IOSR Journal of Multidisciplinary Research (IOSR -JMR)
ISSN: 3048-7439 Volume 3, Issue 2, Series 1, Mar. - Apr. (2026), PP 26-28
www.iosrjournals.org

Anatomical Snuffbox: Detailed Anatomy, Variational Morphology And Expanding Role In Distal Transradial Interventions

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Abstract
The anatomical snuffbox is a triangular depression located on the dorsolateral aspect of the wrist that has traditionally served as an important anatomical landmark in clinical examination. In recent years, it has gained considerable importance as an access site for distal transradial approach in coronary angiography and percutaneous coronary intervention, as well as for arteriovenous fistula creation and reconstructive procedures. The region contains the distal radial artery, cephalic vein, and superficial branch of the radial nerve, all of which exhibit significant anatomical variability in diameter, course, and spatial relationships. Variations such as hypoplastic distal radial artery, superficial radial artery variants, venous duplication, valvular distribution, and nerve-artery proximity influence procedural feasibility and complication rates. This review comprehensively discusses the classical and variational anatomy of the ASB, correlates morphometric findings with interventional outcomes, and highlights its expanding clinical applications. Detailed anatomical understanding and pre-procedural imaging are critical to optimize safety and procedural success.

Keywords – *Anatomical snuff box, arteriovenous fistula, radial artery, reconstructive surgery, distal transradial approach*

Date of Submission: 01-03-2026 Date of Acceptance: 11-03-2026

I. Introduction

The anatomical snuffbox (ASB) is a well-defined triangular depression on the radial aspect of the wrist that becomes prominent upon extension and abduction of the thumb. Historically associated with the placement of powdered tobacco, the region has long been recognized as an important anatomical landmark, particularly in the clinical assessment of scaphoid fractures (1-3).

Beyond its musculoskeletal relevance, the ASB has recently emerged as an important vascular access site. The distal radial artery within the snuffbox is now utilized in the distal transradial approach (dTRA) for coronary angiography and PCI (4,5). Additionally, the cephalic vein in this region is frequently employed for intravenous cannulation and radiocephalic arteriovenous fistula formation (6). The growing adoption of ASB access has renewed interest in its detailed anatomy and morphometric variability. Understanding these variations is essential for reducing procedural complications and improving technical success.

Gross Anatomy of the Anatomical Snuffbox

The anatomical snuffbox is bounded Laterally by the tendons of abductor pollicis longus (APL) and extensor pollicis brevis (EPB), Medially by the tendon of extensor pollicis longus (EPL), proximally by the styloid process of the radius and distal margin of the extensor retinaculum and distally by the base of the first metacarpal (4,7). Its floor is formed by scaphoid and trapezium (8). The scaphoid is directly palpable in this region; tenderness in the ASB is a classical sign of scaphoid fracture (2,3). The ASB contains three principal neurovascular structures - radial artery, cephalic vein and superficial branch of radial nerve. The radial artery passes obliquely across the floor of the ASB before entering the first intermetacarpal space to form the deep palmar arch (3,8). Its superficial location makes it accessible for arterial cannulation. The cephalic vein courses superficially within the roof of the snuffbox (9). It drains the dorsal venous network of the hand and ascends along the lateral forearm. The superficial branch of the radial nerve runs subcutaneously, typically lateral or superficial to the artery (2,3). Its proximity makes it vulnerable during vascular puncture (20,21).

Variational Anatomy of ASB

The cephalic vein demonstrates significant variability in diameter, branching, and valvular anatomy. Typical diameter ranges from 2.0–3.5 mm (9), but variation depends on hydration status, dominance, and previous cannulation. Documented variations include: duplication of cephalic vein (10); hypoplastic or absent segment within ASB (11); prominent dorsal venous arch tributaries (11) and presence of valves near wrist limiting catheter advancement (12). Venous duplication may provide alternative access but may also complicate identification during cannulation.

Similarly, quite a lot of variations have been reported in case of radial artery. Ultrasound studies have reported mean distal radial artery (dRA) diameter between 2.0–2.6 mm (13,14). It is typically 0.2–0.5 mm smaller than the proximal radial artery. Radial arteries with diameters below 2.0 mm may limit 6F sheath insertion and increase risk of spasm or occlusion (15). Ethnic variations have also been reported in case of radial artery diameter, with smaller mean diameters in Asian populations (16). Further, its course has also been observed to depict variations. Classical course of radial artery is deep to tendon of APL and EPB, across scaphoid and trapezium into first intermetacarpal space. Reported variations include: superficial radial artery (17); hypoplastic distal radial artery (18) and early branching patterns (19). Superficial variants increase risk of accidental arterial puncture during venipuncture.

Anatomical studies describe variability in the spatial relationship between artery, vein, and nerve. Some of the studies have reported superficial radial nerve crossing anterior to artery (20), while other studies have observed reduced artery–nerve distance in small wrists (21) and even medial overlap of vein over artery (19). These variations might influence procedural risk.

Clinical Applications

Distal Transradial Approach (dTRA) - The concept of radial artery access was introduced in 1989 (22) and expanded for PCI in 1993 (23). The distal transradial approach represents a modification of conventional TRA (4,5). **Its** advantages include reduced proximal radial artery occlusion**,** improved patient comfort**,** early ambulation **along with the** preservation of proximal radial artery. Observational data demonstrate feasibility (24-28). Comparative studies between right and left distal access show variable puncture times and success rates (28,29). Complication rates such as hematoma vary across studies (30-33). Ultrasound guidance improves procedural success.

Arteriovenous Fistula Creation - The cephalic vein in ASB is used for radiocephalic AV fistula formation. Adequate diameter (>2 mm) and absence of valvular obstruction are critical for maturation (6). Morphometric variability influences surgical planning.

Reconstructive Surgery - The radial artery serves as a pedicle in reconstructive flap surgeries. Awareness of arterial branching patterns prevents ischemic complications (17,35).

Limitations of ASB Access

Despite advantages, limitations include reduced effective catheter length by 3–5 cm (5), smaller arterial diameter, increased tortuosity, higher propensity for spasm, close proximity to nerve and periosteum and difficulty inserting sheaths >7 Fr (5). Potential complications that can occur while using ASB as site for various interventions include radial artery occlusion, hematoma, arterial spasm, nerve injury and accidental intra-arterial injection. Therefore, to avoid any complications careful patient selection is essential. Ultrasound evaluation of vessel diameter, depth, and course might reduce the incidence of complications (35).

Future Directions

Although growing evidence supports feasibility (5), distal radial access has not yet been universally incorporated into guidelines (4). Large randomized controlled trials are needed.

Future research areas include: population-specific morphometric studies, long-term radial artery patency data, device development for smaller distal arteries and standardized ultrasound-based selection criteria.

II. Conclusion

The anatomical snuffbox demonstrates substantial variability in the diameter, course, and spatial relationships of the radial artery and cephalic vein. The distal radial artery is generally smaller and more variable than its proximal counterpart, while the cephalic vein exhibits duplication, hypoplasia, and valvular variations. The proximity of the superficial radial nerve introduces procedural risk. The expanding role of distal transradial access in interventional cardiology underscores the importance of precise anatomical knowledge. Detailed morphometric assessment and ultrasound guidance are essential to optimize procedural safety and outcomes. Continued research will further refine patient selection and procedural strategies.

Conflict of interest
Authors have no conflict of interest

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