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Embryological Basis And Clinical Importance of the Variant Branching Pattern of the Axillary Artery

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Abstract: *The arterial pattern of the upper limb is one of the systems that display many variations in the adult human body. Accurate information regarding these variations is important during vascular & reconstructive surgery and also in evaluation of angiographic images. Axillary artery is the direct continuation of the subclavian artery from the outer border of the first rib. The course of the axillary artery is anatomically divided into three parts by the pectoralis minor muscle. The variant case was found during the routine dissection classes in the Department of Anatomy at LLRM Medical College on a 40-year old formalin fixed female cadaver. Axilla was carefully dissected and axillary artery and its branches were cleared & documented. There was unilateral variation in the branching pattern of the first and second part of the axillary artery on right side. From the first part of axillary artery arose two superior thoracic arteries. From the second part of axillary artery arose a common trunk for thoracoacromial, lateral thoracic and subscapular arteries. The common trunk first gave origin to thoracoacromial and subscapular artery. Subscapular artery in turn branched into lateral thoracic and circumflex scapular and then continued as thoracodorsal artery. The left axillary artery exhibited the normal branching pattern. Arterial anomalies in the upper limb are due to defects in embryonic development of the vascular plexus of upper limb bud.*

Keywords*: Axillary artery, common trunk, seventh intersegmental artery, anterior interosseous artery, median artery, vascular endothelial growth factor.*

I. Introduction

Variations in the arterial pattern of the upper limb are common and have long received the attention of anatomists, radiologists, cardiologists, orthopedic and reconstructive surgeons and especially, vascular specialists. Detailed information about the vascular structure of the upper extremity is important for diagnostic interventions and surgical approaches [1].

Axillary artery is the direct continuation of the subclavian artery extending from the outer border of the first rib to the lower border of the teres major muscle, where it continues as the brachial artery. Throughout its course, the artery is closely related to the cords of the brachial plexus and their branches and is enclosed with them in a connective tissue sheath called the axillary sheath. If this sheath is traced upward into the root of the neck, it is seen to be continuous with the prevertebral fascia [2].

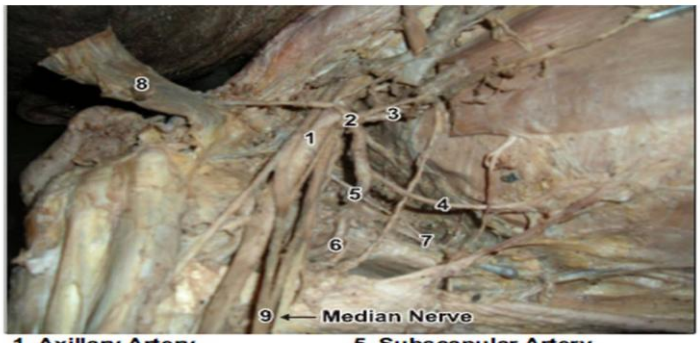
The course of the axillary artery is anatomically divided into three parts by the pectoralis minor muscle. The first part begins at the outer border of the first rib and extends to the medial border of the pectoralis minor muscle. The second part of the axillary artery lies deep to the pectoralis minor muscle. The third part lies between the lateral border of the pectoralis minor muscle and the inferior border of the teres major muscle. The axillary artery is usually described as giving off six branches. The first part of the artery gives superior thoracic artery. The second part gives lateral thoracic and thoracoacromial branches. The third part gives subscapular artery, anterior and posterior circumflex humeral arteries. The thoracoacromial trunk pierces the clavipectoral fascia and immediately divides into clavicular, pectoral, acromial and deltoid terminal branches [3].

Variations in branching pattern of axillary artery are due to defects in embryonic development of the vascular plexus of upper limb bud. According to Hollinshead (1958), as the aortic arches are resolved into their definitive condition, a part of the aortic arch system plus the seventh segmental artery becomes the subclavian-axillary stem on the right side and the seventh segmental artery alone becomes the subclavian-axillary stem on the left side [2].

II. Case Report

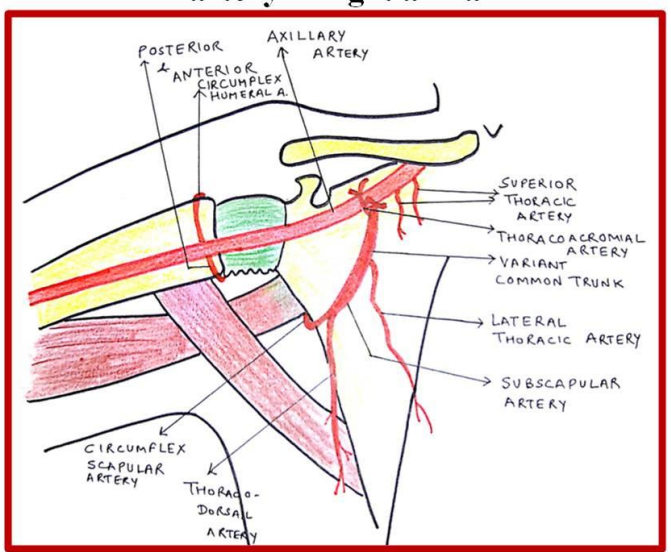
During routine dissection of undergraduate teaching in the Department of Anatomy at LLRM Medical College, Meerut on 40-year old formalin fixed female cadaver, a unilateral variation in the branching pattern of the axillary artery in right axilla was noticed (Fig. 1,2). The first part gave origin to two superior thoracic arteries. The second part had one branch instead of two. It gave origin to a common trunk for thoracoacromial, lateral thoracic and subscapular arteries. The common trunk first gave origin to thoracoacromial and subscapular artery. Thoracoacromial artery pierced the clavipectoral fascia and divided into four branches- pectoral, acromial, clavicular and deltoid. Subscapular artery in turn branched into lateral thoracic and circumflex scapular and then continued as thoracodorsal artery. The third part had two branches instead of three branches. It gave origin to anterior and posterior circumflex humeral arteries.The left axillary artery exhibited the normal branching pattern.

Figure 1. Right axilla showing common trunk for thoracoacromial artery, lateral thoracic and subscapular artery from second part of axillary artery



1. Axillary Artery
2. Common Trunk
3. Thoracoacromial Artery
4. Lateral Thoracic Artery
5. Subscapular Artery
6. Circumflex Scapular Artery
7. Thoracodorsal Artery & Nerve
8. Pectoralis Minor

Figure 2. Schematic diagram showing variant common trunk from the second part of axillary artery in right axilla



III. Discussion

Earlier studies by many observers showed that variations in the branching pattern of the axillary artery are very common. Many of its branches may arise by a common trunk or a branch of the named artery may arise separately [2]. De Garis & Swartley (1928) described 23 different types of axillary artery on the basis of the origins of the branches [4].

A common trunk of thoracoacromial artery and lateral thoracic artery from second part of the axillary artery was reported in 6.4% by DeGaris and Swartley [4] and in 3.9% by Huelke [5]. A common trunk for lateral thoracic with subscapular artery from second part of the axillary artery were reported in 1.2% by DeGaris and Swartley [4], in 6% by Patnaik et al [6] and as a case by Mehrdad and Sadeghi [7] and Sreeja and Leo Rathinaraj [8]. Saeed et al. (2002) reported a common trunk arising from the second part branching into lateral thoracic, circumflex humeral, subscapular and thoracodorsal arteries [9].

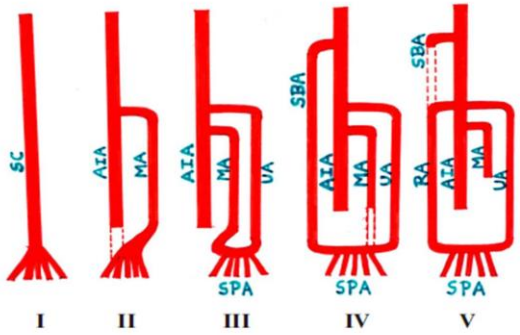
Bhat et al (2008) observed common trunk arising from second part of axillary artery from which arose thoracoacromial, lateral thoracic, subscapular & posterior circumflex humeral arteries [10]. Swamy et al (2013) reported a common trunk from the second part of axillary artery which gave origin to lateral thoracic, subscapular & posterior circumflex humeral arteries [11]. The present case correlates with them but posterior circumflex humeral artery arose separately from third part of the axillary artery in our case.

The development of the entire arterial tree of the upper limb (Fig. 3) occurs in stage-wise fashion with five stages [12, 13]. Williams et al (1995**)** also agreed to this theory [14].

Stage I: At first, the lateral branch of seventh intersegmental artery, i.e., the subclavian artery extends up to the wrist as the axis artery of upper limb, where it terminates by dividing into terminal branches for the fingers forming a capillary plexus. The proximal portion of it forms axillary and brachial arteries respectively, whereas distal portion persists as the anterior interosseous artery of forearm.

Stage II: Subsequently a median artery arises from the anterior interosseous artery, grows along the median nerve to communicate with palmar capillary plexus to feed it. By this time the anterior interosseous artery undergoes regression.
Stage III: In embryos of 18 mm, the ulnar artery arises from brachial artery and unites distally with the median artery to form superficial palmar arch. Digital branches arise from this arch.
Stage IV: In embryo of 21 mm length, the superficial brachial artery develops in the axillary region and traverses the medial surface of the arm and runs diagonally from the ulnar to the radial side of the forearm to the posterior surface of the wrist. There it divides over the carpus into branches for the dorsum of the thumb and index finger
Stage V: Finally three changes occur. When the embryo reaches the length of 23 mm, the median artery undergoes retrogression becoming a small slender structure, now known as *arteria nervi mediana*. The superficial brachial artery gives off a distal branch which anastomoses with the superficial palmar arch already present. At the elbow an anastomotic branch develops between the main trunk of brachial artery and existent superficial brachial artery, which shortly enlarges to form the radial artery with the distal portion of the superficial brachial artery, where as the proximal portion of the superficial brachial artery atrophies correspondingly.

Figure 3. Schematic diagram showing stages of development of arteries of the upper limb [12,13] (SC – subclavian artery, AIA – anterior interosseous artery, MA – mediam artery, SPA – superficial palmar arch, UA – ulnar artery, SBA – superficial brachial artery, RA – radial artery)



Arey (1957) is of view that the anomalous blood vessels may be due to the choice of unusual paths in the primitive vascular plexuses, the persistence of vessels which are normally obliterated, the disappearance of vessels which are normally retained, incomplete development & fusions and absorption of the parts which are usually distinct [15].

Fibroblast growth factor, FGF2, induces blood island development from competent mesoderm cells that form hemangioblasts. Hemangioblasts are directed to form blood cells and vessels by vascular endothelial growth factor (VEGF), which is secreted by surrounding mesoderm cells. VEGF stimulates proliferation of endothelial cells at points where new vessels will sprout from the existing ones. Final modeling and stabilization of the vasculature are accomplished by platelet derived growth factor (PDGF) and transforming growth factor β (TGF-β) [16]. Any disturbance in this process may result in variant arterial pattern.

Awareness of such abnormal axillary vasculature is crucial in use of superficial brachial artery flap in plastic surgery [17], protection of axillary artery in breast cancer surgery [18], in cases of arteriovenous fistulae, aneurysms and abscess drainage in region of axilla, arm and cubital fossa [19], while treating the axillary artery thrombosis [20], during antegrade cerebral perfusion in aortic surgery [21], reconstructing the axillary artery after trauma, treating axillary artery hematoma and brachial plexus palsy, considering the branches of the axillary artery for the use of microvascular graft to replace the damaged arteries, during surgical intervention of fractured upper end of humerus and shoulder dislocations [22].

Yoshinga et al (2006) found that the branches of the upper limb arteries have been used for coronary bypass and flaps in reconstructive surgery. Thus, accurate knowledge of the normal and variant arterial pattern of the human upper extremities is important both for reparative surgery and for angiography [23]. The subclavian and axillary arteries have been successfully used as cannulation sites for cardiopulmonary bypass in thoracic aortic procedures and for insertion of intra aortic balloon pumps and most recently they are under discussion for use as an inflow vessel in coronary artery surgery [24].

IV. Conclusion

Knowledge of variant branching pattern of axillary artery is necessary for accurate diagnostic interpretation and while treating the axillary artery thrombosis, brachial plexus palsy, shoulder dislocations and arthroscopy and considering the use of the branches of the axillary artery for microvascular graft to replace the damaged arteries, in coronary bypass and flaps in reconstructive surgery.

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