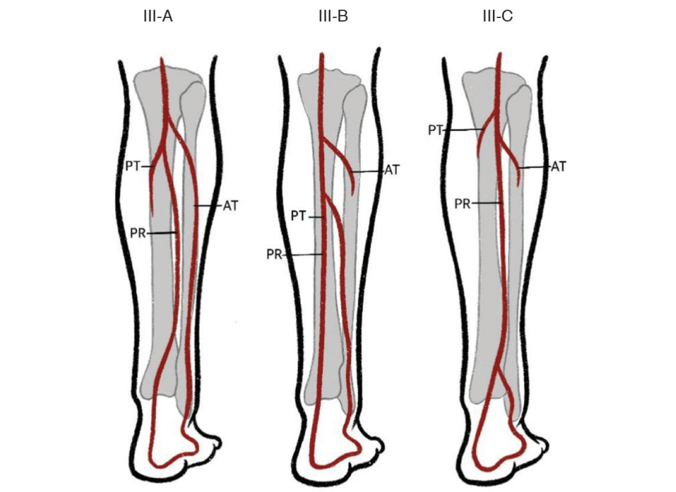


[Table/Fig-2]: Type II: High branching of popliteal artery above the tibial plateau. Type IIA: Division of AT above tibial plateau. Type IIA1: AT follows normal course after division. Type IIA2: AT follows medial course after division. Type II-B: Division of PT above tibial plateau as the first branch with AT and PR as branches of ATPT. Type IIC: Division of PR above tibial plateau as the first branch with AT and PT as branches of TPT.

The distance of the medial tibial plateau and the origin of ATA and the mean length of the subsequent segment (TPT) up till division, comprise the morphometric analysis of the popliteal artery along with the mean diameter of the popliteal artery at the level of sub condylar plane. These variables were also documented for all patients [4].

STATISTICAL ANALYSIS

Continuous variables such as age were assessed as mean/median ±standard deviation. Categorical variables such as gender, limb side, number of variant arteries were studied as percentages. Tests of associations were done by Chi-square test. The p-value <0.05 was considered significant. All statistical analysis was done using Graph Pad 9.3.1.



[Table/Fig-3]: Type III: characterised by change in distal blood supply along with hypoplastic and aplastic branching. Type IIIA: PT is hypoplastic which is replaced by distal PR. Type IIIB: AT is hypoplastic and PR is replacing the foot arch arteries. Type IIIC: Both AT and PT are hypoplastic and PR is replacing both dorsal arch artery and foot arch artery.

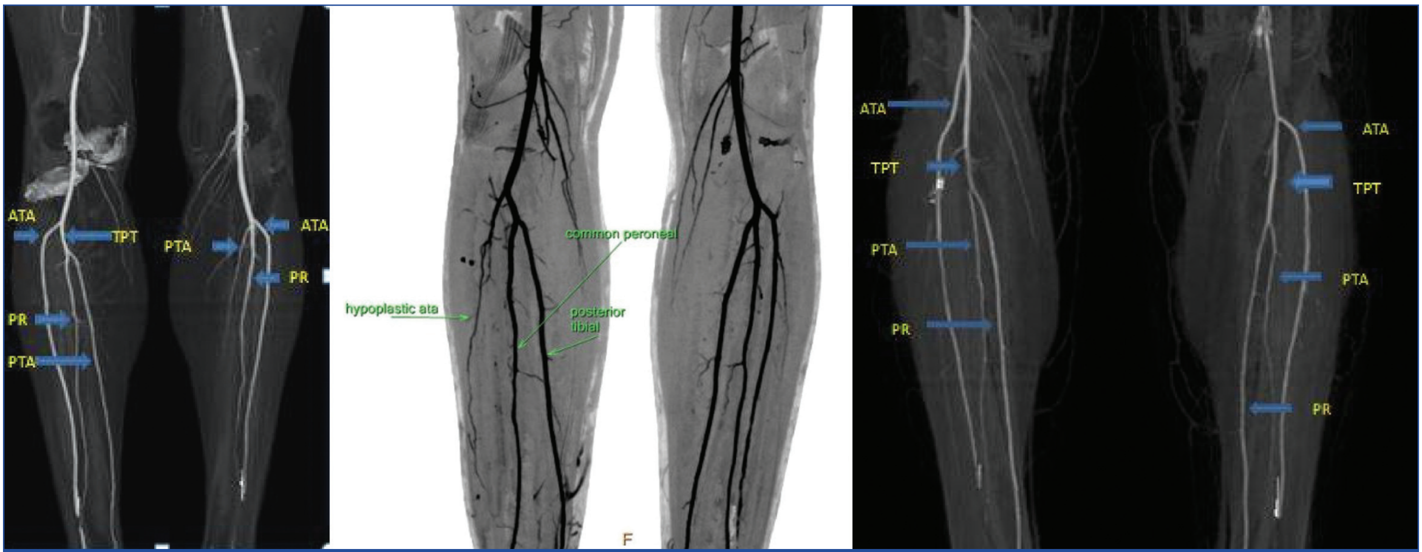
RESULTS

The present study group consisted of 152 patients ranging from age group of 23-80 years with mean age of presentation being 54.18 years. Males predominated the study group with a prevalence of 72.37% (n=110). Amongst the 304 limbs available for evaluation, the data from six limbs could not be assessed due to atherosclerotic blockage in four patients, extensive calcification in one patient and amputation in one patient. Hence, 298 limbs were evaluated on MDCT angiography for the pattern of branching of popliteal artery. Unilateral limb variant popliteal division was observed in 18 patients while bilateral was observed in six patients, resulting in a total of 30 limbs with variant popliteal anatomy. Therefore, the prevalence of variant popliteal anatomy within the study group was 10.06%. Amongst the six patients where both limbs had variations, four patients had the same variation in both limbs while two patients had different anatomical variants [Table/Fig-4].

Variables	n (%)
Mean age (years)	54.18
Gender	
Male	110 (72.36%)
Female	42 (27.63%)
Total limbs Included	298
1. Variant limbs	30 (10.06%)
2. Type IA anatomy	268 (89.93%)
A. Unilateral variation	18 (6.04%)
B. Bilateral variation	6 (2.01%)
a) Similar variation	4 (1.34%)
b) Different variation	2 (0.67%)

[Table/Fig-4]: Demographic profile of the study group.

Type I division, where the popliteal artery divides below the knee joint was seen as the most prevalent type of popliteal division (n=275, 92.28%). While Type IA, where ATA divides first followed by TPT was the single most common subtype (n=268, 89.93%) [Table/Fig-5]. Type IB, where a trifurcation of ATA, PTA and PR was seen without the formation of a TPT was seen in five patients (1.67%) [Table/Fig-6]. The least common type of division was Type IC, where PTA is the first branch and ATA and PR arise from anterior TPT, seen in only two patients (0.6%).



[Table/Fig-5]: Type IA anatomy with division of popliteal artery below knee joint in right leg. Trifurcation of popliteal artery in left leg with no TPT. **[Table/Fig-6]:** Type IIIB anatomy showing hypoplastic ATA with normal posterior tibial and common peroneal arteries. Type IB pattern showing trifurcation of popliteal artery is seen in the left lower limb. **[Table/Fig-7]:** High division of popliteal artery on right side with normal course of high origin ATA (Type IIA). Normal branching is seen in left leg with Type IA anatomy. (Images from left to right)

Type II variant with a high popliteal division above the tibial plateau was seen in 11 patients (3.6%). Type IIA1 pattern where ATA is the first division of popliteal artery above the tibial plateau following a normal course after division, was the most common Type II variant was seen in seven patients (2.3%). This was followed by Type IIA2 variant, where a high ATA follows a medial course, seen in three patients (1.01%) [Table/Fig-7]. Type IIB pattern where the PTA is the branch arising above tibial plateau was seen in a single patient in the present study group (0.33 %). Type IIC variation, where PR artery is the first branch of popliteal artery, dividing above knee, was not observed in any patient.

Type III division, characterised by hypoplastic/aplastic branching, was the second most prevalent group after Type I popliteal anatomy seen in 12 patients (4.03%). Type IIIA branching with hypoplastic PTA was seen in eight patients (2.6%) [Table/Fig-8]. Type IIIB anatomy with hypoplastic ATA was observed in three patients (1%) [Table/Fig-6]. Type IIIC division was seen in one patient (0.33%) [Table/Fig-9].

[Table/Fig-8]: Type IIIA anatomy showing hypoplastic PTA with normal anterior tibial and common peroneal arteries.

The patterns of variation had no significant difference between males and females (p=0.5). In patients showing variations in bilateral limbs, four patients had similar variations bilaterally. Two of these patients had Type IB anatomy, one had Type IIA and one had Type IIIA anatomy. While two patients had separate variants in both

Branching pattern of popliteal artery	n	%
Type I	**275**	**92.28**
Type IA	268	89.93
Type IB	5	1.67
Type IC	2	0.6
Type II	**11**	**3.6**
Type IIA1	7	2.3
Type IIA2	3	1.01
Type IIB	1	0.33
Type IIC	0	0
Type III	**12**	**4.03**
Type IIIA	8	2.6
Type IIIB	3	1.01
Type IIIC	1	0.33

[Table/Fig-9]: Branching pattern of popliteal artery in study group as per Kim's classification.

limbs, one of them showing Type IC and Type IIA2 while the other showing Type IIIB and Type IB pattern in bilateral limbs.

While analysing the morphometric characters of popliteal artery, the mean distance between the medial tibial plateau and the origin of ATA was 61.2 mm (5.8-85.2 mm) while the mean length of the subsequent segment was 31.3 mm (7.4-72.2 mm). The mean diameter of the popliteal artery at the level of sub condylar plane was found to be 8.4 mm (6.1-10.2 mm) [Table/Fig-10].

Distance A (mm) Mean (Range)	Distance B (mm) Mean (Range)	Popliteal artery diameter (mm) Mean (Range)
61.2 (5.8-85.2)	31.3 (7.4-72.2)	8.4 (6.1-10.2)

[Table/Fig-10]: Morphometric parameters in study population.
Distance A=distance between the medial tibial plateau and the origin of ATA. Distance B=the mean length of the subsequent segment (TPT) up till division. Popliteal artery diameter taken at subcondylar plane

DISCUSSION

The variations in the division of the popliteal artery have been attributed to changes at the time of embryological development. Previous literature explains that normal embryological development begins with development of deep popliteal artery anterior to popliteus muscle which divides into two branches. These two branches fuse to form the adult popliteal artery. Further division into ATA occurs which develops a communicating branch with the developing peroneal artery, thereafter the deep popliteal artery proximal to the communication is obliterated. Multiple variations in this developmental pattern including the improper fusion and lack of timely obliteration are believed to be the cause of common variations in the branching patterns of the popliteal artery [6-8].

The knowledge of variant popliteal arterial anatomy is required for the success of various procedures including vascular grafting, vascular injury repair, popliteal artery aneurysm treatment, popliteal artery entrapment syndrome. Also, in order to choose and vary surgical approaches for pathologies around the knee joint, popliteal arterial anatomical map is essential [9-11].

Type II or higher branching has been associated with higher risk of iatrogenic injury during surgical procedures such as high tibial osteotomy, meniscal repair, posterior cruciate ligament reconstruction and total knee replacement, due to direct contact of the artery with posterior tibial cortex [12,13]. Also, in popliteal artery entrapment syndrome, where gastrocnemius muscle plays an important causative part, a correlation with type IIA2 variation of medially placed ATA is often seen [2].

A revision in planning for fibular free flap grafting is required in Type III variations. The harvesting of popliteal artery is contraindicated in Type IIIC branching due to impending ischaemic changes in the limb. The success of popliteal artery aneurysm repair depends on the number of run-off vessels, which is lesser in Type III variants, thereby making these patients high risk group for complications [14,15].

In other clinical scenarios also the various branching patterns of popliteal artery is helpful, such as in cases of baker cyst removal and balloon angioplastic procedures in cases of atherosclerosis and diabetes [16,17].

remains the universal most common pattern of division, Type III pattern is more common in Asian population as compared to North Americans and Europeans, with more prevalence of Type IIIB pattern in Asians [2].

In the present study, no significant difference was found in the variant anatomical profile between the two genders (p=0.5). Bilateral variations were seen in 3.9% patients (n=6), similar to the findings of another previous study (5.5%) [21].

Type I (92.28%) was the most common group of variants with Type IA (89.93%) being the single most common subgroup. While there were no Type IIC variations in the present study group, Type IIIA (2.6%) and Type IIA1 (2.3%) consisted the second and third most common patterns of popliteal division. Tomassewski KA et al., [2] discussed in their review that Type III variations are more prevalent than Type II variations in Asian population, similar to the findings of the present study (Type III was 4.06% and Type II was 3.6%).

The variation pattern was similar to the DSA study done by Kil SW and Jung GS [3] and the MDCT studies done by Ostekin PS et al., [21] and Demirtas H et al., [22] all of which show Type III pattern to be more common than Type II pattern of division. Whereas, in pioneer DSA study of Kim DU et al., [5] and MDCT study of Calisir C et al., [10] Type II pattern was more predominant. In the present study, Type IIIA is more common than Type IIA pattern, similar to the studies of Kil SW et al., [3] Ostekin PS et al., [21] and Oner S and Oner Z [4]. Comparative analysis with other DSA studies [3,5] and MDCT angiographic studies [4,10,20,21] is presented in [Table/Fig-11].

Variables	Present study	Kim DU et al., [5]	Kil SW and Jung GS, [3]	Oztekin PS et al., [21]	Calisir C et al., [10]	Demirtas H et al., [22]	Oner S and Oner Z, [4]
Sample size	298	605	1242	495	742	652	340
Location	India	United States of America	Poland	Turkey	Japan	Turkey	Turkey
Year of study	2022	1989	2009	2015	2015	2016	2020
Type I	**92.28%**	**95.4%**	**90.8%**	**90.62%**	**91.4%**	**91.9%**	**94.1%**
Type IA	89.93%	92.2%	89.2%	87.5%	87%	88.7%	89.4%
Type IB	1.67%	2%	1.5%	3%	4.2%	2.5%	3.2%
Type IC	0.6%	1.2%	0.1%	1.2%	0.2%	0.6%	1.5%
Type II	**3.6%**	**5.8%**	**3.2%**	**2.8%**	**7.8%**	**3.2%**	**1.8%**
Type IIA1	2.3%	4.5%	1.2%	1.4%	5.2%	2.2%	0.3%
Type IIA2	1.01%			0.4%		0.4%	0.6%
Type IIB	0.33%	1.1%	0.4%	1%	2.6%	0.6%	0.9%
Type IIC	0	0.2%	0	0	0	0	0
Type III	**4.03%**	**1%**	**7.6%**	**4.3%**	**3.6%**	**4.9%**	**4.1%**
Type IIIA	2.6%	0.8%	5.1%	3.3%	2.7%	3.5%	2%
Type IIIB	1.01%	0.1%	1.7%	0.6%	0.9%	1.2%	1.5%
Type IIIC	0.33%	0.1%	0.8%	0.4%	0	0.1%	0.6%

[Table/Fig-11]: Comparison with other angiographic studies percentages of popliteal artery division patterns as per classification of Kim DU et al., [5]. [3,4,10,21,22].

Morphometric assessment of popliteal artery is also essential for surgical planning. In popliteal arterial aneurysms where endovascular stent placement is done the literature suggests a proximal popliteal arterial diameter of <12 mm and a distal diameter of >5 mm provide best results [18]. In arthroscopic surgeries, the knowledge of distance of ATA and tibioperoneal trunk from the knee joint is important, implying that a shorter distance has more risk for complications [19]. The mean popliteal artery diameter in the study group was 8.4 mm, complying with the literature is 5-12 mm. The mean length of ATA was 61.2 mm (5.8-85.2 mm) and TPT was 31.3 mm (7.4-72.2 mm), in concordance with the findings of Sanders RJ and Alston GK, and Oztekin PS et al., [20,21].

In previous literature, the branching pattern of popliteal artery has shown variation amongst ethnic populations. While Type IA

Limitation(s)

The present study was conducted in a tertiary medical centre with robust vascular and endovascular departments, thereby the study population suffered from a referral bias for peripheral vascular diseases. The limited study duration and retrospective nature of the study prevented major impact on clinical outcomes of procedures done after the MDCT study.

CONCLUSION(S)

In present study the variation in popliteal anatomy was 10.06% (30 out of 298) of the sample population, which is not an uncommon occurrence. Type III anatomy was more common than Type II anatomy. The knowledge of variations and meticulous evaluation is essential to provide a successful roadmap for therapeutic measures. The MDCT angiography provides a comprehensive, quick and efficient evaluation of the popliteal arterial anatomy along with surrounding structures and related pathologies of the vascular and non vascular structures. A large prospective study in co-ordination with Orthopaedics and Endovascular Departments will be more helpful in studying impact of these variations in the local population.

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REFERENCES

[1] Kropman RH, Kiela G, Moll FL, de Vries JP. Variations in anatomy of the popliteal artery and its side branches. Vasc Endovascular Surg. 2011;45(6):536-40.
[2] Tomaszewski KA, Popieluszko P, Graves MJ, Pękala PA, Henry BM, Roy J, et al. The evidence-based surgical anatomy of the popliteal artery and the variations in its branching patterns. J Vasc Surg. 2017;65(2):521-29.
[3] Kil SW, Jung GS. Anatomical variations of the popliteal artery and its tibial branches: Analysis in 1242 extremities. Cardiovasc Intervent Radiol. 2009;32(2):233-40.
[4] Oner S, Oner Z. Popliteal artery branching variations: A study on multidetector CT angiography. Sci Rep. 2020;10(1):8147.
[5] Kim DU, Orron DE, Skillman JJ. Surgical significance of popliteal arterial variants. A unified angiographic classification. Ann Surg. 1989;210(6):776.
[6] Soler AG, Quiles-Guiñau L, Mata-Escolano F, Sanchis-Gimeno JA. Anatomic variations of the popliteal artery branches in present Spaniard population. Ital J Anat Embryol. 2017;122(3):206-15.
[7] Kuznetsov MR, Reshetov IV, Magnitskiĭ LA, Vasilive V, Matveev AD, Lugovoĭ AA, et al. Embryology, anatomy and rare pathologies of the popliteal artery: Peculiarities of surgical treatment. Angiol Sosud Khir. 2018;24(2):146-57.
[8] Qazi E, Wilting J, Patel NR, Alenezi AO, Kennedy SA, Tan KT, et al. Arteries of the lower limb-embryology, variations, and clinical significance. Can Assoc Radiol J. 2021:08465371211003860.
[9] Nithin S, Reddy AG, Muralidhar S. Popliteal artery complications of total knee replacement-Our experience in large volume centre and review of literature. Reconstr Rev. 2018;8(1):11-13.
[10] Calisir C, Simsek S, Tepe M. Variations in the popliteal artery branching in 342 patients studied with peripheral CT angiography using 64-MDCT. Jpn J Radiol. 2015;33(1):13-20.
[11] Yanik B, Bulbul E, Demirpolat G. Variations of the popliteal artery branching with multidetector CT angiography. Surg Radiol Anat. 2015;37(3):223-30.
[12] Tindall AJ, Shetty AA, James KD, Middleton A, Fernando KW. Prevalence and surgical significance of a high-origin anterior tibial artery. J Orthop Surg (Hong Kong). 2006;14(1):13-16.
[13] Klecker RJ, Winalski CS, Aliabadi P, Minas T. The aberrant anterior tibial artery: Magnetic resonance appearance, prevalence, and surgical implications. Am J Sports Med. 2008;36(4):720-27.
[14] Pulli R, Dorigo W, Troisi N, Innocenti AA, Pratesi G, Azas L, et al. Surgical management of popliteal artery aneurysms: Which factors affect outcomes? J Vasc Surg. 2006;43(3):481-87.
[15] Chow LC, Napoli A, Klein MB, Chang J, Rubin GD. Vascular mapping of the leg with multi–detector row CT angiography prior to free-flap transplantation. Radiology. 2005;237(1):353-60.
[16] Kp V, Yoon JR, Nha KW, Yang JH, Lee JH, Jegal H. Popliteal artery pseudoaneurysm after arthroscopic cystectomy of a popliteal cyst. Arthroscopy. 2009;25(9):1054-57.
[17] Pernes JM, Auguste M, Borie H, Kovarsky S, Bouchareb A, Despujole C, et al. Infrapopliteal arterial recanalization: A true advance for limb salvage in diabetics. Diagn Interv Imaging. 2015;96(5):423-34.
[18] Midy D, Berard X, Ferdani M, Alric P, Brizzi V, Ducasse E, et al, AURC French University Association for Vascular Surgery. A retrospective multicenter study of endovascular treatment of popliteal artery aneurysm. J Vasc Surg. 2010;51(4):850-56.
[19] Szpinda M. Angiographic study of the tibioperoneal trunks in patients with aorto-iliac occlusive disease. Ann Anat. 2005;187(4):405-10.
[20] Sanders RJ, Alston GK. Variations and anomalies of the popliteal and tibial arteries. Am J Surg. 1986;152(5):531-34.
[21] Öztekin PS, Ergun E, Cıvgın E, Yigit H, Kosar PN. Variants of the popliteal artery terminal branches as detected by multidetector ct angiography. Open Med (Wars). 2015;10(1):483-91.
[22] Demirtaş H, Değirmenci B, Çelik AO, Umul A, Kara M, Aktaş AR, et al. Anatomic variations of popliteal artery: Evaluation with 128-section CT-angiography in 1261 lower limbs. Diagn Interv Imaging. 2016;97(6):635-42.

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