



A rare bifurcation of the external iliac artery into femoral and deep femoral arteries

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Abstract

Purpose The current cadaveric report describes a quite rare unilateral bifurcation of the external iliac artery (EIA) into two femoral arteries (FAs) of almost equal diameter and parallel course, at the level of the inguinal ligament (IL).

Methods The variant FAs were identified on a 75-year-old formalin-embalmed female cadaver, derived from a body donation program after a signed informed consent.

Results The EIA bifurcated into a FA and a deep femoral artery (DFA). The DFA extremely high origin was identified at the IL level. Both lateral and medial circumflex femoral arteries originated from the DFA.

Conclusion The in-depth knowledge of the FA variant origin is of paramount importance to vascular surgeons and interventional radiologists during vessel catheterization and attempts to interpret the angiographic findings. In particular, the DFA's high origin from the EIA and the coexistence of two FAs in a parallel course may pose problems to clinicians during angiographic procedures leading to diagnostic errors. The DFA high origin may also complicate femoral arterial and venous puncture and femoral nerve blocks, due to the close neurovascular relationship. There is a possibility for the FA to be mistaken for a vein leading to accidental intra-arterial injection and consequently thrombosis. Thus, variable arterial pattern is important to be identified preoperatively using Doppler ultrasound imaging.

Keywords Femoral artery · Deep femoral artery · Profunda femoris artery · Variation · High origin

Introduction

The femoral artery (FA), the primary supplying vessel of the lower limb, is the direct continuation of the external iliac artery (EIA) and originates underneath the inguinal ligament (IL), at a variable distance from it, at the midpoint between the anterior superior iliac spine (ASIS) and the pubic tubercle. The FA after giving off the deep femoral artery (DFA), usually 3–4 cm distal to the IL, gives off the lateral and

the medial circumflex FAs (LCFA and MCFA). The DFA typically courses along the femur's anteromedial side within the femoral triangle (FT) to enter the adductor canal, passes between thigh muscles, and penetrates the adductor hiatus, joining the popliteal artery's branches [2, 4]. FA variants include the FA duplication or trifurcation [5], the DFA high or low origin from the FA, the DFA absence and duplication [2, 4], as well as the persistent sciatic artery [9]. The DFA origin from the EIA was also described [6]. FA variants' meticulous knowledge is of paramount importance to vascular surgeons and interventional radiologists during vessel catheterization and attempts to interpret the angiographic findings [9]. In particular, the knowledge of the DFA variable origin with an emphasis on the level of origin is of great importance for preventing flap necrosis in plastic and reconstructive surgery [10].

The current report describes the FA and DFA rare origins, at the same level, after the EIA bifurcation, delineates the embryological basis, and highlights possible clinical significance.

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Case report

Dissection was performed on a formalin-embalmed female cadaver, 75 years of age, derived from a body donation program, after a signed informed consent. The dissection occurred during our department's undergraduate educational session. Both FTs were dissected. After the skin and subcutaneous tissue resection, the superficial fascia, the fascia lata, and the FT borders were exposed. The sartorius (lateral), the adductor longus (medial), the pectineus (FT floor) muscles, as well as the IL (superior) were identified. From lateral to medial, femoral nerve (FN) and femoral sheath (FS) were revealed. The FS anterior wall was excised on the right side and the DFA extreme high origin, just below the IL, was identified. The EIA bifurcated into two FAs, a FA (of 5.4 mm the diameter of the luminal

caliber) and a DFA (of 4.9 mm) instead of continuing as the FA (Fig. 1). Both FAs distally coursed posterior to the FN. The LCFA and MCFA's direct origins from the DFA were also recorded. Veins of the thigh followed the variant arterial pattern. The case belongs to group A branching pattern according to Perera [7] (MCFA and LCFA branching off the DFA). The remaining FT neurovascular structures' origin, course, and topography were typical.

Discussion

The external iliac artery division into femoral arteries and the deep femoral artery high origin

The cadaveric report highlights a rare EIA bifurcation into the FA and DFA (the so-characterized extremely high

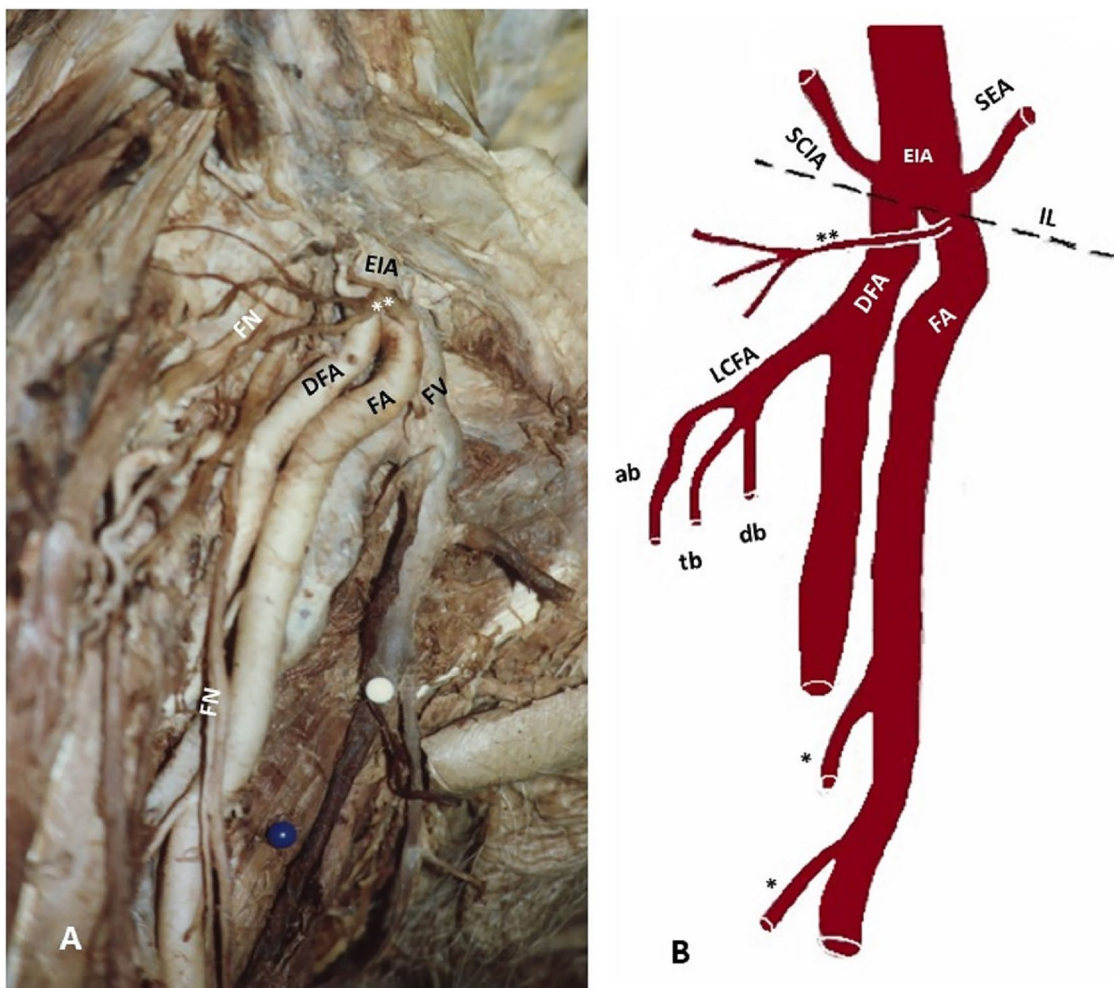


Fig. 1 Image (A) and schematic drawing (B) of the deep femoral artery (DFA) extreme high origin, just below the inguinal ligament (IL). The external iliac artery (EIA) bifurcation into DFA and femoral artery (FA), A femoral nerve (FN) anterior to the DFA and FA,

femoral vein (FV), B SCIA-superficial circumflex iliac artery, SEA-superficial epigastric artery, **Muscular branches, LCFA-lateral circumflex femoral artery (ascending branch-ab, transverse branch-tb and descending branch-db), *perforating branches

origin) of equal lumen diameter. Dubreuil-Chambardel [5] described the EIA trifurcation into FA, DFA, and MCFA, and Rusu and Brezean [9] the EIA division into FA, DFA, and LCFA, just below the IL. Bilgic and Sahin [3] described a quite rare DFA origin from the EIA, 1 cm above the IL. Massoud and Fletcher [6] recorded the DFA origin from the EIA in a frequency of less than 1% of the cases. Quain [cited by Bergman, 2] recorded the DFA origin from the FA, at the IL level in 1.63% (7 out of 430 thighs). Claassen et al. [4] in their study in 111 cadavers, identified an extremely high incidence (39.3%) of DFA high origin (1–2 cm below the IL). The DFA absence was found in 3.6% and its duplication in 0.9% [4].

Developmental anatomy

The sciatic artery, a branch of the umbilical (the future internal iliac) artery, is observed in a fetus of 9 mm in length. The FA gradually replaces the sciatic artery, which remains an inferior gluteal artery and eventually forms the main lower limb artery during the 3rd gestational month. Four theories were developed for the embryological interpretation of the vessel's variants: (a) the choice of unusual paths in the primitive vascular plexuses, (b) the persistence of vessels normally obliterated, (c) the disappearance of vessels normally retained, and (d) the incomplete development or fusions and absorptions of parts usually distinct. Abnormalities, such as in the current case, belong to the 4th developmental theory, and it is formatted due to the EIA high bifurcation [1].

Clinical significance of the femoral artery variants

Comprehensive knowledge of the FA variable origin is essential for surgeons, orthopedics, and radiologists in thrombectomy, hip joint, and plastic reconstructive surgery [9, 10]. The DFA's high origin from the EIA and the coexistence of two FAs in a parallel course, after the EIA bifurcation, may pose problems to clinicians during angiographic procedures leading to diagnostic errors. There is a possibility for the FA to be mistaken for a vein leading to accidental intra-arterial injection and consequently thrombosis. The variable pattern of origin and branching is important to be identified preoperatively by Doppler ultrasound imaging or angiography, assisting safe catheterization [6]. Since DFA participates in thigh vascular reconstruction, surgeons should be familiar with all possible DFA origins. The knowledge of the DFA variable anatomy is of paramount importance since the artery serves as an access point for invasive and diagnostic angiographic procedures. Although rare, complications like femoral arteriovenous fistula may occur. Since all the fistulas are identified below the FA bifurcation, interventionists should try to puncture just inferior to the IL, after a detailed scanning of the area. The DFA high origin

may also complicate femoral arterial and venous puncture and FN blocks [6, 8, 10].

Conclusion

An extremely DFA high origin from the EIA together with the FA emersion is described. Comprehensive knowledge of the FA variable origin is essential for surgeons, orthopedics, and radiologists in thrombectomy, hip joint surgery, and plastic reconstructions. The DFA's high origin from the EIA and the coexistence of both FAs in a parallel course may pose problems to clinicians during angiographic procedures leading to diagnostic errors. There is a possibility for the FA to be mistaken for a vein leading to accidental intra-arterial injection and consequently thrombosis. Thus, the variable FA origin is important to be identified preoperatively using Doppler ultrasound imaging.

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Availability of data and materials The raw data are available when asked.

Declarations

Competing interests The authors declare no competing interests.

Conflict of interest The authors report no declarations of interest.

Ethical approval The cadaveric study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Faculty of Health Sciences, School of Medicine, Aristotle University of Thessaloniki.

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