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RESEARCH ARTICLE

Anatomical Variations in the Origin and Course of the Radial Artery: A Cadaveric Study

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ABSTRACT

Background: The radial artery is an important artery of the forearm and hand and usually arises from the brachial artery in the cubital fossa. Variations in its origin and course are clinically relevant because of its frequent use in vascular and surgical procedures.

Objectives: To study variations in the origin and course of the radial artery in adult human cadavers and to assess their potential clinical significance.

Materials and Methods: A descriptive cadaveric study was conducted on 30 adult cadavers, comprising 60 upper limbs. Routine anatomical dissection was performed to expose the brachial artery and trace the radial artery from its origin through the forearm. The site of origin and course of the radial artery were examined and variations were documented.

Results: The radial artery showed the usual origin and course in 54 of 60 limbs (90.0%). Variations were observed in 6 limbs (10.0%). A high origin from the brachial artery was observed in 3 limbs (5.0%), while origin directly from the axillary artery was noted in 1 limb (1.7%). A superficial course and tortuosity were each observed in 1 limb (1.7%).

Conclusion: Although the radial artery generally follows its classical anatomical pattern, variations in its origin and course may occur. Recognition of these variations is important during anatomical dissection and has clinical relevance in arterial cannulation, transradial coronary procedures and upper-limb surgery.

Keywords: Radial artery; anatomical variation; high origin; brachial artery; axillary artery; cadaveric study; upper limb

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INTRODUCTION

The radial artery is an important terminal branch of the brachial artery and contributes substantially to the blood supply of the forearm and hand. Normally, it arises in the cubital fossa near the level of the neck of the radius and descends along the lateral aspect of the forearm. Near the wrist, it becomes superficial and passes around the lateral aspect of the wrist before entering the hand. Although this is the usual arrangement, variations in its origin, course and branching pattern have been reported. [1]

A high origin is one of the recognized variations of the radial artery. The artery may arise from the brachial artery at a level above the cubital fossa or, less commonly, directly from the axillary artery. Such a vessel is often described as a brachioradial artery. Haładaj et al. reported high origin of the radial artery in 9.2% of 120 upper limbs examined, with origins from both the brachial and axillary arteries. [2]

Variations may also affect the course of the artery. These include an unusually superficial trajectory, tortuosity and altered relationships with adjacent muscles and neurovascular structures. In a cadaveric study of 53 specimens, variations in the site of origin were observed in 13.21% of specimens, and bilateral tortuosity was identified in one cadaver. [3]

These arterial variations are related to the complex embryological development of the upper-limb vasculature. Persistence or regression of primitive vascular channels during vascular remodeling can result in deviations from

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the usual adult arterial pattern, including variations in the origin and course of the radial artery. [2]

Knowledge of radial artery variations is clinically important because the vessel is commonly used for arterial cannulation, invasive blood pressure monitoring and transradial coronary angiography and intervention. An abnormal origin, tortuosity or course may complicate catheter or guidewire advancement and increase the risk of vascular injury during procedures. [4,5]

The radial artery is also used as a conduit in coronary artery bypass surgery and may be encountered during procedures involving the wrist and hand. A superficially positioned or unusually coursing artery may be particularly vulnerable to accidental injury. Therefore, awareness of possible variations is important for anatomists, surgeons and clinicians performing vascular procedures. [1,5]

Cadaveric dissection provides an effective method for identifying these variations because it permits direct visualization of the artery from its origin through its entire course and allows assessment of its relationships with surrounding structures. Documentation of such variations contributes to anatomical knowledge and provides clinically relevant information for vascular and surgical procedures. [1,3]

Therefore, the present study was undertaken to investigate variations in the origin and course of the radial artery in cadaveric specimens, with emphasis on identifying deviations from the normal anatomical pattern and assessing their potential clinical significance.

MATERIALS AND METHODS

Study Design and Setting

The present study was a descriptive cadaveric study conducted in the Department of Anatomy, Viswabharathi Medical College, Kurnoolfor a period of 6 months. Adult human cadavers available for routine undergraduate were included in the study.

Study Specimens

A total of 30 adult cadavers (60 upper limbs) were examined. Both right and left upper limbs were included wherever adequately preserved and suitable for dissection. Cadavers with significant damage, previous surgical intervention or extensive tissue decomposition affecting the arterial system were excluded.

Dissection Procedure

The upper limbs were dissected using standard anatomical dissection techniques. The skin and superficial fascia were carefully removed to expose the muscles and neurovascular structures. The brachial artery was identified in the arm and followed distally through the cubital fossa to identify its terminal branches. The radial artery was traced from its origin throughout its course in the forearm up to the wrist and hand.

The site of origin of the radial artery was carefully examined and compared with the usual anatomical level. Its course was followed in relation to the brachioradialis muscle, surrounding muscles, nerves and other blood vessels. Any deviation from the usual origin or course was documented. Variations such as high origin, unusual arterial trajectory, tortuosity or abnormal relationships with adjacent structures were recorded.

Documentation of Variations

For each specimen, the side of occurrence, site of origin and nature of the variation were recorded. When an anatomical variation was identified, its course and relationship with adjacent structures were carefully documented. Photographs were obtained where appropriate for further documentation and illustration.

Ethical Considerations

The study was conducted using legally donated/authorized human cadavers available for teaching purposes in the institution. The study followed the institutional guidelines for the ethical use and handling of human cadaveric material.

RESULTS

A total of 30 adult cadavers comprising 60 upper limbs were examined for variations in the origin and course of the radial artery. The radial artery showed the usual origin and course in 54 limbs (90.0%). Variations were identified in 6 limbs (10.0%).

A high origin from the brachial artery was observed in 3 limbs (5.0%), while an unusually high origin directly

Table 1: Distribution of variations in the origin and course of the radial artery

Finding	*Number of limbs*	*Percentage (%)*
Normal origin and course	54	90.0
High origin from brachial artery	3	5.0
High origin from axillary artery	1	1.7
Superficial course	1	1.7
Tortuous course	1	1.7
Total	60	100.0

from the axillary artery was observed in 1 limb (1.7%). A superficial course was noted in 1 limb (1.7%), and tortuosity of the radial artery was observed in 1 limb (1.7%). The variations were observed predominantly on the right side.

DISCUSSION

The radial artery usually arises as a terminal branch of the brachial artery within the cubital fossa and follows a relatively predictable course through the forearm. However, variations in its origin and course are well documented. In the present study, 54 of 60 upper limbs (90.0%) demonstrated the usual anatomical pattern, whereas variations were identified in 6 limbs (10.0%). This finding indicates that although the conventional arrangement predominates, clinically relevant variations are encountered with sufficient frequency to warrant careful anatomical examination. [6]

The frequency of variation observed in the present study is comparable with findings reported in previous cadaveric investigations. Shrestha et al. examined 53 upper limbs and found variations in the origin of the radial artery in 7 specimens (13.21%). They also reported a bilaterally tortuous radial artery in one cadaver. The slightly higher frequency in their study may be related to differences in sample size and the population studied. [7]

High origin of the radial artery was the most prominent origin-related variation in the present study. Three limbs (5.0%) showed a high origin from the brachial artery, while one limb (1.7%) demonstrated origin from the axillary artery. High-origin radial artery, also termed the brachioradial artery, has been reported with varying frequencies in anatomical studies. Haładaj et al. reported high origin in 9.2% of 120 upper limbs, with 7.5% arising from the brachial artery and 1.67% from the axillary artery. [6]

The occurrence of an axillary origin in 1.7% of limbs in the present study is particularly comparable with the 1.67% reported by Haładaj et al. Their review demonstrated that the frequency of radial artery origin from the axillary artery has generally been low, with reported values ranging from approximately 0.67% to 3.7%. Thus, the finding in the present study falls within the range described in previous anatomical literature. [6]

Rodríguez-Niedenführ *et al*., in a large morphological study involving 192 cadavers, emphasized that upper-limb arterial patterns show considerable variability and proposed a systematic classification of these patterns. Their work also demonstrated that differences in the origin and course of the radial artery form part of a broader spectrum of developmental arterial variations rather than representing isolated abnormalities. [8]

The superficial course observed in one limb in the present study is of particular clinical importance. A radial artery that becomes superficial earlier than expected may be mistaken for a vein or may be exposed to accidental trauma during invasive procedures. Shrestha et al. similarly emphasized that a superficial radial artery can be vulnerable to injury and that recognition of such a variant is important during clinical procedures. [7]

Tortuosity was observed in one limb in the present study. Although this represented only 1.7% of the examined limbs, such a variation may have procedural significance. Tortuous or looped radial arteries can make advancement of guidewires and catheters difficult during transradial coronary procedures. Anatomical variations of the radial artery have therefore been recognized as one of the factors that may contribute to technical difficulty or failure of transradial access. [9,10]

The embryological basis of these variations is related to remodeling of the primitive arterial network of the upper limb. Persistence of channels that normally regress or regression of vessels that normally persist can produce unusual arterial origins and courses. The brachioradial artery has consequently been discussed as a developmental variant associated with persistence of an embryonic arterial pathway. [6,8]

The findings of the present study have practical relevance because the radial artery is frequently used for arterial cannulation, coronary angiography, percutaneous coronary intervention and coronary artery bypass grafting. Awareness of an unusual origin or course can help clinicians anticipate difficulties during vascular access and reduce the risk of inadvertent arterial injury. [9,10]

CONCLUSION

The present cadaveric study demonstrates that although the radial artery usually follows its classical pattern of origin and course, anatomical variations are not uncommon. Variations involving a high origin, superficial course and tortuosity were identified in a proportion of the examined upper limbs. Knowledge of these variations is important for anatomists, surgeons and clinicians performing arterial cannulation, transradial interventions and procedures involving the upper limb. Careful identification of the radial artery and its variations during anatomical dissection can therefore provide valuable information for both anatomical education and clinical practice.

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