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Blood vessels of the shin — posterior tibial artery — anatomy — own studies and review of the literature

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Abstract: Anatomy of the vascular system of the leg was studied using classical anatomical dissection methods. Based also on literature we have reviewed the current knowledge on the vascularization of the lower leg and its embryological background with special respect toward the posterior tibial artery and its branches.

Key words: posterior tibial artery, anterior tibial artery, medial plantar artery, lateral plantar artery, fibular artery, injection.

Introduction

Posterior tibial artery originates in the popliteal fossa as relatively stronger branch of the popliteal artery and is assumed usually as a main continuation of its trunk. At the level of soleal line of tibia soleus muscle creates the tendinous arch which demarcates beginning of this artery. The vessel ends in the vicinity of its entrance into the medial malleolar canal or inside it between the superficial and deep layers of the flexor retinaculum (this place is marked by the concavity on the medial aspect of calcaneus). Quite commonly posterior tibial artery enters canal being still subdivided into medial and lateral plantar arteries. The artery runs downwards along the deep layer of flexors of the shin covered by the deep lamina of crural fascia and triceps surae muscle. Its position with respect to surrounding muscles usually differs depending on the level. In its upper portion it is localized on the tibialis posterior muscle, however when the belly of the flexor hallucis longus overlies the previous muscle, the artery enters the groove limited medially by flexor digitorum longus and laterally flexor hallucis longus. In the lower half of the shin artery goes more superficially then in the upper because triceps surae becomes Achilles tendon. It lies quite superficially and is one out of four arteries in the lower limb used for pulse inspection. Above the medial ankle posterior tibial artery runs medial to the Achilles tendon and is covered by superficial and deep lamina of crural fascia and small amount of fat tissue. It preserves its superficial location until its entrance into the medial malleolar canal where it is positioned between tendons of tibialis posterior and flexor digitorum longus on one side (posterior to them) and tendon of flexor hallucis longus (anterior to it) and here one can easily palpate it. Posterior tibial artery is accompanied by two veins and tibial nerve, which in upper portion of its course is placed lateral to the vessels and next beneath an arch of the soleus muscle it is moved slightly medial. In the end the nerve crosses vascular structures and runs to their lateral aspect achieving this way the level of the medial ankle. In the lower shin artery runs anterior and embraces the medial malleolus running to the medial side of calcaneus, where it gives off its terminal branches — the lateral and the medial plantar arteries. Branches and further details on the course were reported in [1, 2].

Material and methods

Material and methodology was described in a previously published study [1]. 50 lower limbs of adult cadavers of both sexes, aged 36 to 76. obtained from autopsies in the Department of Forensic Medicine JU CM were dissected. The study was approved by local Bioethical Committee (KBET/167/B/2009).

The whole material was divided into four age groups [1].

To visualize the vessels visible, posterior aspect of the shin was sectioned in the median sagittal plane of the leg (from popliteal fossa till Achilles tendon), to dissect muscles of the posterior group of the leg. Next muscles of the superficial layer of

posterior group (gastrocnemius and soleus) were sectioned transversely and gently removed to show the main branches of the popliteal artery (anterior and posterior tibial) and study their course. Subsequently the popliteal vessels were injected with a water solution of acrylic emulsion Liquitex R (Binney and Smith, USA) [3]. This filling allowed to make even minute vessels visible what was used in our department in some previous studies [4, 5]. After injection the specimens were placed for 24 hrs in containers with formalin for solidification of the mass. Next material was inspected according to extravasations and then gently dissected. Thus obtained specimens were examined both according to number and type of branches, course of the main arteries and possible variations.

Results and discussion

Posterior tibial artery is a branch of the popliteal artery which begins at the level of tendinous arch of the soleus muscle. In our studies it was present in 100%. It ends opposite the entrance to medial malleolar canal or within this canal by dividing into medial and lateral plantar arteries. In the lower shin it runs anterior enfolding medial malleolus from behind. Posterior tibial artery gave off several branches during its course. The main and strong branch was fibular artery. The posterior tibial artery may be underdeveloped or absent — then plantar arteries originate from fibular artery. According to Adachi [6] it may be absent in 2% (10 cases for 486 specimens). Dubreuil-Chambardel [7] did not find such case (complete absence) in his studies. Day and Orme [8] found in their studies 0.8% of hypoplastic posterior tibial artery. Piral *et al.* [9] described a case where posterior tibial artery was absent. Also Zwass and Abdelwahab [10] reported a case where posterior tibial artery was absent and the plantar arteries originated from fibular artery. Similarly Jiji *et al.* [11] reported a case of hypoplastic posterior tibial artery, while enlarged fibular artery ended as lateral plantar. In such case fibular artery replaces posterior tibial thus providing blood supply to the sole of the foot [12]. Also Kil and Jung [13] reported a case of hypoplastic or completely absent posterior tibial artery (5.1%) — being substituted by fibular artery.

A case where posterior tibial artery was aplastic or absent was described by Mavili *et al.* [14] — in such case distal leg is supplied by fibular artery only.

Table 1. Frequency of absent or hypoplastic posterior tibial artery.

Author	Frequency (%)
Adachi	2.0
Day and Orme	0.8
Kil and Jung	5.1
Our studies	0.0

Usually posterior tibial artery is of greater caliber than fibular, but certain cases occur when proportions are reversed — i.e. Ozgur *et al.* [15] proved such situation in 42.5% cases. Similar report was given by Yldiz *et al.* [16]. In our studies it was posterior tibial artery of greater caliber but in 4% of cases fibular artery was larger. It was denoted mostly in these cases where anterior tibial artery was absent or reduced.

Absent or hypoplastic posterior tibial artery occurs then in 0.8–5.1%.

Fibular artery originated from the posterior tibial below the fibular neck (about 5 cm below bifurcation of the popliteal artery). It is located deep in the flexor chamber. It runs initially toward fibula over posterior tibial muscle, next descends downward along medial surface of fibula between tibialis posterior and flexor hallucis longus muscles. Lower portion adheres to interosseous membrane, and next to inferior tibiofibular joint [2], giving off calcaneal branches. Branches given off by fibular artery are: muscular (supplying soleus, tibialis posterior, flexor hallucis longus and fibular muscles), nutrient fibular artery, perforating branch (pierces interosseous membrane below inferior tibiofibular joint) which courses anteriorly and anastomoses with anterior lateral malleolar artery, communicating branch (which originates below the tendon of flexor hallucis longus and runs transversely to posterior tibial artery, anastomosing with it). Ending branches of the fibular artery are calcaneal branches.

Quite commonly fibular artery is bigger than posterior tibial — we have seen that in recent studies in 4% of cases.

Fibular artery is quite stable vessel contrary to posterior tibial artery which is commonly reduced (Adachi [6] in 8.5% of Caucasians and 5% in Japanese) or completely absent. It may be of lesser caliber. Dubreuil-Chambardel [7] did not find such case when artery is absent, while Edwards [17] reported a case where both perforating branch, and posterior lateral malleolar branch were absent.

In case of absence of the posterior tibial artery or hypoplasticity of its distal fragment, fibular artery may give off plantar arteries, which are usually ending branches of the posterior tibial artery. Such occurrence was described by Zwass and Abdelwahab [10], Kutoglu *et al.* [18], Jiji *et al.* [11].

Conflict of interest

None declared.

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