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Original Research Article

Analyzing Uncommon Variations in the Femoral Artery and Profunda Femoris Artery through Cadaveric Examination

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Abstract:

The standard femoral artery branching pattern typically involves the common femoral artery dividing into the superficial and deep femoral arteries, followed by the lateral and medial circumflex femoral arteries branching off after the deep femoral artery. The femoral artery is a vital blood vessel for the lower extremity, with the deep femoral artery serving as a critical conduit for the thigh, supplying blood to the hip joint, femur, and thigh muscles. The primary blood supplier to the hip joint is the medial femoral circumflex artery, while the lateral femoral circumflex artery provides blood to the surrounding hip tissues. Understanding variations in these arteries is crucial for vascular surgeries and lower extremity orthopedic procedures. We encountered two unique cases during cadaver dissections, one involving a tetrafurcation of the common femoral artery, and the other where the profunda femoris artery had an atypical origin behind the inguinal ligament, with distinct branching patterns. These variations are significant for clinical and surgical applications.

Keywords: Inguinal ligament, Profunda femoris artery, Medial femoral circumflex artery, Lateral femoral circumflex artery, Femoral artery.

Introduction

The usual arrangement at the femoral bifurcation involves a common femoral artery dividing into the superficial and deep (profunda) femoral arteries, while the lateral and medial circumflex femoral arteries typically branch out after the origin of the profunda femoris artery. The femoral artery serves as the primary blood vessel for the lower extremity. A crucial offshoot of the femoral artery is the profunda femoris artery, which acts as the principal conduit for the thigh, delivering blood to the hip joint, femur, and thigh muscles. The primary blood supplier for the hip joint is the medial femoral circumflex artery. The lateral femoral circumflex artery provides blood to the soft tissues surrounding the hip joint. Both of these arteries are either the initial branches of the profunda femoris artery, or they have their origin directly from the common femoral artery or superficial femoral artery. Differences in the femoral artery, specifically the presence of the profundal femoris artery and the lateral circumflex femoral artery, are of paramount importance in vascular reconstruction surgeries. In the realm of lower extremity orthopedic surgery, the use of myocutaneous grafts with pedicle attachment brings about a host of benefits for patients. Comprehending the variances in the starting point and trajectory of the profunda femoris artery, along with its circumflex branches, is of considerable clinical significance in the context of diagnostic imaging techniques and surgical procedures conducted within the femoral triangle. The femoral artery, the principal arterial supply to the thigh, is essentially a continuation of the external iliac artery. Profound knowledge of the anatomical divergences within the femoral artery and its subsidiary branches is of significant importance, especially since it is a frequent point of access for both surgeons and radiologists in their medical interventions.

We wish to present two remarkable cases that came to our attention during our standard dissection of a male cadaver aged 54 and a female cadaver aged 48. In one instance, the origins of both the lateral circumflex femoral artery and the medial circumflex femoral artery merged with the point of origin of the profunda femoris artery, creating a genuine tetrafurcation in the common femoral artery.

In a different instance, we observed the profunda femoris artery originating from the femoral artery just behind the inguinal ligament. From the profunda

femoris artery, three branches of the medial circumflex femoral artery emerged, while the left circumflex femoral artery originated directly from the femoral artery.

Case Series

1. While conducting routine dissections for the undergraduate students of the 2022-2023 class at Institute of Medical Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh), we came across an unusual anatomical variation involving the tetrafurcation of the right common femoral arterial trunk in a 54 year old male embalmed cadaver. A distinctive irregularity was detected in which the tetrafurcation of the right common femoral arterial trunk was situated approximately 4.4 cm below the inguinal ligament as shown in Figure 1(a). The series of four arteries, in order from the medial side to lateral side, consisted of the medial circumflex femoral artery, the femoral artery, the profunda femoris artery and lateral circumflex femoral artery. The femoral artery maintained its standard trajectory and seamlessly transitioned into the popliteal artery. The profunda femoris artery, which had its origin at the posteromedial aspect of the femoral artery, initially travelled beneath the femoral vein, proceeding in a downward and posterior direction, positioned toward the posterior and the medial side of the femoral artery as shown in Figure 1(a). The medial circumflex femoral artery had its inception as a delicate branch, which then subdivided into transverse and ascending branches as shown in Figure 1(b). The profunda femoris artery proceeds along its usual path, and as it descends, it generates perforating branches as well as a few muscular branches. When examining the lateral circumflex femoral artery, it was observed to provide branches consisting of ascending, transverse, descending and muscular arteries.

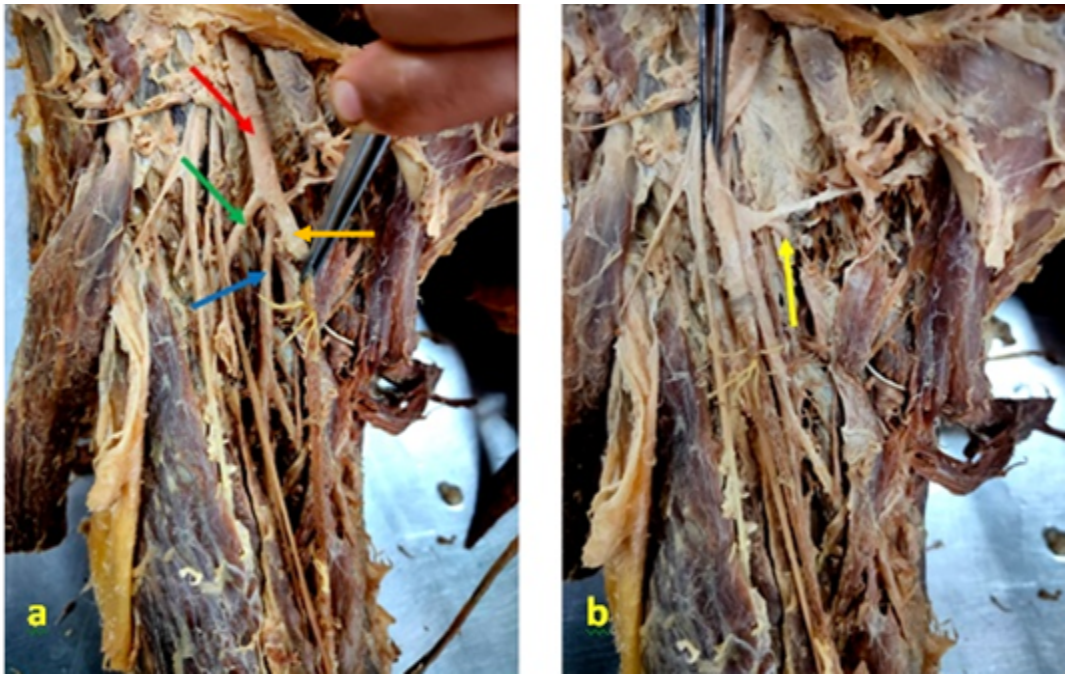

Figure 1.(a). Right sided Common Femoral arterial trunk is indicated by red arrow, Lateral circumflex femoral artery is indicated by green arrow, Profundafemoris artery is indicated by blue arrow and Femoral artery is indicated by orange arrow. (b). Medial circumflex femoral artery is indicated by yellow arrow.

2. In another female cadaver, aged 48 years, we discovered the right profunda femoris artery arising from the inner aspect of the femoral artery immediately posterior to the inguinal ligament as shown in Figure 2(a). As it descends, it traverses over the femoral vein. The profundal femoris artery continues its standard course, producing perforating and muscular branches as it descends. The noteworthy observation here is the occurrence of three medial circumflex femoral arteries originating from the profunda femoris artery at distances of 5.1cm, 5.2cm, and 5.22cm, respectively as shown in Figure 2(b). At the 5cm mark, the femoral artery issues the lateral circumflex femoral artery from its posterior-lateral position as shown in Figure 2(a) while investigating the lateral circumflex femoral artery, we noted that it gave off branches comprising ascending, transverse, descending and muscular arteries.

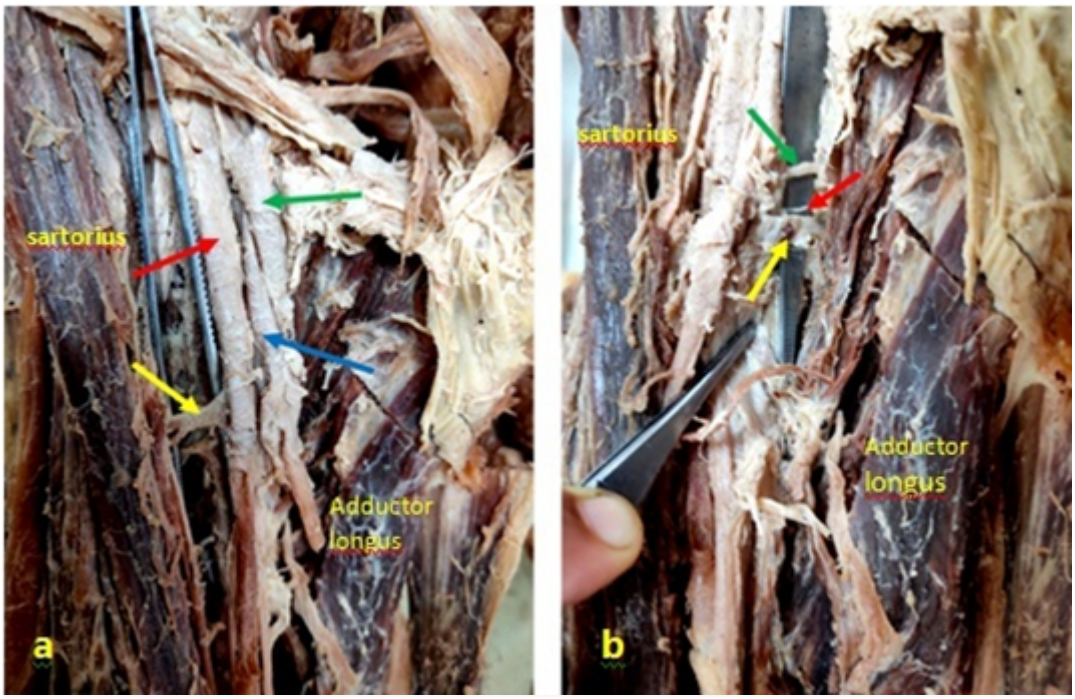

Figure 2.(a). Right sided Femoral artery is indicated by red arrow, Lateral circumflex femoral artery originating directly from the femoral artery is indicated by yellow arrow, Profunda femoris artery is indicated by green arrow and Femoral vein is indicated by blue arrow. (b). Upper, Middle and Lower Medial circumflex femoral arteries are indicated by green, red and yellow arrows respectively.

Discussion

The femoral artery is one of the preferred location for arterial line placement. When superficial veins are not easily accessible, the femoral vein serves as an alternative for blood collection. Therefore, the clinical importance of the femoral triangle lies in its significance for vessel access.

Adachi's 1928 study disclosed that the medial femoral circumflex artery had its source from the profunda femoris artery in 67.2% of instances and from the femoral artery in 14% of cases [1]. Additional research conducted by Lippert in 1985 indicated that the medial femoral circumflex artery had its origin from the profunda femoris artery in 58% of individuals and from the femoral artery in 18% of cases [2]. In a separate investigation carried out by Siddharth in 1985, the medial femoral circumflex artery was observed to originate from the profunda femoris artery in 63% of patients and from the femoral artery in 26% of cases [3]. Correspondingly, in a study by Massound in 1997, the percentages were 81% from the profunda femoris artery and 6.4% from the femoral artery [4]. In our specific case, the common femoral arterial trunk exhibited a tetrafurcation, resulting in the emergence of a slender medial circumflex artery. In a different scenario, the profunda femoris artery gave rise to three medial circumflex femoral arteries at specific levels, namely 5.1cm, 5.2cm, and 5.22cm from the midpoint of the inguinal ligament.

While variations in the origin of the profunda femoris artery and its branches typically do not pose a life-threatening risk to patients and often go unnoticed clinically, it remains crucial for preventing complications such as flap necrosis, particularly in procedures like plastic and reconstructive surgery where the tensor fascia lata is involved. Additionally, this knowledge holds importance for vascular surgeons and interventional radiologists [5,6]. This blood vessel serves as a valuable resource for conducting Doppler ultrasound imaging, arteriography, angiography, as well as magnetic resonance imaging. Typically, the profunda femoris artery originates at a distance of approximately 3 to 4 centimeters from the midpoint of the inguinal ligament [7,8]. However, in our specific case, we noticed that the common femoral trunk divided into four branches at a point located around 4.4 centimeters from the midpoint of the inguinal ligament. Typically, the profunda femoris artery is most commonly known to originate from the posterolateral aspect of the femoral artery. However, in one of our cadavers, on the right side, we observed the profunda femoris artery originating from the medial side of the femoral artery, with its point of origin situated just behind the inguinal ligament. As it descended, the profunda femoris artery applied pressure to the underlying femoral vein. Sabnis noted that the lateral side serves as a more frequent point of origin compared to the posterolateral aspect [9]. Also, in our current investigation, we observed an instance where the profunda femoris artery had its origin on the

posteromedial aspect of the femoral artery. It's worth noting that some authors regard the posterolateral and lateral origins as the prevailing pattern. Dixit et al. also reported that in 31.25% of cases, the profunda femoris artery had its origin on the posteromedial and posterior aspects of the femoral artery [10]. The benefit of this elevated origin of the profunda femoris artery is its suitability for catheterization procedures and subsequent exploration of various arterial systems within the body.

Baptist M et al. have also documented instances in which the lateral circumflex femoral artery originates directly from the femoral artery [11]. Tanyeli E et al. reported cases in which the lateral circumflex femoral artery emerges from the femoral artery, positioned below the profundal femoris artery [12]. In a study by Uzel M et al., involving 110 inguinal regions, it was observed that the lateral circumflex femoral artery arose from the profundal femoris artery in 85 cases (77.3%) and from the femoral artery, either as a separate branch or part of a common stem, in 25 cases (22.7%) [13]. In our specific case, this blood vessel was observed to originate from the tetrafurcation point of the common femoral arterial trunk. In another cadaver, we observed a distinct variation where the lateral circumflex femoral artery originated directly from the femoral artery at a specific level, precisely 5 centimeters from the midpoint of the inguinal ligament.

Evans CA et al. discovered that both the medial and lateral circumflex femoral arteries had a common origin from the femoral artery [14]. In 1996, Bergman RA et al. observed 200 limbs, and in 123 of these cases, both the lateral and medial circumflex femoral arteries originated from the profunda femoris artery. In the remaining instances, the medial circumflex femoral artery originated from the femoral artery in 41 cases, while the lateral circumflex femoral artery arose from the femoral artery in 29 cases [15].

It's essential to take into account the anatomical characteristics when devising various diagnostic and therapeutic interventions involving the femoral artery and its associated branches.

Vascular variations are prevalent because the development of the lower limb's vasculature precedes the morphological and molecular changes in the limb mesenchyme, as highlighted in source [16]. Atypical configurations of the vascular system can be attributed to several factors, including variations in the mode and proximo-distal level of branching, the presence of unique compound arterial segments, anomalous vessels connecting with the main vessels, arcades, or plexuses, and the presence of vessels located in unusual tissue planes with unexpected neural, mycological, or osteoligamentous relationships [17,18].

Conclusion

It is essential to take into account the aforementioned anatomical details when planning various diagnostic and therapeutic procedures involving the femoral artery and its branches. Understanding these variations can enhance clinician's ability to achieve better outcomes in diagnosing and treating patients. Surgeons can significantly lower the risk of intra-operative secondary hemorrhage and post-operative complications by having a good understanding of these variations.

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