The evidence-based surgical anatomy of the popliteal artery and the variations in its branching patterns

Krzysztof A. Tomaszewski, MD, PhD,[a,b] Patrick Popieluszko,[a,b] Matthew J. Graves,[a,b] Przemysław A. Pękala,[a,b] Brandon Michael Henry,[a,b] Joyeeta Roy,[a,b] Wan Chin Hsieh,[a,c] and Jerzy A. Walocha, MD, PhD,[a,b] *Krakow, Poland; and Prague, Czech Republic*

Objective: **The goal of our study was to analyze the prevalence of branching pattern variations in the popliteal artery (PA) along with morphometrics of the PA to better address its importance in disease and vascular surgical procedures.**
Methods: **An extensive search for the PA and its anatomic variations was done in the major online medical databases. The anatomic data found were extracted and pooled for a meta-analysis.**
Results: **A total of 33 studies (N = 12,757 lower limbs) were included in the analysis. The most common variant was a division of the PA below the knee into the anterior tibial artery and a common trunk for the posterior tibial and peroneal arteries, with a prevalence of 92.6% (95% confidence interval [CI], 90.2-93.8). The second most common variation was a trifurcation pattern of all three branches dividing within 0.5 cm of each other, with a prevalence of 2.4% (95% CI, 1.4-3.5). Of the three studies that reported the diameter of the PA at the level of the subcondylar plane, a mean diameter of 8 mm (95% CI, 7.29-8.70) was found.**
Conclusions: **The PA most commonly divides below the knee into the anterior tibial artery and the common trunk of the posterior tibial artery and the peroneal artery. Knowledge of the prevalence of possible variations in this anatomy as well as morphometric data is crucial in the planning and execution of any surgical intervention in the area of the knee. (J Vasc Surg 2016;■:1-9.)**

The popliteal artery (PA) is a continuation of the femoral artery that crosses the popliteal fossa, splitting into the anterior tibial (AT) artery and a trunk, which further divides into the posterior tibial (PT) and peroneal (PR) arteries.[1] Variations of the branching pattern have been attributed to the arrested development of embryologic structures.[2] Detailed knowledge of the variations of the PA is essential in understanding the role that branching patterns play in popliteal artery entrapment syndrome (PAES) and popliteal artery aneurysms (PAAs). PAAs specifically can often be asymptomatic and lead to acute and chronic limb ischemia, with a 76% risk of complications up to 5 years after initial diagnosis without surgical treatment.[3] With vascular repair being the advised method of treatment of PAA, detailed anatomic knowledge of the PA and its branches is crucial for surgical success and diminishing postsurgical complications.

Anatomy of the vasculature in the popliteal fossa has implications in PAES and its treatment. PAES is described as claudication due to the PA's being constricted against the femoral condyle, with the two most common causes being variations in the PA or in attachment of muscles, like the gastrocnemius or plantaris.[4] Aside from atherosclerosis, PAES is the most common surgically correctable reason for leg claudication, responsible for 60% of cases of claudication in athletes.[5] Claudication due to PAES is influenced by movement of the lower limb and can present as pain; however, the real danger lies in the progression of the resulting ischemia.

Significant past research has focused on the classification of branching patterns of the PA. The original system of classification was first described by Lippert and Pabst in 1985 and was modified to the most commonly used system by Kim et al in 1989.[6] The classification system used consists of 3 primary types, with 10 subtypes. Type I, the most common, encompasses all divisions of the PA below the level of the knee joint. Type II, the "high divisions," includes all divisions of the PA at or above the level of the knee joint. Type III includes all cases of hypoplasia or aplasia of any of the branches.

The anatomy of the vessels in the popliteal fossa, especially those found on the medial side, contributes to the vascular network of the knee.[7] In procedures like total knee replacement, an incomplete knowledge of the possible variations can lead to iatrogenic injury that could have otherwise been avoided.

From the International Evidence-Based Anatomy Working Group[a] and the Department of Anatomy, Jagiellonian University Medical College,[b] Krakow; and the First Faculty of Medicine, Charles University, Prague.[c]
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Correspondence: Krzysztof A. Tomaszewski, MD, PhD, Department of Anatomy, Jagiellonian University Medical College, 12 Kopernika St, 31-034 Krakow, Poland (e-mail: krtomaszewski@gmail.com).
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Table I. Complete search strategy for PubMed

1	((((((((((((((Popliteal Artery[Title/Abstract]) OR Arteria Poplitea[Title/Abstract]) OR Anterior Tibial Artery[Title/Abstract]) OR Posterior Tibial Artery[Title/Abstract]) OR Circumflex Fibular Artery[Title/Abstract]) OR Nutrient Arteries[Title/Abstract]) OR Superior Lateral Genicular Artery[Title/Abstract]) OR Superior Medial Genicular Artery [Title/Abstract]) OR Inferior Medial Genicular Artery[Title/Abstract]) OR Inferior Lateral Genicular Artery[Title/Abstract]) OR Descending Genicular Artery[Title/Abstract]) OR Descending Branch of Lateral Circumflex Femoral Artery[Title/Abstract]) OR Patellar Network[Title/Abstract]) OR Geniculate Anastomosis[Title/Abstract]) OR Genicular Anastomosis[Title/Abstract]) OR Patellar Anastomosis[Title/Abstract]
2	((((((((((((Anatomy[Title/Abstract]) OR Anatomical[Title/Abstract]) OR Variation[Title/Abstract]) OR Variations [Title/Abstract]) OR Distribution[Title/Abstract]) OR Origin[Title/Abstract]) OR Anomalies[Title/Abstract]) OR Course[Title/Abstract]) OR Division[Title/Abstract]) OR Branching[Title/Abstract]) OR Variant[Title/Abstract]) OR Variants[Title/Abstract]) OR Anastomosis[Title/Abstract]) OR Collateral circulation[Title/Abstract]
3	1 AND 2
4	(Popliteal Artery[MeSH Major Topic]) AND (Anatomic Variation OR Anatomy & Histology[MeSH Major Topic])
5	3 OR 4

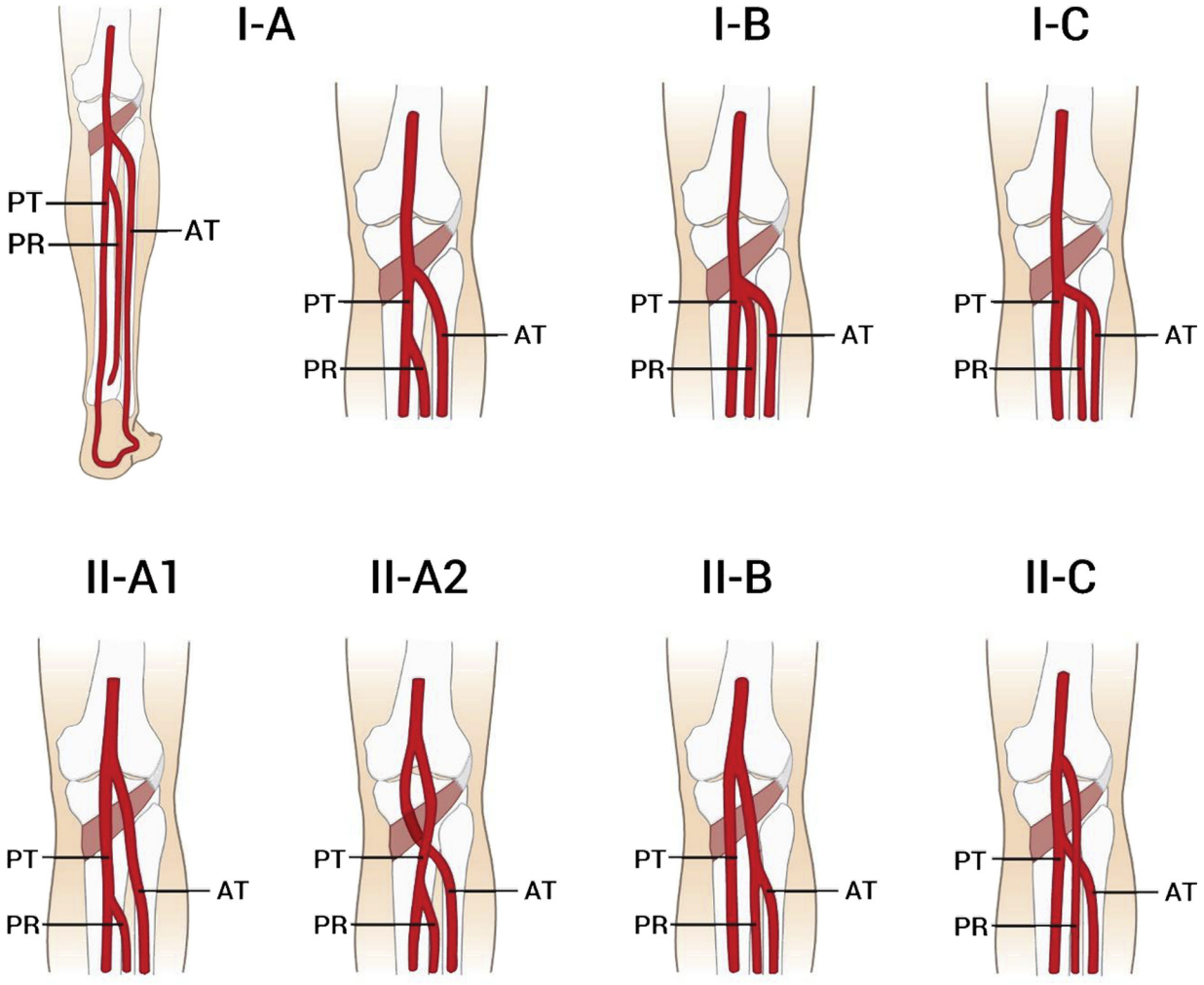

Fig 1. Type I and type II variations of the popliteal artery (PA). *AT,* Anterior tibial; *PR,* peroneal; *PT,* posterior tibial.

Owing to the clinical relevance of the PA, the aim of our study was to perform a comprehensive meta-analysis to determine the true prevalence of the most common branching patterns of the PA, to analyze its morphometric variables, and to provide an evidence-based assessment of the PA to improve surgeons' planning and approach when considering interventions in the area.