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A Cadaveric Investigation of Femoral nerve, its branching pattern and relationship to neighbouring structures

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ABSTRACT

Objective: This cadaveric study delves into the morphology of the femoral nerve, focusing on its formation, associations with neighboring structures, and the intricacies of its branching pattern within the Jharkhand population. This investigation aims to delineate the variations and anomalies that may exist in the branching of the femoral artery, enhancing our comprehension of vascular anatomy. Such knowledge is instrumental in clinical practice, surgical procedures, and diagnostic interventions related to the lower limb, ultimately promoting a deeper understanding of the intricate vascular network in this anatomical region.

Methods: Using cadaveric dissections, this research meticulously examined the femoral nerve, mapping its course, relationships with adjacent structures, and recording the branching pattern specific to individuals in the Jharkhand region. Results were statistically analyzed.

Results: Researchers dissected 90 femoral triangles from 45 cadavers, finding the profunda femoris artery typically 30-43 mm from the center of the inguinal ligament on both sides. It was observed that the profunda femoris artery primarily arising from the back and outer side of the femoral artery (59%-65.5%). The LCFA usually originating from the Profunda Femoris Artery (68%-72%). MCFA's varied distance from the Profunda Femoris Artery, with 40%-44% within 0-15mm.

Conclusion: The findings in the research article collectively contribute comprehensive insights into the arterial patterns within the femoral triangle. The consistent observations regarding the (PFA) source and its association with other arteries establish crucial anatomical reference points. These insights are invaluable for medical practitioners, aiding in surgical planning, diagnostic assessments, and enhancing the understanding of this critical anatomical region for clinical applications.

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INTRODUCTION

The morphological study of the branching and division pattern of the “femoral artery” is a crucial exploration in anatomical research, providing essential insights into the vascular anatomy of the lower limb. The femoral artery, a major vessel of the lower extremity, is vital for maintaining adequate blood supply to the thigh and other associated structures [1]. Delineating the variations and anomalies that may exist in the branching of the femoral artery, enhancing our comprehension of vascular anatomy is crucial. Such knowledge is instrumental in clinical practice, surgical procedures, and diagnostic interventions related to the lower limb, ultimately promoting a deeper understanding of the intricate vascular network in this anatomical region.

The “femoral artery” gains access to the thigh at the midpoint between the “anterior superior iliac spine” and the pubic symphysis [1]. Positioned on the tendon of the psoas major, it maintains separation from the hip joint capsule [2]. Notably, at this location, the pulsation of the femoral artery is palpable, offering a suitable site for arterial catheterization [3].

This artery is commonly used for various medical procedures such as angiographies, central line insertion, doppler imaging, MRI, and other diagnostic procedures [3]. Precise understanding of the anatomical diversity in the “profunda femoris”, and “lateral femoral circumflex arteries” hold significant importance for procedural radiologists. The “profunda femoris artery” frequently plays a role in vascular restoration treatments for the thigh area [4]. Grasping the diverse beginnings of the “profunda femoris artery” and how its branches spread out is highly critical in averting tissue death in flap-based procedures within plastic and reconstructive surgeries. [5].

There is a scarcity of research focusing on the morphological distinctions among the origins of the "femoral artery" and its divisions. This study intends to determine the frequency of these variations within the Indian population. The findings will assist interventional radiologists in identifying potential variations in the branching pattern and will also benefit vascular surgeons in understanding and taking appropriate precautions when dealing with abnormal femoral artery branching patterns.

MATERIALS AND METHODS

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Study Design: This study was conducted on 45 embalmed cadavers (25 male and 20 female) obtained from the Anatomy Department of Medinirai Medical College in Palamu, Jharkhand, India.

Methodology: 90 femoral were segmented. An incision was made in the anterior thigh, followed by the removal of superficial “inguinal lymph nodes” and the great “saphenous vein”. Subsequently, the "fascia lata" was cut to reveal the femoral triangle to dissect the femoral sheath. The “profunda femoris artery”, including its medial and circumflex femoral branches, was dissected to identify their source. The relationship between the “profunda femoris artery” and the “femoral artery” at its source was observed.

Distance was measured from the “profunda femoris artery” to the center of the “inguinal ligament” and recorded in millimeters. The source site and patterns of the medial and “lateral circumflex femoral arteries” were examined, and their distances from the source of the “profunda femoris artery” was documented. Using vernier calipers, the diameter of the “femoral artery” near its origin was measured and recorded.

Statistical Analysis: The collected data was organized in a tabular format, and statistical analysis was performed.

RESULTS

While dissecting 90 femoral triangles from 45 cadavers, the researchers observed that the spatial distance of the “profunda femoris artery” source from the center of the “inguinal ligament” was typically between 30 and 43 mm on each side.

Table 1: Source Of Profunda Femoris Artery from Femoral Artery

LFCA Origin site	Right Side		Left Side	
	Number of Cases	Percentage	Number of Cases	Percentage
Profunda Femoris Artery	31	64.7%	26	59%
Femoral Artery in Association With PFA	9	16%	10	18%
Femoral Artery Above PFA	3	7%	5	9%
Femoral Artery Below PFA	2	5%	4	6%

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The distribution of the “Lateral Femoral Circumflex Artery” origin sites on both sides is as follows: On the right side, 64.7% of LFCA origins are from the “Profunda Femoris Artery”. Additionally, 16% are associated with the “Femoral Artery” in conjunction with the PFA, while 7% originate above the PFA and 5% below it. On the left side, 59% of LFCA origins are from the “Profunda Femoris Artery”. Furthermore, 18% are associated with the “Femoral Artery” in conjunction with the PFA, with 9% arising above the PFA and 6% below it. Overall, the most common origin site for LFCA is from the “Profunda Femoris Artery” on both sides, followed by association with the “Femoral Artery” in relation to the PFA. Origins above or below the PFA are less frequent occurrences.

Table 2: Site of origin of Lateral circumflex femoral artery (LCFA)

LCFA origin site	Right Side		Left Side	
	No. of cases	Percentage	No. of cases	Percentage
Profunda femoris artery	30	70 %	26	66%
Femoral artery in association with PFA	7	14.44%	9	16%
Femoral artery above PFA	5	10%	4	9.5%
Femoral artery below PFA	3	4.5%	6	8%

On the right side, 70% (30 cases) originate from the (PFA). Additionally, 14.44% are associated with the “Femoral Artery” in conjunction with the PFA, 10% originate above the PFA, and 4.5% below it. On the left side, 66% arise from the “Profunda Femoris Artery (PFA). Furthermore, 16% are associated with the “Femoral Artery” in conjunction with the PFA, 9.5% originate above the PFA, and 8% below it. In summary, the majority of LCFA origins, around 66-70%, arise from the Profunda Femoris Artery on both sides. Association with the “Femoral Artery” in relation to the PFA or origins above or below the PFA are less frequent occurrences, ranging from 4.5-16%

Table 3: Origination of Medial Circumflex Femoral Artery distance (mm) from Profunda Femoris artery on each side

Distance (mm)	Right side		Left Side	
	No. of cases	Percentage	No. of cases	Percentage

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0-15	15	35%	20	42%
16-25	10	18%	10	18%
26-35	9	13%	5	7%
36-45	4	6.6%	5	8%
46-55	5	8%	2	2%
56-65	2	2%	3	3%

The examination of the MCFA origin distance from the PFA unveiled diverse measurements on both sides. On the right side, 35% of cases displayed an MCFA origin within 0-15 mm of the PFA, followed by 18% within 16-25 mm, and 12% within 26-35 mm. Similarly, on the left side, 42% exhibited an MCFA origin within 0-15 mm of the PFA, with subsequent percentages of 18% within 16-25 mm and 10% within 26-35 mm. The distribution reveals the proximity of MCFA origin concerning the PFA, offering insights into anatomical variations.

DISCUSSION

Knowledge about the femoral artery and its divisions holds significant medical relevance. For medical procedures such as arterial catheterization, the femoral artery serves as a primary site. Its intricate anatomy and branching patterns are crucial in vascular surgeries, aiding surgeons in precise interventions and reconstructions [3]. In diagnostic imaging, understanding these structures allows for accurate interpretation and assessment of various vascular pathologies. Moreover, in medical education, the femoral artery's detailed study forms a fundamental aspect of anatomy, providing students with essential insights into vascular anatomy and physiology. Clinically, this knowledge is indispensable for diagnosing and managing vascular disorders, guiding treatment decisions, and implementing effective therapeutic interventions to address conditions impacting this artery and its branches [4].

The anatomical diversifications observed in the origin of the “profunda femoris artery” and its branches have been extensively documented in medical literature. These variations often trace their origins to evolutionary and developmental processes that have shaped the vascular anatomy [4]. In lower animals, the profunda femoris artery typically arises directly from the internal iliac artery. However, through the course of evolution, a notable shift occurred in its origin, leading to its distal connection with the femoral artery in higher animals, including humans. This evolutionary shift, termed ontogeny repeating phylogeny, signifies that developmental processes

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recapitulate evolutionary history [5]. Consequently, any disruptions or developmental arrests at different stages of growth can result in variations in the anatomical configuration, particularly concerning the femoral artery's branching pattern [5].

The establishment of the blood vessels in the lower limb comes before the changes seen in the structure and genetic composition noticed in the mesenchyme of the limb [5]. This chronological sequence suggests that vascular variations are a common occurrence rather than an exception [6]. These variations often occur due to developmental processes that might halt or progress at different stages, leading to a spectrum of anatomical differences in the “femoral artery” and its associated branches. This understanding is critical in clinical practice, as it accounts for the diverse presentations of vascular anatomy encountered during diagnostic and surgical procedures involving the lower limb [6]. Researchers recorded that “profunda femoris artery” acts as a collateral artery when the main part of “femoral artery” is obstructed [7]. Due to this “profunda femoris artery” has a bigger lumen.

During the examination of 90 femoral triangles from 45 cadavers, observations regarding the origins of arteries within the region were meticulously recorded. The study revealed consistent patterns in the separation amid the roots of “profunda femoris artery” (PFA) and center of the “inguinal ligament” on both sides, typically falling around 30 and 43 mm. This consistency implies a reliable anatomical positioning in this region, potentially crucial for diagnostic and operative interventions utilizing the femoral artery. Studies have also observed 30-41 mm and between 41-50 mm on the right and left side [3]. The separation amid the starting point to the center of the “inguinal ligament” was demarcated at 5.5cm on the right side and 2.2 cm on the other side. The measurements taken are critical because it helps ensure that when cannulating the “femoral artery”, the PFA is not encountered [7].

Analysis of the origination sites of the “profunda femoris artery” from the “femoral artery” demonstrated that most cases on both sides displayed an origin from the back and outer side, highlighting a prevalent anatomical arrangement. The location where PFA originates from the femoral artery, as stated in Grays Anatomy, is on the other side [8]. Furthermore, the investigation into the arising site of the “lateral circumflex femoral artery” (LCFA) elucidated a prominent association with the “profunda femoris artery” (PFA) on both sides, providing essential insights into the main arterial branching patterns in the femoral region. The study also evaluated the distance of the source of the “medial circumflex femoral artery” (MCFA) from the

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“profunda femoris artery” (PFA) on both sides. This analysis revealed varying measurements, indicating a diverse distribution of the MCFA origin concerning the PFA. These findings underscore the anatomical diversity in the positioning of the MCFA, potentially influencing surgical approaches or diagnostic interpretations involving this arterial pathway. The location of the deep femoral artery's origin holds significance in the context of catheter placement, the creation of pedicle flaps in reconstructive surgery, and the implementation of bypass procedures to provide blood flow to the lower extremities [8].

The research studies the origination sites of the “Lateral Circumflex Femoral Artery” on both sides. Most cases showed LCFA arising from the “Profunda Femoris Artery”1q, constituting 72% and 68% on right and left respectively. Additionally, LCFA exhibited varying associations with the “Femoral Artery”, with 14.44% in association with PFA, 10% above PFA, and 4% below PFA. On the left side, these percentages were 16%, 9.5%, and 8%, respectively. The detailed distribution provides insights into the anatomical variations in LCFA origin. A Turkish study found that LCFA originates from “Profunda Femoris Artery” in 78% and from “femoral artery” in 22% of investigated cases [9].

During the present investigation, the separation between the MCFA from the PFA unveiled diverse measurements on both sides. On the right side, 40% of cases displayed an MCFA origin within 0-15 mm of the PFA, 18% within 16-25 mm, and 12% within 26-35 mm. Similarly, on the left side, 44% exhibited an MCFA origin within 0-15mm of the PFA, with subsequent percentages of 20% within 16-25mm and 10% within 26-35mm. The distribution reveals the proximity of MCFA origin concerning the PFA, offering insights into anatomical variations. These findings are quite like 59% and 36% found by researchers in previous studies [10, 11].

In essence, the research offers comprehensive insights into the anatomical variations and distribution patterns of crucial arteries within the femoral triangle. These observations are instrumental for medical practitioners, particularly in surgical and diagnostic settings where a detailed understanding of arterial origins and spatial relationships is paramount. The consistent patterns observed in this study provide valuable anatomical reference points, contributing significantly to the comprehension and potential clinical applications within this anatomical region. One potential limitation of our study is the absence of a comparative analysis involving radiology departments that utilize angiography. Incorporating such a comparison would allow for a larger study population to be included.

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CONCLUSION

The findings above collectively contribute comprehensive insights into the arterial patterns within the femoral triangle. The consistent observations regarding the “profunda femoris artery's” (PFA) source and its association with other arteries establish crucial anatomical reference points. These insights are invaluable for medical practitioners, aiding in surgical planning, diagnostic assessments, and enhancing the understanding of this critical anatomical region for clinical applications. This study will help medical practitioners and radiologists to explore different alterations.

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