

An Observational Study on the Anatomical Variations of the Anterior Tibial Artery in Cadavers

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Abstract:

Background: The anterior tibial artery (ATA) is a major branch of the popliteal artery and plays a crucial role in supplying the anterior compartment of the leg and the dorsum of the foot. Anatomical variations in its origin, course, and termination are clinically significant during orthopedic, vascular, and reconstructive surgical procedures.

Aim: To observe and document the anatomical variations of the anterior tibial artery in cadavers.

Materials and Methods: The present observational study was conducted on adult human cadavers during routine undergraduate dissection in the Department of Anatomy. The popliteal fossa and anterior compartment of the leg were carefully dissected to study the origin, course, branching pattern, and termination of the anterior tibial artery. Observed variations were recorded, photographed, and analyzed descriptively.

Results: In the majority of specimens, the anterior tibial artery originated from the popliteal artery at the lower border of the popliteus muscle and followed a normal course. Variations observed included high origin of the anterior tibial artery, altered course in the proximal leg, hypoplastic anterior tibial artery, and variations in its termination as dorsalis pedis artery. The incidence of these variations was documented and compared with previous studies.

Conclusion: Anatomical variations of the anterior tibial artery are not uncommon. Awareness of these variations is essential for surgeons, radiologists, and clinicians to avoid iatrogenic injury and to improve the outcomes of diagnostic and therapeutic procedures involving the lower limb.

Keywords: Anterior Tibial Artery, Anatomical Variations, Popliteal Artery, Cadaveric Study, Lower Limb.

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Introduction

The anterior tibial artery (ATA) is one of the terminal branches of the popliteal artery, arising at the lower border of the popliteus muscle, and plays a pivotal role in supplying the anterior compartment of the leg and dorsum of the foot. It continues as the dorsalis pedis artery at the ankle, making it clinically significant in vascular, orthopedic, and reconstructive surgical procedures. Anatomical variations of the ATA, including differences in its origin, course, branching pattern, and termination, have been frequently reported in cadaveric and radiological studies. Such variations are of considerable importance to surgeons performing flap surgeries, arterial bypass procedures, angiographic interventions, and in the management of trauma to the lower limb. Lack of awareness of these variations may lead to inadvertent injury, compromised blood flow, or surgical complications. Despite its clinical significance, comprehensive data on the anatomical variations of the ATA in the Indian population remain limited. Cadaveric studies

provide a reliable means to identify and document these variations, contributing valuable information for clinical practice.

Objective: The present study was undertaken to observe and document the anatomical variations of the anterior tibial artery in cadavers, with a focus on its origin, course, and termination patterns.

Materials and Methods

The present observational study was conducted in the Department of Anatomy at Nalanda Medical College and Hospital Patna, Bihar. Study duration is one year. On 27 adult human cadavers (54 lower limbs) during routine undergraduate dissection. Cadavers with a history of trauma, surgery, or pathological deformities of the lower limb were excluded to avoid distortion of the arterial anatomy.

Dissection Procedure

- The popliteal fossa and anterior compartment of

the leg were carefully dissected following standard anatomical techniques.

- Skin, superficial fascia, and muscles overlying the popliteal fossa and anterior compartment were removed to expose the popliteal artery and its branches.
- The anterior tibial artery was identified at its origin from the popliteal artery at the lower border of the popliteus muscle.
- Its course along the anterior compartment, branching patterns, and termination as the dorsalis pedis artery were meticulously traced.
- Any anatomical variations in origin, course, branching, or termination were noted and photographed.

Data Collection and Analysis:

- Observed variations were recorded in a structured proforma.
- Descriptive analysis was performed to determine the frequency and types of variations.
- Comparative references were made with previous studies to highlight clinical significance.

Results

A total of 54 lower limbs from 27 cadavers were dissected to observe the anatomical variations of the anterior tibial artery (ATA).

Origin of the Anterior Tibial Artery:

- In the majority of cases (48 limbs, 88.9%), the ATA originated normally from the popliteal artery at the lower border of the popliteus muscle.
- High origin of the ATA, above the lower border of the popliteus, was observed in 6 limbs (11.1%).

Course and Branching Patterns:

The ATA followed its usual course in the anterior compartment in 50 limbs (92.6%).

- Variation in the proximal course, such as a tortuous or lateral deviation, was observed in 4 limbs (7.4%).
- Hypoplastic ATA (thin caliber throughout the leg) was seen in 2 limbs (3.7%), associated with a compensatory enlargement of the posterior tibial artery.

Termination:

- The ATA terminated as the dorsalis pedis artery in 52 limbs (96.3%).
- In 2 limbs (3.7%), the dorsalis pedis artery was absent or underdeveloped, with the blood supply predominantly via the posterior tibial artery.

Summary Table:

Parameter	Normal (n, %)	Variation (n, %)	Remarks
Origin from popliteal artery	48 (88.9%)	6 (11.1%)	High origin above popliteus
Normal course in anterior leg	50 (92.6%)	4 (7.4%)	Tortuous/lateral deviation
Hypoplastic ATA	52 (96.3%)	2 (3.7%)	Compensatory posterior tibial enlargement
Termination as dorsalis pedis	52 (96.3%)	2 (3.7%)	Absent or underdeveloped

Observations:

- Variations were more common on the right side (4/27 cadavers) compared to the left side (2/27 cadavers), although this difference was not statistically analyzed.
- No significant gender-based differences could be assessed due to limited sample size.

Interpretation:

The study demonstrates that while the ATA usually follows its textbook origin and course, anatomical variations are not uncommon. Awareness of these variations is essential for surgical planning, angiographic procedures, and flap surgeries involving the lower limb.

Table 1: Variations in the Origin of the Anterior Tibial Artery (ATA)

Origin of ATA	Number of Limbs (n)	Percentage (%)
Normal origin from popliteal artery	48	88.9
High origin above popliteus muscle	6	11.1

Table 2: Variations in the Course of the Anterior Tibial Artery

Course of ATA	Number of Limbs (n)	Percentage (%)
Normal course in anterior compartment	50	92.6
Tortuous/lateral deviation	4	7.4

Table 3: Hypoplasia of the Anterior Tibial Artery

ATA Caliber	Number of Limbs (n)	Percentage (%)
Normal	52	96.3
Hypoplastic	2	3.7

Table 4: Termination of the Anterior Tibial Artery

Termination Type	Number of Limbs (n)	Percentage (%)
Normal termination as dorsalis pedis	52	96.3
Absent or underdeveloped dorsalis pedis	2	3.7

Discussion

The anterior tibial artery (ATA) is a key vessel supplying the anterior compartment of the leg and dorsum of the foot. Knowledge of its anatomical variations is crucial for vascular, orthopedic, and reconstructive procedures. In the present study of 54 lower limbs from 27 cadavers, we observed several variations in the origin, course, and termination of the ATA.

Origin Variations: The ATA originated normally from the popliteal artery in 88.9% of limbs, while a high origin above the popliteus muscle was observed in 11.1%. This finding aligns with previous studies reporting high origin incidences ranging from 5–15%. Such variations are clinically important during popliteal artery surgeries, arteriography, and flap harvests, as an unusually high origin may alter the usual landmarks for dissection.

Course Variations: In most limbs (92.6%), the ATA followed its standard course along the anterior compartment. Variations such as tortuous or lateral deviation were noted in 7.4% of limbs. These deviations may predispose the artery to compression or complicate surgical approaches to the leg. Surgeons should be aware of such variations to prevent accidental injury.

Hypoplasia and Termination: Hypoplastic ATA was observed in 3.7% of limbs, associated with compensatory enlargement of the posterior tibial artery. Similarly, the ATA terminated as the dorsalis pedis artery in 96.3% of limbs, with 3.7% showing underdevelopment or absence. Such variations are significant for flap surgeries, reconstructive procedures, and clinical assessment of peripheral pulses.

Clinical Significance: The findings underscore the importance of preoperative vascular mapping, particularly for free flap surgeries, bypass grafting, and angiographic interventions in the lower limb. Awareness of these variations can prevent iatrogenic injury and ensure successful surgical outcomes.

Comparison with Previous Studies: The incidence of high origin (11.1%) is consistent with reports by Lippert and Pabst (1985) and Aziz et al. (2007). Similarly, hypoplasia and abnormal termination of the ATA have been documented in 2–5% of cases in

earlier cadaveric studies, supporting the clinical relevance of our observations.

Limitations: The study was limited by the sample size (27 cadavers), and gender-based differences could not be fully assessed due to unequal distribution. Further studies with larger populations and imaging correlation are recommended for comprehensive evaluation.

Conclusion

The anterior tibial artery exhibits notable anatomical variations in origin, course, and termination. In this study of 54 lower limbs, while most arteries followed the classical pattern, high origin, tortuous course, hypoplasia, and underdeveloped dorsalis pedis artery were observed in a small but clinically significant proportion of cases. Awareness of these variations is essential for surgeons, radiologists, and clinicians to avoid iatrogenic injury and to improve the outcomes of vascular, orthopedic, and reconstructive procedures involving the lower limb.

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