# Lateral thoracic artery and subscapular artery variation

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## ABSRACT

Variability in the branching patterns of the arterial tree can have important clinical implications for many specialties. Knowledge of patient-specific arterial anatomy is critical to successfully perform interventions, such as arterial embolization aimed at stopping hemorrhages, successful use of flaps in reconstructive surgeries, selective intra-arterial delivery of chemotherapy agents for treating cancer, and revascularization procedures in acute and chronic arterial occlusions in both peripheral and coronary artery diseases. The constellation of the anomalies has been attributed to the failure of development or growth-arrest of specific vascular sprouting in the upper limb's main axial vessel in any stage of development, due to mostly ambiguous factors. Anatomy Labs are usually one of the richest resources providing knowledge of vascular variations. We describe a case of arterial variation in the branching pattern of 2nd and 3rd parts of the left axillary artery in an 87-year-old male cadaver, discovered during routine dissection.

**Key Words:** *Axillary artery; Common stem; Lateral thoracic artery; Subscapular artery*

## INTRODUCTION

The axillary artery is a continuation of the subclavian artery. This vessel begins within the axilla at the outer border of the 1st rib. The prolongation of prevertebral fascia called the axillary sheath covers the artery, the cords of the brachial plexus, and the terminal branches of the brachial plexus. The structures are all embedded in axillary fat and are within immediate proximity of each other [1-9]. The pectoralis minor muscle divides the axillary artery into three parts. Proximal to the pectoralis minor muscle contains the first part of the axillary artery, which only contains the superior thoracic artery branch. The superior thoracic artery supplies the 1st and 2nd intercostal spaces, and the first and second digitations of serratus anterior muscle. The thoraco-acromial and lateral thoracic arteries arise posterior to muscle; the former artery, thoraco-acromial, pierces the clavipectoral fascia and supplies the soft tissue of the upper lateral thoracic wall [9]. The later branch, the lateral thoracic artery, supplies the nipple-areolar complex of the breast, and regularly, becomes much more evident in a lactating breast. The third part of the axillary artery (distal portion) commonly gives rise to three branches: subscapular, and the anterior & posterior humeral circumflex arteries. The subscapular artery is the main provider for scapular region. This vessel plays a critical role in the scapular anastomosis in case of injury to the axillary artery. The anterior and posterior circumflex humeral arteries are the main provider for upper humeral soft tissue and shoulder joint [9].

Transarterial interventions are used for a variety of conditions. For instance, intravascular therapies aimed at halting a hemorrhage by way of selective arterial embolization, or those intended for treating cancers through intrarterial delivery of chemotherapy agents and or to deliver viable cells to fill a defect, rely on a precise and accurate knowledge of arterial branching anatomy for the overall success of the intervention while at the same time minimizing negatives effects of the intervention.

Similarly, in the setting of traumatic arterial injury or arterial occlusive disease, the pathophysiologic repercussions anticipated by a trauma or vascular surgeon can be affected by the exact location of the interruption in blood flow, and whether or not there are other arterial branches that can supply collateral blood flow to the tissues distal to the injury of occlusion in question. For plastic and reconstructive surgeons, the course of the lateral thoracic artery and its caliber can be very important pieces of anatomic knowledge than can dictate surgical options for breast reconstructive procedures, as this vessel is responsible for the arterial perfusion to the nipple areolar complex. For these reasons, it is a crucial issue to know patient-specific branching pattern of any arterial tree to minimize iatrogenic injury. In the axilla, arterial branching patterns can have clinical implications in settings such as the reduction of old dislocation, antegrade perfusion in treating thrombosis in the brachial arteries, and in embolectomies [4,10-23].

## CASE REPORT

During a routine graduate-level biology human cadaver dissection lab, in the department of Biology at Chatham University (Pittsburgh, Pennsylvania), we discovered an unusual unilateral variation in the branching pattern of the left axillary artery in the axilla of an 87-year-old male cadaver. The cause of death was reported to be from end-stage COPD and there is no medical history documented that was associated with the variation in the upper limb. This case was photographed using an iPhone 7 mobile phone (Figure 1) and the following findings were noted. It was observed that the first part of

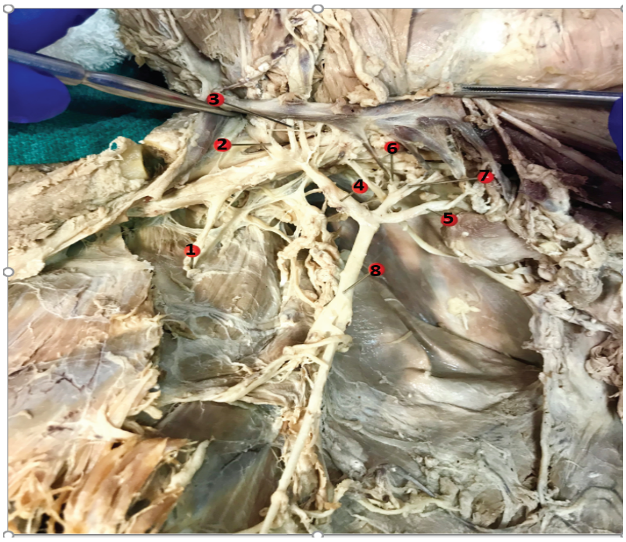


**Figure 1)** *Indicates, 1-Superior thoracic A, 2-Thoraco-acromial A, 3- Musclo-pectoral branches, 4-Common trunk, 5-Subscapular A, 6-Posterior circumflex humeral A, 7-Anterior circumflex humeral A, 8-Lateral thoracic A.*

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axillary artery gave rise to the superior thoracic artery as described typically in standard textbooks, and the second part gave rise to the thoraco-acromial artery with its normal 4 branches. However, adjacent to the thoraco-acromial artery, presence of musculo-pectorial artery branches was observed. In addition to this finding, the second part also gave a large common stem which gave rise to: (i) Lateral thoracic artery, (ii) subscapular artery, and (iii) from the confluence of the lateral thoracic and subscapular artery arose an additional arterial stem that further divided into the anterior and posterior circumflex humeral arteries. Furthermore, the anterior circumflex humeral artery was split into two branches, vid infra. There were no observed variations in the nerves and muscles of the upper limb.

## DISCUSSION

Anatomical variations of the axillary artery are commonly reported in literature. The history of a series of dissections have indicated cases that lack uniformity in the replication of the origin for the main six vessels arising from the axillary artery, indicating that any branch does not follow a predictable pattern at times, and thus, allowing for the assertion that any branch can arise from any segment in the axilla. McCormack et al. [17] examined 750 extremities in 386 cadavers. The study noted that deviations from normal anatomy occurred in 139 (18.5%) of these limbs. Thampi et al. [5] observed that the normal pattern of distribution was seen in 20% of the specimens while 80% of the specimens showed variations in the origin, branching pattern and distribution. For our study, high incidences of variation have been observed in the proximal part of axillary artery, however, variant branching usually continues in the distal portions as well for many studies [1,6,11,14,21]. In our case, the distal portion displays normal branches and inserts perplexing questions regarding the development of the artery (Figure 2). In a clinical setting, the significance of anatomical variations is that, though they are often asymptomatic in daily living, they can present a problematic diagnosis or exacerbating conditions can create symptomology of the variant [10].

In the anatomic variant described in this case, an interruption in arterial flow by traumatic injury, thrombus or embolus that occurs in the distal 2nd part of the axillary artery is more likely to result in critical limb ischemia than would be expected in the case of standard axillary artery branching anatomy. This is because the subscapular artery that allows for preserved brachial artery vascular inflow through the scapular anastomosis is not in its usual location in the 3rd part of the axillary artery and would likely be involved in this hypothetical interruption in arterial flow, and illustrates one possible clinical implication of this variant. Notably, approximately 6% of all fractures occur to the proximal humerus, and are twice as likely for females [7]. One of the main vessels that can be injured in a proximal humerus fracture is the posterior circumflex humeral artery [14]. In our case, the variation of the posterior circumflex humeral artery branches from a common arterial stem that arises from the confluence of the lateral thoracic and subscapular artery, which creates an even greater risk of critical upper limb ischemia in case of an injury.

In reconstructive plastic surgery use of connected or combined tissue transfer flaps that have a single vascular pedicle can be invaluable in the reconstruction of injuries that result in both bone and soft tissue damage, and their success is predicated on the accurate knowledge of the location, size, and variable anatomy of that vessel [13]. One type of such combined tissue transfer flap is the scapular free flap, which involves the transection of the subscapular artery, and the removal en bloc and relocation of a scapular skin flap supplied by the circumflex scapular artery, as well as a portion of resected inferolateral scapula supplied by branches from the thoracodorsal artery, as well as a portion of the latissimus dorsi muscle, supplied by the thoracodorsal artery. This flap can be used for complex defects of the mandible and associated overlying tissues [4]. In this case, the variant's common trunk cold be mistaken for the subscapular artery during resection of the flap from the donor site. Therefore, the tissues supplied to the lateral thoracic artery and the humeral circumflex arteries could be rendered acutely ischemic.


**Figure 2)** *Indicates, 1-Common trunk for four branches of axillary artery, 2-Brachial artery, 3-Profunda brachii artery. It displays normal branching pattern in the distal portions of the artery while the proximal portions are highly variable; this brings perplexing questions regarding the embryogenesis of the artery.*

In the field of breast reconstructive surgery, the Lateral Thoracic Artery Perforator flap (LTAP) is another common tissue flap that relies on a single vessel originating in the axilla for its successful use [18]. In a situation where the existence of this rare variant of the lateral thoracic artery origin is not fully appreciated, inadvertent damage and compromised blood flow may be caused to any of the vessels in the variant's proximity. Therefore, surgeons should be aware of the perfusion rate for lateral thoracic artery, which is the main provider to the nipple-areolar complex.

The explanation for the arterial variations is due to a defective vascular plexus formation during angiogenesis. In development, the vascular plexus in the primitive limb starts as communicative channels and the regression and obliteration of this network of growing vessels is controlled by endogenous and exogenous factors. During this process, some vessels survive as intended, while some may result in vasculature malformation. The early stages of embryogenesis within the limb bud includes endothelial cell cluster proliferation and coalescence into a capillary plexus under the influences of vascular endothelial growth factors and a variety of other molecular factors [8,15]. These signaling factors help navigate channels, collateral formations and disintegrations [8,15,24-27]. Consequently, excretion of different forms and variety of growth factor peptides might promulgate a formation that causes sprouting vessels to be misled from reaching their destination in a proper way in the axilla.

Physical factors may also disrupt the developmental process of the main axillary vessel as described by Kumar et al. [15]. Physical factors include regional hypoxia, arterial pressure and resistances have clear evidence of effecting sprouting and disintegration of growing vessel channels [3,8,15,28-30]. For the case of our axilla, we speculate the malformation goes with low arterial pressure. Notably, the presence of growing fat tissue was observed in the axilla, and may have implications in the development of the variant. We speculate that the migrated axons of the brachial plexus that are attempting to reach their destination to different muscles groups may have been affected by the effects of counteraction of different peptides from variable sources that navigate axons and arterial sprouting.

## CONCLUSION

In our case, we report a rare variation in the branching pattern of a left axillary artery, whereby arteries that typically originate from the 3rd part, were found to branch from a common arterial trunk arising at the 2nd part. This common trunk gives rise to the subscapular artery, anterior and posterior humeral circumflex, and lateral thoracic arteries. We believe this case study will further increase awareness to how variable the axillary arterial anatomy can be, and highlights the importance in characterizing the exact arterial anatomy in clinical situations where success is predicated on this knowledge. This is perhaps most important for plastic and reconstructive surgeons using the axillary artery and its branches as the basis for pedicled flaps in the reconstruction of complex injures and while performing breast reconstructions, with specific attention on an accurate understanding of the anatomy of the lateral thoracic artery and its importance in supplying arterial inflow to the nipple-areolar complex.

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