Case Report

Unusual Multiple Arterial Variations of the Upper Limb

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Abstract

During routine dissection of a 64-year-old male cadaver, multiple variations were observed in the arteries of the upper extremities. The first part of the axillary artery did not give any branches. The second part, after giving superior thoracic and thoracoacromial arteries divided into deep and superficial brachial arteries. Superficial brachial artery gave lateral thoracic artery and continued into the arm. After giving anterior circumflex humeral artery, the deep brachial artery trifurcated into the subscapular artery, posterior circumflex humeral artery, and profunda brachii artery. Understanding upper limb arterial variations are important for performing safer clinical procedures.

Keywords: *Arterial variations, axillary artery, deep brachial artery, superficial brachial artery, upper limb arteries*

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Introduction

According to classical anatomical knowledge, the arterial supply of the upper extremity is provided by the axillary artery (AA). The AA starts at the level of the first rib and progresses to the lower border of the teres major muscle and continues as the brachial artery that divides into the radial and ulnar arteries at the elbow.

The AA is divided into three parts with regard to the pectoralis minor muscle and normally gives a total of six branches: one branch from the first, two branches from the second, and three branches from the third part. However, the frequency for the classical branching pattern of the AA was 27% in the study by Huelke.[1]

Anatomical information regarding the branching and course of upper extremity arteries is important because these branches can be used as arterial flaps or grafts during surgical reconstruction procedures. In addition, physicians working in this field should be aware of possible variations to prevent unwanted complications and ensure successful operation during the surgery of conditions such as breast cancer, humerus fractures and dislocations, and brachial plexus and arterial injuries. This study describes multiple variations of the upper limb arteries that have not been previously reported.[2-4]

Case Report

During the routine dissection of the upper extremity in a 64-year-old Caucasian male donor cadaver, multiple variations were observed in the right upper extremity arteries. No surgical incisions or scar tissue were observed. The study was approved by the ethics committee and conforms to the provisions of the Declarations of Helsinki (date: May 16, 2019, number: 680).

The AA did not give any branches in the first part. The superior thoracic artery and thoracoacromial artery originated from the second part. Following these branches, the AA was divided into two terminal branches. One of these branches coursed superficial to the median nerve (MN) and was named the superficial brachial artery (SBA). The second one coursed deeper and therefore was named the deep brachial artery (DBA).[4] SBA gave the lateral thoracic artery (LTA) and then continued as the brachial artery. The DBA gave anterior circumflex humeral artery and then trifurcated into the subscapular artery (SSA), posterior circumflex humeral artery (PCHA), and profunda brachii artery. The SSA gave the thoracodorsal artery and circumflex scapular artery. This branching pattern is shown in Figure 1. The left side

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branched in the classic pattern. The classical branching pattern of the axillary artery is shown in Figure 2a and the branching pattern, in this case, is shown in Figure 2b.

Discussion

Embryological basis

Upper limb vascular development begins at the 12th stage when the upper limb bud first appears. Initially, newly developed capillary vessels enter the limb bud. As the limb bud develops, capillary vessels also develop from the distal direction. In the continuation of the development process, an artery originating from the seventh intersegmental artery becomes dominant and the other capillary vessels degenerate. This artery is named the axial (axis) artery because it develops along the central axis of the limb bud. The artery then continues to develop as the main artery supplying the upper limb. The axial artery forms the AA in the axilla in stage 15, the brachial artery in the arm at stage 17, the interosseous artery in the forearm at stage 18, and the deep palmar arch at stage 19.[5] Other arteries of the upper extremity develop as sprouts of the axial artery.

Anomalies of the upper limb arteries are quite common and can be explained by the deviation of vascular plexuses from normal morphogenetic development and temporal sequence in the embryological period.[6,7] Some arteries that are dominant in the initial stages of embryological development may regress later. Accordingly, SBA joining the axillary and brachial artery regresses over time.

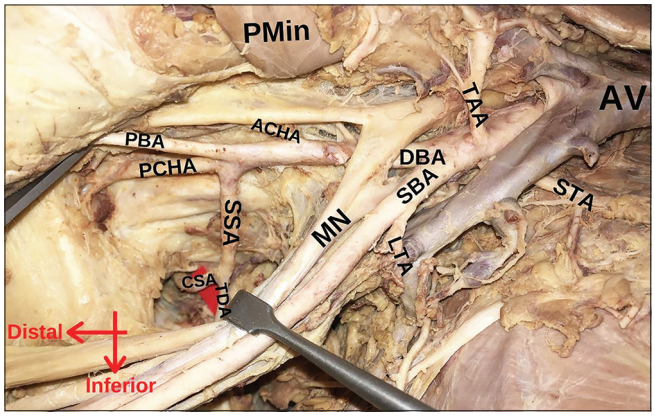


Figure 1: Branching type of the AA. ACHA: Anterior circumflex humeral artery, AV: Axillary vein, CSA: Circumflex scapular artery, DBA: Deep brachial artery, LTA: Lateral thoracic artery, MN: Median nerve, PBA: Profunda brachii artery, PCHA: Posterior circumflex humeral artery, PMin: Pectoralis minor, SBA: Superficial brachial artery, SSA: Subscapular artery, STA: Superior thoracic artery, TAA: Thoracoacromial artery, TDA: Thoracodorsal artery, AA: Axillary artery

Clinical relevance

The axillary region is of critical importance in routine clinical practice for radiologists, cardiovascular, plastic, and orthopedic surgeons who are actively interested in this region because it includes the brachial plexus, axillary lymph nodes, and axillary tail of the breast. An important weapon for a surgeon to make the necessary decisions is the knowledge of the origin, course, distribution, and anastomotic networks of the arterial branches in the region.[8] Preparing for the presence of anatomical variations can prevent postoperative complications or unsuccessful surgery due to incorrect identification of the artery. In the literature, arterial injuries have been reported as a result of dislocation of the shoulder reduction,[9] axillary-femoral bypass disruption,[10] and postcatheterization.[11] These injuries are extremely high risk as they can cause limb loss or death. This risk is further increased as a result of differences in branching patterns of the arteries in the upper extremities.

The SBA was first defined in 1928 by Adachi.[6,12] According to this, if the brachial artery is in front of the MN, it is called the SBA.[2,6] Therefore, in this case, the two terminal branches of the AA were defined as the SBA in front of the MN and the DBA behind it (a. brachialis profunda). The incidence of the SBA in the different populations studied ranged from 0.12% to 19.7%.[12]

Variant superficial arteries such as SBA are more vulnerable to injury and trauma, and their damage can cause severe

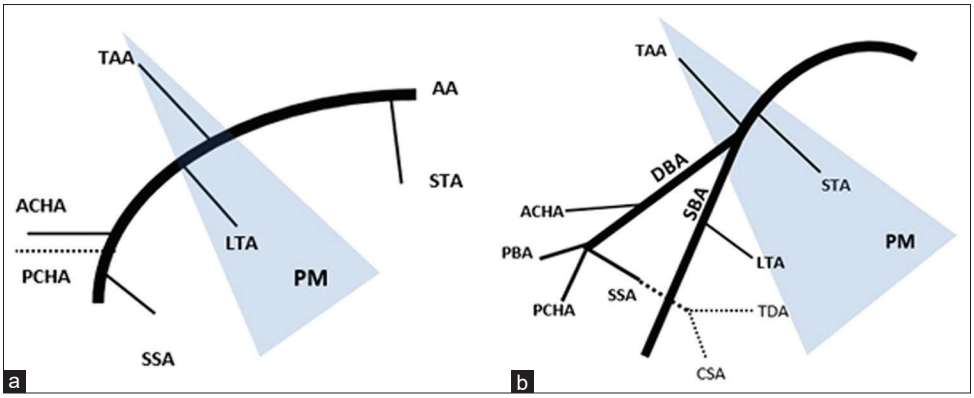


Figure 2: (a) Schematic image of the classical branching pattern of the AA. (b) Schematic image of the branching pattern in the presented case. AA: Axillary artery, PM: Pectoralis minor muscle, ACHA: Anterior circumflex humeral artery, CSA: Circumflex scapular artery, DBA: Deep brachial artery, LTA: Lateral thoracic artery, PBA: Profunda brachii artery, PCHA: Posterior circumflex humeral artery, SBA: Superficial brachial artery, SSA: Subscapular artery, STA: Superior thoracic artery, TAA: Thoracoacromial artery, TDA: Thoracodorsal artery

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bleeding.[7] During intravenous administration and catheterization, it can be considered a vein and accidentally injured. Accidental intraarterial administration of drugs can cause reflex vascular occlusion, and consequently, can lead to forearm and hand gangrene.[13] SBA can also cause idiopathic neuropathies.[12] In addition, it can disrupt radiological diagnostic methods such as angiography and surgeons may encounter intraoperative difficulties.[6] Conversely, the presence of superficial arteries can provide pedicles to lift flaps for local reconstructive surgery.

LTA contributes to the supply of the breast tissue and is an important vessel as the main artery of the nipple–areolar complex.[8,14] The nipple–areolar complex should be protected in breast surgeries such as tumor resection, reduction in gigantomastia cases, and implant placement for cosmetic or reconstruction purposes. The most important complication stated for these procedures is nipple necrosis due to arterial insufficiency.[14] LTA is also a reliable flap option for a variety of reconstructions in terms of size, thickness, and tissue composition and is easily configurable.[15] In this case, since LTA originates from a more distal level than its normal course, it may complicate the identification of the artery, as a result, it may disrupt the planning for reconstructive, and if damaged, it may cause problems in circulation of the breast tissue.

Circumflex arteries provide arterial supply of the humeral head, anatomical and surgical neck of the humerus, glenohumeral joint, and surrounding shoulder muscles. According to recent studies, it is suggested that the main blood supply of the humeral head is the PCHA.[16] In deltopectoral and transdeltoid surgical approaches traditionally used for open reduction and internal fixation of proximal humeral fractures, injury to the circumflex arteries has been reported as common complications.[16,17] Chen *et al*. aimed to define anatomical landmarks and specified reference distances for identifying and preserving the circumflex arteries.[17] However, they stated that they analyzed these landmarks in cadavers with normal branching patterns of circumflex arteries. These reference values may not valid in our case, due to the locations and origins of the circumflex arteries.

The SSA offers a predictable and versatile donor site that can meet the needs of many microvascular reconstructions, provide any combination of subcutaneous tissue, fascia, muscle, and bone.[18,19] It is an ideal donor artery due to its size, length, diameter, its suitable anatomical features, and is easy to harvest.[18] Therefore, SSA flaps have been widely used in various surgeries such as upper limb restoration,[18] repair of oromandibular and facial defects,[20] and lower extremity soft-tissue reconstructions.[19]

Conclusion

In conclusion, axilla is frequently used in routine clinical applications for reasons such as axillary lymph node dissection in total and partial mastectomy, axillary lymph node biopsy, proximal humerus fractures, regional nerve block in upper extremity surgeries, and a donor area for various flaps used in reconstructive microsurgery. In these interventional procedures, knowledge of regional anatomy is important to complete surgical operations safely. Therefore, awareness on such anatomical variations and understanding that they may be more common than thought will help clinicians and surgeons achieve better and safer results.

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Conflicts of interest

There are no conflicts of interest.

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