Unilateral and Bilateral Axillary Arches in Male and Female Cadavers

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ABSTRACT

Among sixteen donors (32 axillae) dissected in our gross anatomy lab, axillary arch was incidentally observed in three cases (five axillae). In three cases, the axillary arch was observed in five axillae-bilateral in one male and one female donor, and unilateral in one male donor. In all the three cases, the five arches consisted of muscular and connective tissue (aponeurotic/tendinous) parts. The muscular parts originated as slips from the lateral borders of the latissimus dorsi muscles and their connective tissue parts ascended and crossed anterior to the axillary neurovascular bundles to attach to various non-osseus structures on the proximal aspects of the arms. This created a canal dorsal to the axillary arch (designated here as axillobrachial canal or ABC) through which the axillary neurovascular bundles ran to enter the proximal aspect of the arms. The presence of such variant fibromuscular slip can be a cause of neurovascular compression syndrome of the upper limb and may complicate surgical procedures in the axillary region. Therefore, it should be considered in the differential diagnosis of neurovascular compression syndromes of the upper limb and axillary mass to avoid misdiagnosis and unintended damage or injury causing complications.

Keywords: Axilla; Axillary arch; Latissimus dorsi muscle; Axillary neurovascular bundle; Axillobrachial canal; Axillary neurovascular compression syndrome

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INTRODUCTION

Variations in the axillary anatomy is important for all procedures carried out in the region [1], where axillary arch (AA), also known as Langer's axillary arch, achselbogen, axillo-pectoral muscle, pectorodorsalis muscle and arcus axilans, is the most known anatomic variant of definite implication in the region [2]. The AA that arises from the lateral edge of the latissimus dorsi muscle (LDM) may be found unilaterally or bilaterally in about 5% to 8% of the population but according to some sources, a broader range of prevalence from 3%-27% is also noted [3]. However, the study of Moolya et al.[4], on the axillae of 60 cadavers (120 axillae) revealed that the origin of AA is not limited to the lateral edge of the LDM but can also be from the fascia of the LDM or from the fascia of the subscapularis muscle (SSM) and its incidence rate is as low as 2.5%. When present it crosses anterior to the axillary neurovascular bundle and joins the tendon of pectoralis major (PMaM), pectoralis minor, coracobrachialis (CBM), axillary fascia, fascia over the biceps brachii (BBM) or deep surface of deltoid and may also attach anywhere between the pectoralis major and coracoid process of the scapula [5,6]. The tissue composition of the AA is either muscle, connective tissue, or both [7]. Depending on its course in relation to the axillary neurovascular bundle, the AA can be a cause of various neurovascular compression syndromes like brachial plexus impingement, thoracic outlet syndrome, hyperabduction syndrome, shoulder instability, and venous and lymphatic compressions characterized by paresthesia, pain, muscle weakness, edema/lymphedema, and thrombosis. During physical and imaging exams, its presence can be demonstrated by loss of axillary concavity or axillary fullness that may resemble architectural distortion mimicking breast malignancy or sclerosing lesion in mammography [7-9]. Some previous authors like Das et al.[10] elaborated on the classification of the AA into muscular or tendinous based on the type of tissue composition, and complete or incomplete in relation to their extension or insertion and proposed a 6-type novel classification called Das's classification that emphasizes the insertion and degree of compression on the axillary neurovascular bundle with a suggested intervention for each type during axillary dissection. According to these authors the AA can compositionally be either muscular or tendinous. It is complete if it originates from the LDM and inserts to PMaM and is incomplete if it inserts to structures other than the PMaM.

The AA is innervated by nerves or groups of nerves to adjacent structures, which was described inconsistently by different authors that included the medial pectoral or thoracodorsal nerve [11], lateral pectoral nerve, intercostobrachial and thoracodorsal nerves [12], a branch from the pectoral loop (ansa pectoralis) [13] and sharing of the thoracodorsal nerve with LDM [14].

This current study reveals three unique cases of AA (two bilateral and one unilateral) that originated from the lateral border of the LDM with macroscopically different amounts of muscular and connective tissue composition and non-osseous distal attachments (insertions) that created a canal of variable size through which axillary neurovascular bundles ran between the proximal arm and the axilla.

MATERIALS AND METHODS

During the regular summer dissection of sixteen donors' axillae (32 axillae), AAs were observed in two bilateral cases and one unilateral case. The AAs were carefully dissected, thoroughly cleaned, and followed farther from their origins to their insertion on various portions of the proximal aspects of the upper limbs and were documented with photographs for illustration. Some structures were given novel designations, such as axillobrachial canal (ABC), medial and lateral bands of AA and intermediate part of the AA for convenience of description.

RESULTS

In the 80-year-old male donor, the bilateral AAs were found to be composed of muscular and aponeurotic parts. The muscular parts arose as slips from the lateral borders of LDMs and extended into aponeurotic structures that crossed anterior to the axillary neurovascular bundles and blended with the fascia of CBMs short before its attachments to the coracoid processes of the scapula (Figure 1). These bilateral AAs created a canal between the axilla and the proximal aspects of the arms (designated as ABC) with a proximal opening into the axilla and a distal opening into the arm. The walls of each ABC were formed by the AA anteriorly, LDM inferiorly, and LDM, teres major and part of the SSM posteriorly, and shorthead of BBM and CBM laterally, that served as a passage for the axillary neurovascular bundles.

In the 74-year-old male donor, each AA took a similar origin and course except that the aponeurotic fibers are divergent and arranged in three distinct parts: thickened lateral and medial bands with a broader, thinner intermediate part. The thickened lateral and medial bands attached to PMaM and CBM tendons respectively, while the broader and thinner intermediate part spread into the PMaM and CBM tendons (Figure 2). In this case, the bilateral AAs also created relatively narrower ABC between the axilla and the proximal arms with similar walls to those show in Figure 1, except that the PMaM was additionally involved in the formation of the wall of the distal opening into the proximal arms (Figure 2). Each thickened lateral band of both AAs in figure 2 took a distally curved course to attach to the tendon of pectoralis major muscles, creating tight distal openings of the ABC to the proximal arm. This opening is bounded by the lateral band of the AAs anteriorly, LDM inferiorly and posteriorly, the PMaM and CBM laterally (Figure 2).

The right unilateral AA in the 74-year-old male donor had a similar origin, course and tissue composition but the connective tissue part of the AA is a rounded tendon that flattened near its insertion into aponeurosis, which blended with the fascia over the short head of BBM and CBMs (Figure 3). Though there is distinct canal formation as such, there is a similar but slightly wider opening to the proximal arm similar to the one in Figure 2, bounded by the AA ventrally, latissimus dorsi muscle inferiorly and posteriorly, and the BBM and CBMs laterally (Figure 3).

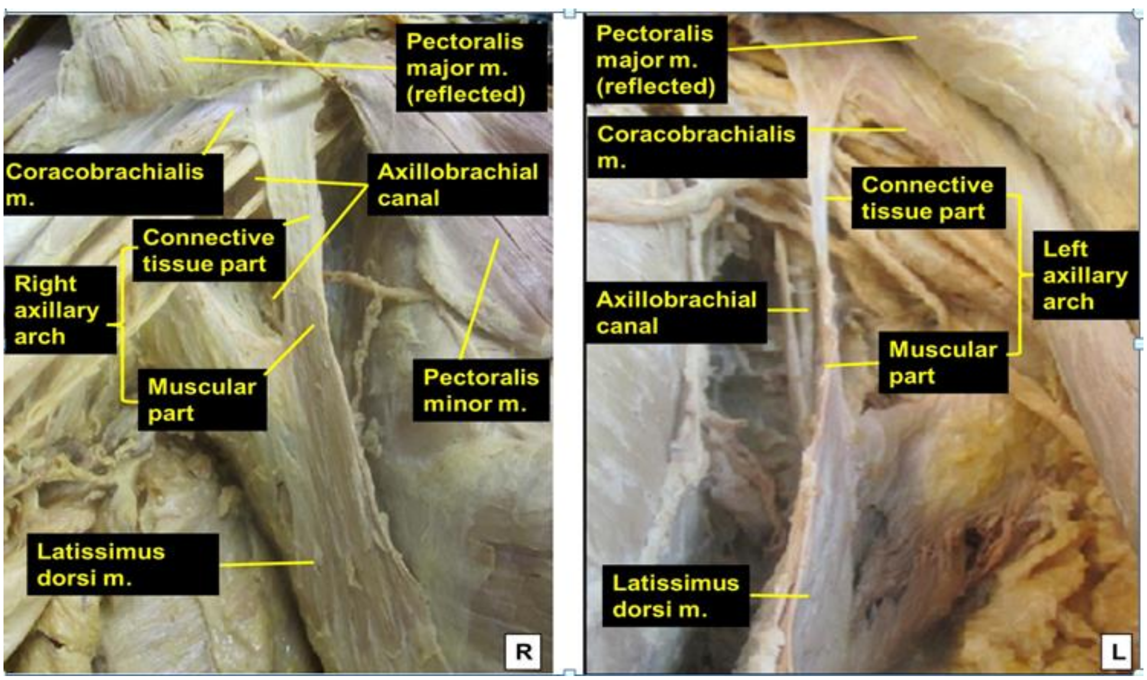

Figure 1: Illustrates the right (R) and left (L) axillary arches in an 80-year-old male donor that arose from the lateral borders of the latissimus dorsi muscles, ascended anterior to the axillary neurovascular bundles with their aponeurotic fibers that blended with the fasciae of coracobrachialis muscles creating the ABCs with wide openings to the proximal aspects of the arms.

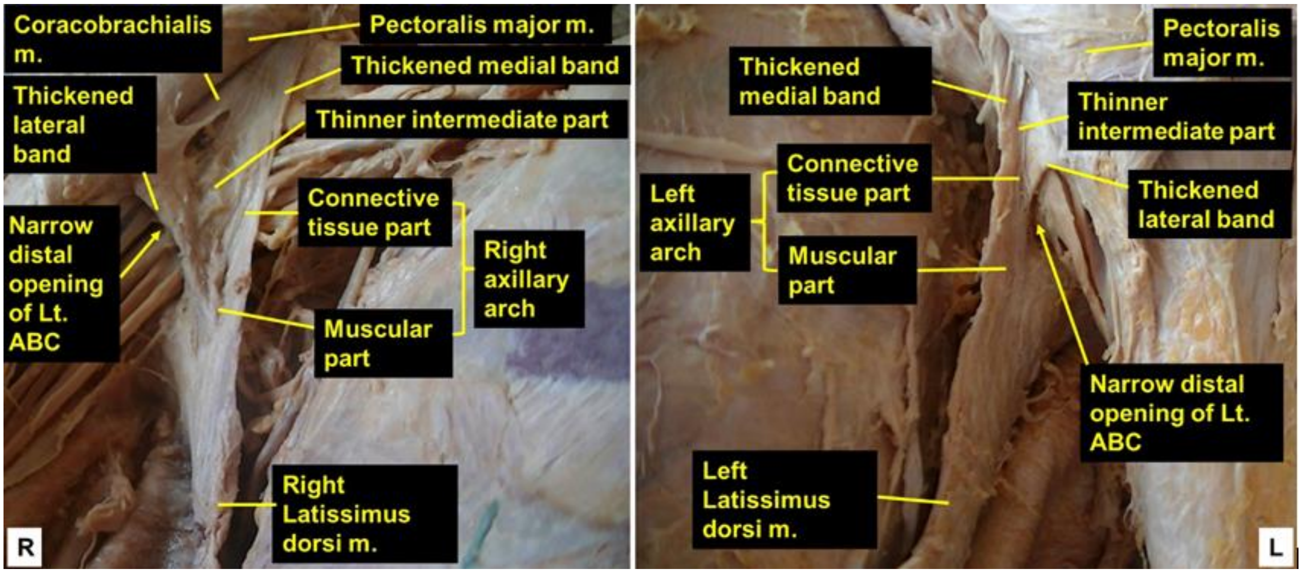

Figure 2: Show the bilateral AAs in the right (R) and left (L) axillae of a 75-year-old female donor with their muscular and connective tissue parts. The AAs on both sides arose from the latissimus dorsi muscles, crossed ventral to the axillary neurovascular bundles to attach to pectoralis major and coracobrachialis tendons by their thick medial and lateral bands and the thin intermediate part. The narrow distal openings of the ABCs to arm are also shown.

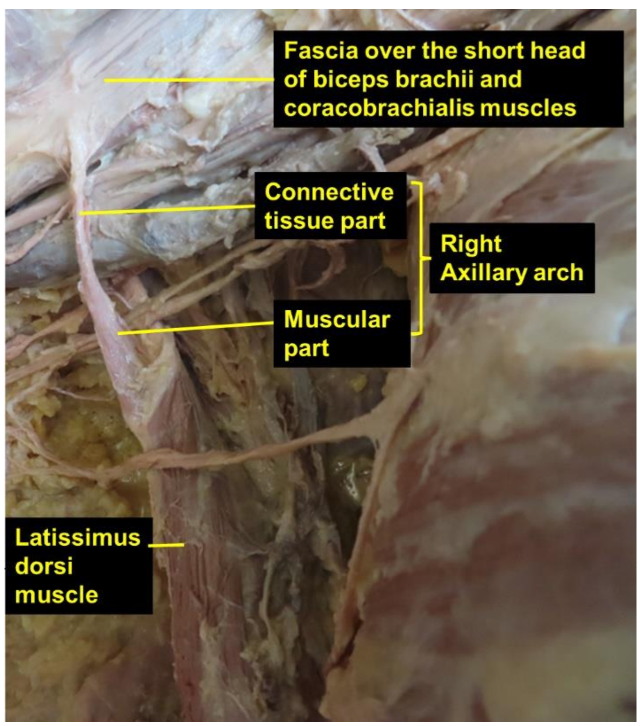

Figure 3: Demonstrates a right unilateral AA in a 74-year-old male donor. It originates as a muscular slip from the latissimus dorsi muscle, crosses ventral to the axillary neurovascular bundle, and its rounded connective tissue (tendinous) part flattens and blends with the fascia over the short head of biceps brachii and coracobrachialis muscles. The gap through which the axillary neurovascular bundle passes is also shown.

DISCUSSION

The practical importance of variations of structures in the axillary region is well recognized [1], with the AA being the best-known anatomic variant of definite implication [2]. This variation in the axilla is found either unilaterally or bilaterally in about 5% to 8% of the population but according to the retrospective study by Guy et al. [3] on 1109 shoulder-MRIs, there is a broader range of incidence, from 3%-27%. Moreover, in another study conducted by Moolya et al. [4] on 120 axillae, only three (2.5%) unilateral AAs were found; all of which were in males. Of these three, only one ran ventral to the axillary neurovascular bundle, while two (one on the left and one on the right) passed through the bundle, dividing the posterior cord of the brachial plexus into superior and inferior parts [4]. However, most resources agree that the AA arises as a slip from the latissimus dorsi muscle, crosses ventral to the axillary neurovascular bundle but it variably attaches to the pectoralis major, fascia of coracobrachialis or short head of biceps brachii and anywhere between pectoralis major and the coracoid process of the scapula [5,6]. The occurrence of multiple as well as single AA with numerous insertions have also been reported [5,6]. According to a study conducted on 200 unembalmed cadavers (400 axillae), the tissue composition of the AA is either muscle, connective tissue or both [7]. However, as the current finding showed, the tissue composition of the AA is both muscle and connective tissue. AA arising from anterior border of LDM, splitting into two slips: one attaching to the CBM and the other to the PMaM were also reported [8]. In the current report, out of the thirty-two dissected axillae, both bilateral and unilateral AAs arising from the LDM were observed in five axillae, which is consistent with most previous reports. The bilateral ones were in four axillae of two (one male and one female) and the unilateral finding was in the right axilla of a male. In all five axillae, the AAs ran anterior to the axillary neurovascular bundle and attached to non-osseus (non-bony) structures including the fascia over the CBM, short head of BBM and PMaM by flattened fibrous membrane (aponeurosis) in the bilateral ones and by a rounded tendinous part in the unilateral one. Uniquely, the flat connective tissue parts of the bilateral ones of the 75-year-old male, showed three distinct parts: thickened medial and lateral portions and a thinner intermediate portion, that converted the space dorsal to the AA, into ABC with a narrower opening to the proximal arm through which the axillary neurovascular bundle traveled. Most previous authors have emphasized that AA can cause axillary fullness, can resemble architectural distortion on mammography, compress axillary vessels and nerves and impede access to axillary lymph node during breast surgery [7-9]. Recently, Das et al. [10] proposed a 6-type classification system (1, 1C, 2, 2C, 3, and 3C) known as Das's classification, which particularly emphasizes the insertion and degree of compression on the axillary neurovascular bundle with a suggested interventional measure to be taken for each type during axillary dissection. According to these previous authors including Das et al. [10], the AA can compositionally be either muscular or tendinous. It is complete if it originates from the LDM and attaches to PMaM and is incomplete if it is inserted to other structures. As the finding in this study shows, the bilateral AAs cannot be classified into complete and incomplete for their connective tissue parts are attached to different structures including the PMaM, short head of BBM, and CBM. Therefore, an additional category, such as "combined", may be needed to describe cases like those in this study, which are both complete and incomplete at the same time.

The AA is typically innervated by the medial pectoral nerve or thoracodorsal nerve though some sources suggest innervation by the lateral pectoral, intercostobrachial and thoracodorsal nerves, or by a single nerve branching from the pectoral loop (ansa pectoralis) [11-13]. However, a study done on twenty subjects concluded that the AA being an extension of the LDM shares innervation with it. This shows that there is no consensus as to which nerve innervated the AA.

The author of this paper believes that the formation of the ABC with its variable widths, particularly the width of its opening to the arm could be decisive in the causation of neurovascular compression syndrome. The presence of narrow distal opening to the proximal arm as illustrated in Figure 2, can be considered as a risk factor for the development of neurovascular compression syndrome of the upper limb. However, further study is needed to determine the critical size of the canal and the distal opening through which the axilla communicates with the anteromedial arm.

CONCLUSION

Despite its rarity, such variations can pose risks during invasive procedures, potentially leading to misdiagnosis or iatrogenic injury. This is especially relevant during bilateral mastectomy with axillary lymph node dissection, breast reconstruction surgery using LDM flaps, head and neck surgeries involving PMaM flaps, and other clinical interventions. Surgeons, anesthesiologists, radiologists, and related professionals must be aware of these variations to prevent complications during diagnostic and therapeutic procedures.

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