



Case Report

A Rare Case of Posterior Tibial Artery Hypoplasia and Fibular Artery Enlargement and their Impact on the Arterial Supply of Posterior Crural Region

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Abstract

Background: Detailed knowledge of the popliteal artery division and possible anatomical variants is of paramount importance for vascular surgery.

Aim: The aim of the current study was to highlight a rare unilateral case of posterior tibial artery hypoplasia.

Materials and methods: A dissection was performed at the posterior surface of the tibia in a 78-year-old Caucasian male cadaver of Greek origin.

Results: The findings were consistent with unilateral posterior tibial artery hypoplasia and fibular artery enlargement. The variant fibular artery supplied the posterior surface of the distal leg and foot. Clinical implications of the fibular artery dominance are discussed.

Conclusions: Rare anatomical variants of the tibial artery are of clinical significance to maximize safety and minimize intraoperative complications.

Key words:

hypoplastic tibial artery, enlarged fibular artery, variation, popliteal artery, fibular graft

INTRODUCTION

Popliteal artery (PA) is the continuation of the femoral artery at the popliteal fossa. It descends to the distal border of the popliteus muscle, where it divides into the anterior tibial artery (ATA) and a tibial-fibular trunk which divides into a posterior tibial artery (PTA) and a fibular artery (FA). The ATA runs through the ankle to the dorsum of the foot, as the dorsalis pedis artery. The PTA divides into the me-

dial and lateral plantar arteries under the abductor hallucis muscle. The FA arises about 2.5 cm distal to the popliteus muscle from the PTA. At the area of inferior tibiofibular syndesmosis, it divides into the calcaneal branches. Its perforating branch traverses the interosseous membrane to enter the extensor compartment, where it anastomoses with the anterior lateral malleolar artery. The FA has an interconnection with PTA about 5 cm proximal to the ankle.^{1,2}

The atypical branching pattern of the PA into an ATA, a

hypoplastic PTA and an enlarged FA occurs in 7-12% in the general population.^{3,7} The FA is the unique branch that supplies the plantar surface of the foot in 0.2-5.3% of the cases.⁷ The current study aims to highlight a rare unilateral case of PTA hypoplasia and FA enlargement for the arterial supply of the posterior surface of the distal leg and foot. Clinical implications of the FA dominance are discussed.

CASE REPORT

A dissection was performed at the posterior surface of the tibia in a 78-year-old Caucasian male cadaver of Greek origin. At the right side of the lower border of the popliteus muscle, the PA bifurcated into the ATA and a fibulotibial trunk which further divided into an enlarged FA and a hypoplastic PTA (Figs 1A, C, and 2). PTA emerged from the FA, 33.3 mm below the PA bifurcation (Fig. 1B) and was hypoplastic (length of 17.5 cm from its origin). The PTA supplied the soleus muscle, via a muscular branch (Figs 1A, C). The FA, after supplying the flexor digitorum longus (FDL), entered the fascial canal between tibialis posterior (TP) and flexor hallucis longus (FHL) muscles. It coursed within the fascial canal and further within the TP origin for a short distance of 2 cm to lie behind the interosseous membrane, gave the perforator branch anteriorly near its exit from TP and then a lateral malleolar branch with many calcaneal branches. The FA coursed posterior and medial to the tibial nerve (TN) and the tendon of flexor hallucis longus and continued as the plantar artery of the sole.

FA had four medial and five lateral branches. All deep leg muscles were supplied by FA. The nutrient artery to the fibula was given off, while coursing within the substance of TP and the perforator branch to ATA near its exit from the TP. Both lateral and medial plantar arteries were terminal branches of the FA. The dorsalis pedis artery arose from the ATA (Fig. 3).

The sciatic nerve was undivided below the piriformis muscle (PM) and coursed 18 cm distally to the lower border of PM and 16 cm below the upper border of the femoral head, where it divided into the common peroneal nerve and TN, at the border of the proximal and medial one-third of the posterior compartment of the thigh. At a distance of 8 cm below the femoral head, a muscular branch gave off to the biceps femoris muscle (Fig. 1B).

DISCUSSION

The arterial variants of the leg can be explained by characterizing the FA as the main artery and defining the tibial arteries as its branches. If one of the tibial arteries is lacking or is hypoplastic, the FA supplies that part of the foot. The FA is a major contributor to the blood supply of the foot in about 12% of all cases.² Kim et al.³ classified the PA variant branching pattern and the arterial supply of the foot. They summarized three types and related subtypes. The hypoplastic or aplastic branching pattern with altered distal supply was characterized as type III. The subtype A included a hypoplastic-aplastic PTA and a FA replacing the distal PTA (0.9%-5%). The subtype B included a hypoplastic-aplastic

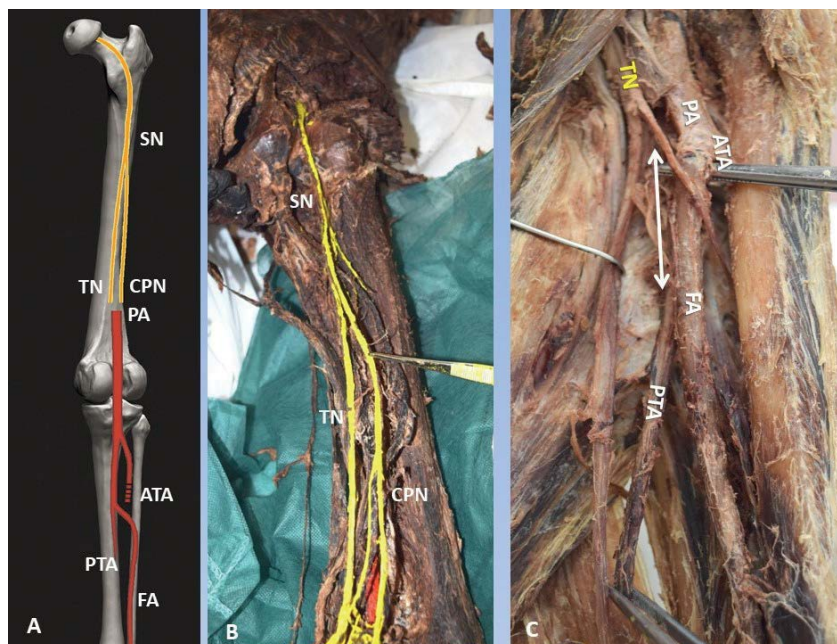


Figure 1. A, C. The atypical division of the popliteal artery (PA) into an anterior tibial artery (ATA), a fibulotibial trunk with a hypoplastic posterior tibial artery (PTA) and an enlarged fibular artery (FA) in coexistence (**B**) with an atypical division of the sciatic nerve (SN) into a tibial nerve (TN) and a common peroneal nerve (CPN).

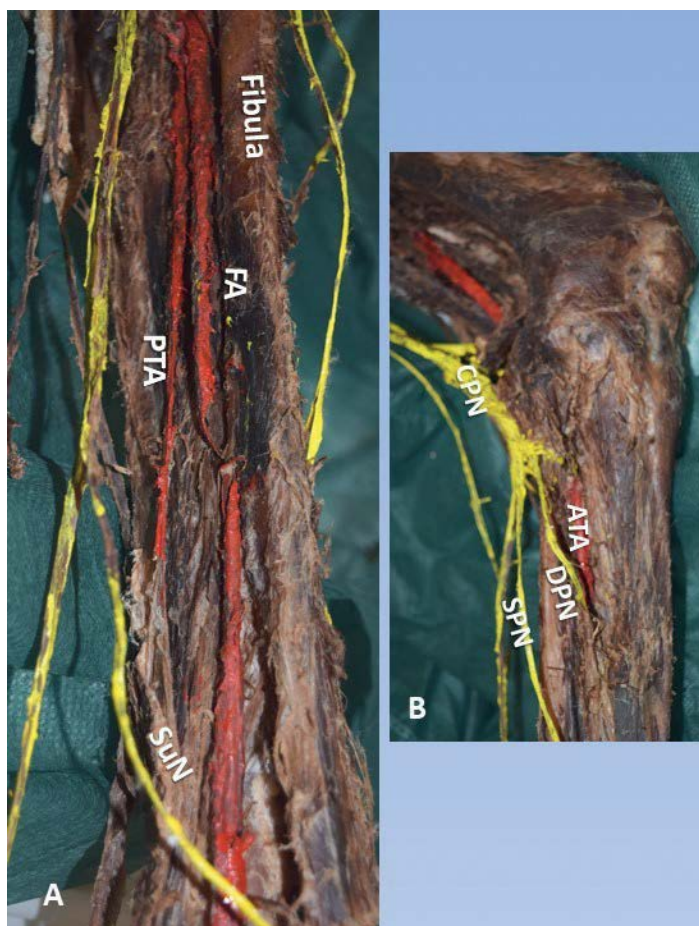


Figure 2. **A.** Posterior view, the fibulotibial trunk division into a hypoplastic posterior tibial artery (PTA) and an enlarged fibular artery (FA), SuN: sural nerve. **B.** Anterolateral view, anterior tibial artery (ATA) and the common peroneal nerve (CPN) division into a superficial and a deep peroneal nerve (SPN and DPN).

ATA and a FA replacing the dorsalis pedis artery (1.6%-7.1%). The subtype C included a hypoplastic-aplastic PTA and ATA and FA replacing plantar arteries and dorsalis pedis artery. Type IIIC was described as the Peronea Magna by Senior⁴ and is rarely observed (0.2%).^{1-3,5-8}

It is important to consider, especially for the vascular and reconstructive surgeons, orthopaedic surgeons and radiologists, whether these variations exist in applications such as diagnosis of an arterial injury, vascular grafting or embolectomy. Harvesting vascularized fibular graft is common in orthopaedic reconstructive surgery in order to address bone defect or bone loss as a result of severe trauma complications, congenital bone abnormalities or after serious bone loss following musculoskeletal tumor resecting operations.⁹ This bone graft is also used as a structural element to support femoral head in case of osteonecrosis and avoid arthroplasty, especially in younger patients.¹⁰ In patients where the PTA is hypoplastic and the FA enlarged, harvesting the FA with the fibular graft may compromise the blood supply to the lower leg, and limb loss is a dreaded complication. Of clinical importance is that enlarged FA accompanied with hypoplastic PTA can be present with a

normal clinical vascular examination. The dorsalis pedis artery and the PTA pulses may be palpable, because they arise from perforating branches of the dominant FA, confusing the clinician that the blood supply is typical.¹¹ Careful examination may reveal that in such cases the dorsalis pedis artery course is more laterally positioned than typical and the medial plantar artery originates deeply as a medial terminal branch of the enlarged FA or may even be absent. With detection of any clinical anatomical variant an angiogram or magnetic resonance angiography is necessary.

Moreover, patients with dominant FA are at great risk for foot ischemia in cases of steno-occlusive arterial disease. In cases of lower extremity arterial reconstruction, alterations in PTA, ATA and FA may influence hypoplastic PTAs and the success of femorodistal popliteal and tibial arterial reconstructions. Nevertheless, people with enlarged FAs are at great risk for foot ischemia, if FA is injured.¹² Also, in tibia reconstruction¹³ when placing the 'pins' and 'half pins' to secure the external fixator to the tibia (an Ilizarov external fixator system), injury at tibial or fibular artery may occur.¹⁴ In cases where the main artery is the enlarged FA, possible damage, as it descends to the posterior leg com-

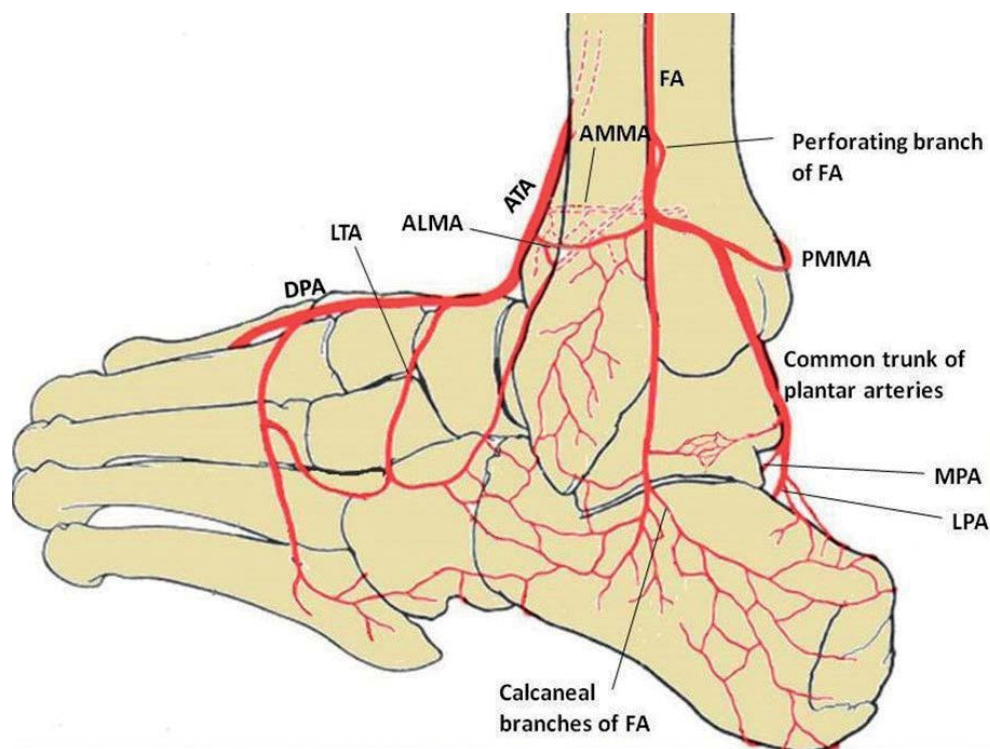


Figure 3. The branching pattern of the dominant fibular artery (FA) and anastomosis with the anterior tibial artery (ATA), ALMA: anterior lateral malleolar artery, PMMA: posterior medial malleolar artery, DPA: dorsalis pedis artery, MPA: medial plantar artery, LPA: lateral plantar artery, LTA: lateral tarsal artery.

partment may lead to negative outcome at the lower limb blood supply.¹⁵

CONCLUSIONS

Knowledge of alterations in arterial variation when performing tibia reconstruction, vascular reconstruction or harvesting fibular flap is of clinical importance in order to avoid possible ischemia.

REFERENCES

- Williams PL, Bannister LH, Berry MM, et al. Gray's anatomy. London: Churchill Livingstone: 1995.
- Lippert H, Pabst R. Arterial variations in man classification and frequency. München, Germany: JF Bergmann Verlag; 1985.
- Kim D, Orron DE, Skillman JJ. Surgical significance of popliteal arterial variation. *Ann Surg* 1989; 210: 776-81.
- Senior HD. Abnormal branching of the human popliteal artery. *Am J Anat* 1929; 44: 111-20.
- Keen JA. A study of the arterial variation in the limbs with special reference to symmetry of vascular pattern. *Am. J Anat* 1961; 108: 245-61.
- Zwass A, Abdelwahab IF. A case report of anomalous branching of the popliteal artery. *Angiology* 1986; 37: 132-5.
- Maura MA, Jacques PF, Moore M. The popliteal artery and its branches: embryologic basis of normal and variant anatomy. *AJR* 1988; 150: 435-7.
- Bardsley DL, Staple TW. Variations in branching of the popliteal artery. *Radiology* 1970; 94: 581-7.
- Rude K, Thygesen TH, Sørensen JA. Reconstruction of the maxilla using a fibula graft and virtual planning techniques. *BMJ Case Rep* 14. doi: 10.1136/bcr-2014-203601
- Vermeersch N, Peters B, Somville J, et al. Massive femur defect after Ewing's sarcoma resection reconstructed with a free vascularised fibular graft in a four-year-old girl. *Acta Chir Belg* 2018; 11: 1-5.
- Tuncel M, Maral T, Celik H. A case of bilateral anomalous origin for dorsalis pedis arteries. *Surg Radiol Anat* 1994; 16: 319-23.
- Hilven PH, Bayliss L, Cosker T, et al. The vascularised fibular graft for limb salvage after bone tumour surgery: a multicentre study. *Bone Joint J* 2015; 97-B(6): 853-61.
- Anil Kumar S, Sahoo NK, Sandhu HS. Vascularised fibula osteocutaneous flap for mandibular reconstruction and multiple implant retained fixed prosthetic rehabilitation of a patient with mandibular ameloblastoma. *Med J Armed Forces India* 2015; 71(Suppl 2): S534-7.
- Semaya Ael-S, Badawy E, Hasan M, et al. Management of post-traumatic bone defects of the tibia using vascularised fibular graft combined with Ilizarov external fixator. *Injury* 2015; 47(4): 969-75.
- Ali SA, Christy JM, Griesser MJ, et al. Treatment of avascular necrosis of the femoral head utilizing free vascularised fibular graft: a systematic review. *Hip Int* 2014; 24(1): 5-13.

Редкий случай гипоплазии задней большеберцовой артерии и увеличения малоберцовой артерии и их влияние на кровоснабжение задней бедренной области

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Введение: Детальное знание особенностей ветвей подколенной артерии и возможных анатомических изменений имеет решающее значение для сосудистой хирургии.

Цель: Целью данного исследования было представить редкий случай односторонней гипоплазии задней большеберцовой артерии.

Материалы и методы: Произведено вскрытие задней поверхности большеберцовой кости трупа 78-летнего мужчины белой расы греческого происхождения.

Результаты: Полученные результаты соответствовали односторонней гипоплазии задней большеберцовой артерии и увеличению малоберцовой артерии. Вариация фибулярной артерии питала заднюю поверхность дистальной части голени и стопы. Обсуждаются клинические осложнения расширения малоберцовой артерии

Выводы: Редкие анатомические изменения большеберцовой артерии имеют клиническое значение для повышения безопасности и минимизации послеоперационных осложнений.