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Clinical Anatomy

LABYRINTHINE ARTERIES OF THE UPPER LIMB: ANATOMICAL AND SURGICAL RELEVANCE

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ABSTRACT The brachial artery and its terminal branches, the radial and ulnar arteries, are the main suppliers of blood to the arm and forearm. While tortuosity is commonly observed in arteries like the uterine, splenic, occipital, and facial arteries—where it accommodates movement and allows for potential expansion—its occurrence in peripheral vessels like the brachial, radial, and ulnar arteries is atypical. **Aims And Objective:** The present study aimed to describe the tortuous course of the brachial, ulnar, and radial arteries and to explore its clinical implications. **Method:** The study was conducted on a 65-year-old male cadaver in the right upper limb. The dissection was carried out as per Cunningham's dissector. The course, and branching pattern of the brachial, ulnar and radial arteries were observed and documented. **Result:** A case of tortuous brachial artery involving radial and ulnar arteries was seen bilaterally till the commencement of superficial palmer arch. **Conclusion:** Expertise in the anatomy and course of the peripheral arteries of the upper limb is crucial for several medical specialties, including cardiology, orthopedics, vascular surgery, and interventional radiology. A comprehensive understanding of these anatomical structures facilitates accurate interpretation of radiographic images, proper planning of surgical repairs, and interventional procedures.

KEYWORDS : Brachial Artery, Radial Artery, Ulnar Artery, Tortuous Artery

INTRODUCTION

The brachial artery serves as the main arterial supply to the upper limb, bifurcating at the neck of the radius into the ulnar and radial arteries, which provide blood to the forearm and hand. (1) These arteries are clinically significant due to their accessibility for various procedures, including intra-arterial blood pressure monitoring, cardiac catheterization, and arterio-venous fistula creation. However, anatomical variations, such as tortuosity, can complicate these interventions, increasing the risk of complications like perforation in peripheral vessels.(2–4) This study investigates the tortuous pathways of the brachial, radial, and ulnar arteries throughout the arm, forearm, and hand, highlighting the importance of recognizing such anatomical variations in clinical practice.

MATERIAL AND METHODS

During a routine cadaveric dissection intended for teaching purposes, a unique twisted course of the brachial, ulnar, and radial arteries was observed in a 65-year-old male donor. The dissection followed Cunningham's manual techniques to ensure a comprehensive exposure of the vascular structures. This variation emphasizes the importance of anatomical studies in understanding arterial pathways, which can significantly impact clinical interventions. Recognizing such atypical presentations is crucial for minimizing risks during procedures involving these vessels.

CASE REPORT

A prominent twisted course of the brachial artery was noted, especially in its lower half. While some tortuosity was present in the lower portions of both the ulnar and radial arteries, it became more pronounced as the ulnar artery progressed into the superficial palmar arch. The causes of this tortuosity may be idiopathic or could stem from a variety of physiological, pathological, genetic, or embryological factors. Understanding these underlying reasons is essential for clinicians to anticipate variations and manage potential complications during surgical and interventional procedures.

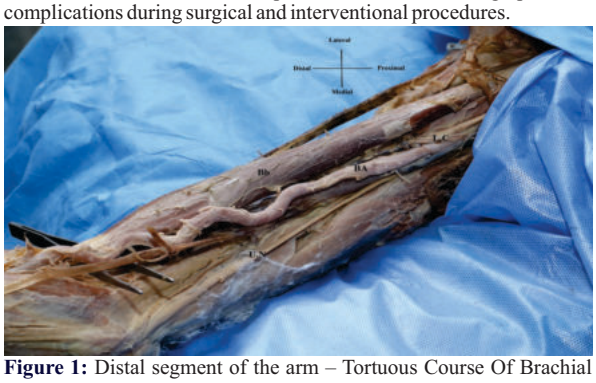

Figure 1: Distal segment of the arm – Tortuous Course Of Brachial Artery (BA). LC- Lateral Cord, Bb- Biceps Brachii, U.N- Ulnar Nerve.

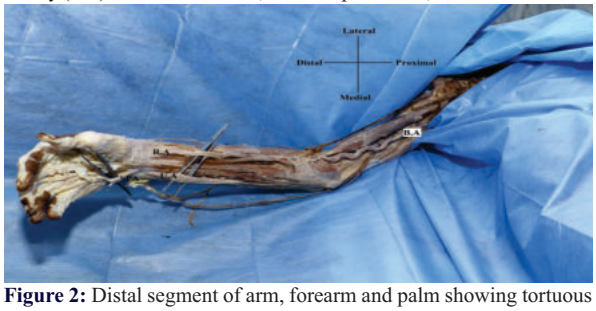

Figure 2: Distal segment of arm, forearm and palm showing tortuous course of Brachial Artery (B.A), Ulnar Artery (U.A), Radial Artery (R.A), and SPA (superficial Palmar Arch).

Sclerotic changes in the tunica media of the brachial, radial, and ulnar arteries can also contribute to tortuosity. These changes may result from aging or vascular diseases, leading to decreased elasticity and increased rigidity of the vessel walls. Additionally, mechanical factors such as hypertension can cause increased vessel wall thickness and elongation, resulting in twists or bends in the arteries courses.(5,6) Understanding these factors is important for recognizing potential complications during clinical interventions and for developing strategies to mitigate risks associated with vascular tortuosity

Vascular endothelial growth factor (VEGF) is crucial for angiogenesis and vasculogenesis. Sprouting angiogenesis is often driven by hypoxia, which enhances the expression of various genes essential for vessel formation, maturation, and patterning, including nitric oxide synthase, VEGF, and angiopoietin-2.(7) Disruptions in this intricate mechanism may contribute to vascular tortuosity, as alterations in the regulatory pathways can lead to abnormal vessel development and morphology.

Tortuosity of the hand arteries may be observed in cases of Hypothenar hammer syndrome, particularly in manual laborers who engage in repetitive hammering or similar traumatic activities. This condition arises from repeated trauma to the ulnar artery, leading to vascular changes that can result in abnormal twisting of the artery.(8) Recognizing this association is important for clinicians, as it can impact both diagnosis and management of vascular complications in individuals exposed to such repetitive stress.

Arterial Tortuosity Syndrome is a rare autosomal recessive disorder caused by mutations in the SLC2A10 gene (solute carrier family 2 member 10). This mutation inhibits the GLUT10 protein, leading to overactive TGF-beta signaling and the suppression of tumor suppressor genes. As a result, there is abnormal growth of epithelial cells, which contributes to the tortuosity, elongation, and aneurysmal formation of major arteries. This condition disrupts the elastic fibers in the middle layer of the arterial wall, highlighting the importance of genetic factors in vascular abnormalities.(9) Understanding this syndrome is essential for proper diagnosis and management of affected individuals.

DISCUSSION

The vascular patterns of the upper limb arteries continue to attract attention due to advancements in vascular surgery for both diagnostic and therapeutic purposes. A study by Sirisha V et al. involving 18 South Indian cadavers found a single female cadaver with tortuosity in all three principal upper limb arteries, mirroring findings in our study. Histological analysis revealed sclerotic changes in the radial and ulnar arteries, with the brachial artery showing tortuosity throughout its course; in our case, tortuosity was confined to the distal half. The radial artery exhibited tortuosity in both the proximal and distal thirds, whereas our findings highlighted maximum tortuosity in the radial artery itself. The ulnar artery was noted to be tortuous only in the proximal third in their study, contrasting with our observations of tortuosity extending to the distal portion and into the superficial palmar arch.(10)

Similarly, Mahajan R et al. reported a case involving a 62-year-old male cadaver with an aberrant head of flexor pollicis longus compressing the ulnar artery. This anatomical variation contributed to a tortuous course characterized by twists and bends along a 15 cm segment in the distal forearm, wrist, and hand, aligning with our findings.(4)

Bhingardeo A et al. documented bilateral tortuosity in the brachial, radial, and ulnar arteries in a single case, noting significant tortuosity in the brachial artery throughout its course, with the radial artery showing tortuosity in the lower third near the flexor retinaculum.(2) While their observations were similar to ours, the specific locations of tortuosity varied.

Malhotra R et al. highlighted cases where high termination of the brachial artery resulted in a medial-origin radial artery forming an upward loop, with less tortuosity in the ulnar artery compared to the radial, a finding that resonates with our study.(3)

Rodriguez et al. described a double loop of the ulnar artery resembling a sigmoid shape in the forearm(11), contrasting with our observations of tortuosity as the ulnar artery approached the superficial palmar arch. Finally, Zeeshan M et al. noted tortuosity in the ulnar artery associated with Guyon's canal syndrome, which echoed our findings, albeit without additional abnormalities.(12)

Overall, these studies underscore the importance of recognizing variations in vascular anatomy, particularly tortuosity, which can have significant implications for clinical practice and interventions.

Clinical Implications

The tortuous course of arteries may seem straightforward, but it can have significant clinical implications that treating clinicians must fully understand. The meandering path of a tortuous artery can affect flow mechanics, leading to inaccurate intra-arterial blood pressure readings due to the elastic band effect. This phenomenon can result in misleading assessments of a patient's hemodynamic status, potentially complicating diagnosis and treatment decisions.(4) Therefore, awareness of these implications is crucial for healthcare providers to ensure accurate monitoring and effective management of patients with vascular abnormalities.

Cardiac and hepatic catheterizations via the upper limb arteries, particularly the radial access, are increasingly being adopted due to their benefits. Hepatic angiography and trans arterial chemoembolization are crucial for treating hepatocellular carcinoma. Radial access reduces patient discomfort and bleeding risks compared to femoral access, often leading to higher patient satisfaction.(13)

The ulnar artery presents a safe alternative for creating arteriovenous fistulas in dialysis patients. Procedures like ulnar-basilic and ulnar-cephalic fistulas can serve as effective substitutes for upper arm fistulas, particularly in individuals with existing ipsilateral radiocephalic fistulas. Additionally, ulnar artery access is beneficial for cerebral angiography and interventional neuroradiology, especially in anticoagulated patients or those receiving antiplatelet and thrombolytic therapy.(5,14,15)

A significant advantage of ulnar artery access over brachial artery access is that the brachial artery functions as an end artery; its occlusion can lead to notable perfusion deficits in the distal arm. Recognizing these benefits can enhance clinical decision-making in various interventional procedures.

CONCLUSIONS

The presence of twisted peripheral arteries in the upper limb can lead to a range of clinical issues, from ischemic symptoms to complications during surgical interventions. Awareness of these variations is critical for effective diagnosis and management, emphasizing the importance of individualized patient care in vascular health. Awareness of the variant tortuous courses of peripheral arteries in the upper limb, as reported in this study, is particularly important for procedures such as cardiac catheterizations, arterial grafting, and various angiographic interventions. Recognizing these anatomical variations can enhance procedural safety, improve patient outcomes, and reduce the risk of adverse events during vascular interventions.

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