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The morphology and clinical importance of the axillary arch

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The axillary arch is the main variation of the axillary muscle. It was first described by Ramsay in 1795. In its classical form, it arises from the latissimus dorsi muscle and extends from this towards the pectoralis major, crossing the base of the axilla and creating a close relationship with the elements of the axillary neurovascular bundle. We describe the finding of 9 axillary arches, including one case of a bilateral arrangement. We develop a searching and finding technique for the axillary arch, essential for the safe and successful development of surgical procedures in the axillary region. Knowledge of this muscle variation and the possibility of finding it during axillary procedures is crucial for lymph node staging and lymphadenectomy and is also important for differential diagnosis in compressive pathologies of the axillary vessels and brachial plexus. (Folia Morphol 2008; 67: 261–266)

Key words: axillary arch, vein compression, axillary fossa

INTRODUCTION

The axillary region is where neurovascular elements extend from the neck to the upper limb and where lymph node structures are situated. As a result of its variable morphology, there may be regional muscle variations in relation to these elements, which can influence the development of different types of pathology of the axillary fossa and its constituents.

The axillary arch (AA) is the main muscular variant of the axilla and is also known as *achselbogen*, arcus axillaris, the pectodorsal muscle and the axillopectoral muscle [3, 8, 11–13, 21, 24–26, 29]. It was first described by Ramsay [22] in 1795.

The classical description defines it as a muscular slip which stretches from the external border of the latissimus dorsi muscle and ends by inserting into the rear side of the pectoralis major muscle distal insertion tendon [22, 24]. It crosses over the entire axillary cavity perpendicularly to the axilla neurovascular bundle, with which it has a close relationship that may have important clinical and surgical consequences [3, 11, 14, 16, 23, 25, 26, 29]. A bibliographical review indicates a 2% to 7% AA presence, more frequently unilateral [3, 11–13, 16–18, 20] and rarely bilateral [13, 16, 19].

The aim of this article is to review the AA with respect to its presence, statistics, variability and its importance for finding, diagnosing and treating compressive and oncological pathologies of the axillary region.

MATERIAL AND METHODS

The dissection team under V.H. Bertone of the Second Chair of Anatomy of the School of Medicine of the University of Buenos Aires dissected 78 axillae from adult cadavers formol-carbol fixed at 10% without regard to sex.

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We developed the following dissection technique to search for and find the AA:
- — dissection of the anterior wall of the axilla as far as the pectoralis major muscle and extension of the dissection throughout the lower muscle border, except for the distal insertion tendon at the humerus level;
- — plane dissection of the external side of the latissimus dorsi muscle until the anterior border is found;
- — determination of a dissection plane within a limited area from the inferior border of the pectoralis major muscle and the anterior border of the latissimus dorsi muscle. Dissection should be carefully continued by following the anterior border of the latissimus dorsi muscle upwards to search for the AA. When this is present it will then be possible to find it above the dissection, thus avoiding damage and the possible involvement of neurovascular structures, including the intercostobrachialis nerve, which in most cases lies medial to the AA;
- — comprehensive dissection of the AA once found, taking into account that it is usually inserted distally at the level of the pectoralis major muscle humeral insertion. This insertion can vary [2, 9, 12, 15–17, 19, 23–25].

RESULTS

Out of 78 axillae dissected, 9 AAs were found. Seven cadavers showed a unilateral arrangement, and one cadaver showed a bilateral AA (Fig. 1). The results are summarised in Table 1.

The cases found to follow Testut's description [24] of a complete and incomplete AA are explained below. The bilateral case is also described.

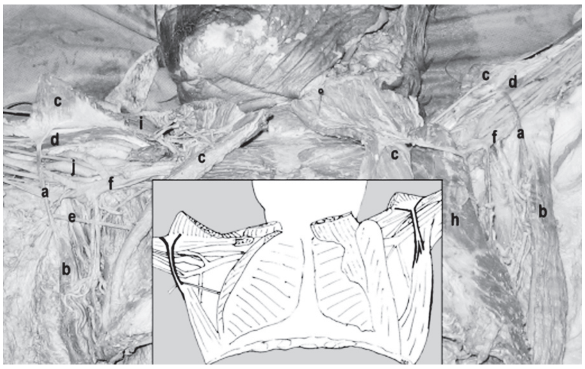

Figure 1. Bilateral axillary arch; a — axillary arch; b — latissimus dorsi muscle; c — pectoralis major muscle; d — corachobrachialis mucle; e — intercostobrachialis nerve; f — axillary vein; h — pectoralis minor muscle; i — deltoideus mucle; j — axillary artery.

Table 1. Axillary arch (AA) found in 78 dissected axillae according to Testut's description [24]

Right side		Left side	
4 cases		5 cases	
5.13%		6.41%	
Complete AA		**Incomplete AA**	
6 cases		3 cases	
7.69%		3.85%	
Right side	**Left side**	**Right side**	**Left side**
2 cases	4 cases	2 cases	1 cases
2.56%	5.13%	2.56%	1.28%
Unilateral	**Bilateral**	**Unilateral**	**Bilateral**
4 cadavers	1 cadaver	3 cadavers	–
5.13%	1.28%	3.85%	–

AA — axillary arch (n = 78); 9 cases; 11.54%

Complete axillary arch

Six "complete" AA arrangements were found. Proximally they originated at the latissimus dorsi muscle level and distally adhered to the pectoralis major muscle tendon posterior side at the humeral insertion level. This muscular slip passes through the axillary cavity and is closely related to the axilla neurovascular bundle. Item C describes in detail two complete AA cases corresponding to the bilateral finding (Fig. 1, 2).

Incomplete axillary arch (Fig. 3–5, Table 2)

The three cases observed show distal insertion at the aponeurosis level of the coracobrachialis muscle, while proximal insertion appears in the latissimus dorsi, involving the following differences: case I.1 (Fig. 3) arises from an aponeurotic intersection as an intermediate tendon; case I.2 (Fig. 4) continues from the muscle fibres of the latissimus dorsi as a supernumerary muscular expansion; I.3 is similar (Fig. 5) but the expansion muscle fibres are fewer in number. The muscle mass volume varies: I.2 shows considerable muscle mass (9.3 × 1.7 cm) as compared to I.1 (5.8 × 0.9 cm), but case I.3 shows a marked difference, as the small muscle portion it presents continues as an aponeurotic tendon.

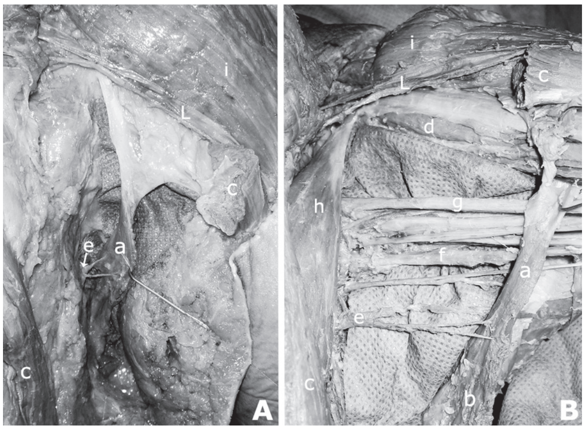

Figure 2. Complete axillary arch. Left side. In this figure we can see the same axilla in two dissection times and the innervation of the axillary arch. **A.** Finding of the axillary arch; **B.** Full final dissection; a — axillary arch; b — latissimus dorsi muscle; c — pectoralis major muscle; d — corachobrachialis mucle; e — intercostobrachialis nerve; f — axillary vein; g — median nerve; h — pectoralis minor muscle; i — deltoideus mucle; L — cephalic vein.

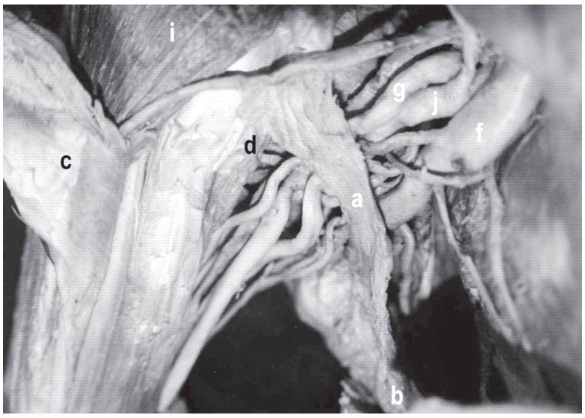

Figure 4. Incomplete axillary arch (I.2). Right side. a — axillary arch; b — latissimus dorsi muscle; c — pectoralis major muscle; d — corachobrachialis mucle; f — axillary vein; g — median nerve; i — deltoideus mucle; j — axillary artery.

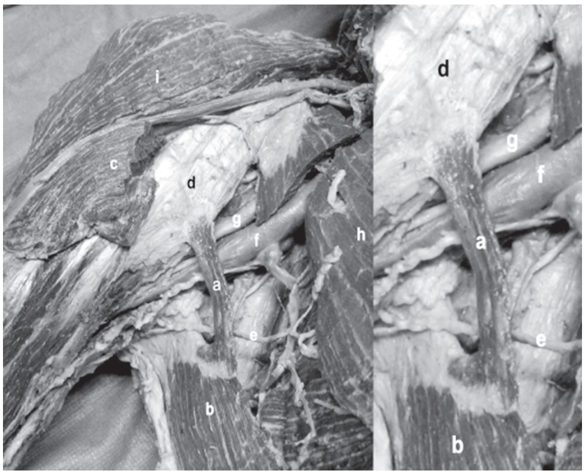

Figure 3. Incomplete axillary arch (I.1). Right side. a — axillary arch; b — latissimus dorsi muscle; c — pectoralis major muscle; d — corachobrachialis mucle; e — intercostobrachialis nerve; f — axillary vein; g — median nerve; h — pectoralis minor muscle; i — deltoideus mucle.

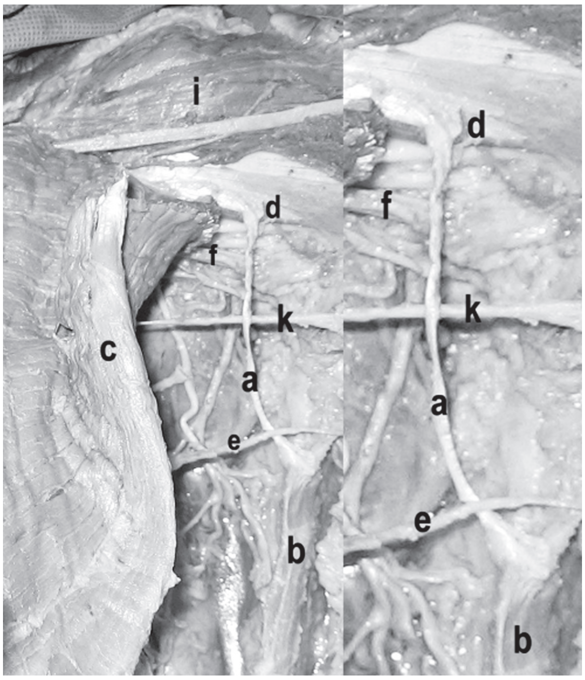

Figure 5. Incomplete axillary arch (I.3). Left side. a — axillary arch; b — latissimus dorsi muscle; c — pectoralis major muscle; d — corachobrachialis mucle; e — intercostobrachialis nerve; f — axillary vein; i — deltoideus mucle; k — medial pectoral nerve.

Bilateral axillary arch (Fig. 1)

The right AA is 9.1 cm long and 0.6 cm wide. It arises in the anterior border of the latissimus dorsi muscle as a muscle fascicle stretching towards the pectoralis major muscle and is closely related to the median nerve, axillary artery, ulnar nerve, internal brachial cutaneous nerve and superior basilar vein.

Distal insertion takes place on the rear side of the pectoralis major distal tendon as a 2.1-cm-base triangular aponeurotic slip.

On the left side the AA measures 8.5 cm and has a particular arrangement. It originates at the level of the latissimus dorsi muscle anterior border, and three sections can be described. The first is inserted in the latissimus dorsi and formed by two totally

Table 2. Characteristics of incomplete axillary arch (AA)

Case	Proximal origin	Distal insertion	Length	Width	Morphological arrangement
I.1 (Fig. 3)	latissimus dorsi m.	Coracobrachialis m.	5.8 cm	1.2 cm	Muscular
I.2 (Fig. 4)	latissimus dorsi m.	Coracobrachialis m.	9.3 cm	1.7 cm	Muscular
I.3 (Fig. 5)	latissimus dorsi m.	Coracobrachialis m.	8.9 cm	0.8 cm	Musculoaponeurotic

Table 3. Investigations comparisons

Authors	Total axillae (n)	AA	AA unilateral Cadavers	AA bilateral Cadavers	Complete/incomplete AA Testut's description
Present Study	78	9 (11.54%)*	7 (8.97%)	1 (1.28%)	6*/3
Georgiev et al. [11]	56	2 (3.57%)	2 (3.57%)	0	2/–
Pai et al. [18]	68	1 (1.47%)	1 (1.47%)	0-	–/1
Besana-Ciani et al. [3]	46	3 (6.52%)	3 (6.52%)	0	–/–
Mérida-Velasco et al. [16]	64	4 (6.25%)*	3 (4.69%)	1 (1.56%)	2*/2
Miguel et al. [17]	100	3 (3.00%)	3 (3.00%)	0	2/1
Kalaycioglu et al. [12]	60	1 (1.67%)	1 (1.67%)	0	–/1
Poitevin [20]	43	3 (6.98%)	3 (6.98%)	0	–/3

*including bilateral axillary arch (AA), considering each AA individually

independent muscle fascicles, namely the anterior fascicle and posterior fascicle. The former is 2.8 cm long and the later 1.3 cm long. These are separated by cellular tissue and axillary aponeurosis and progressively approach each other until they attach like a double barrelled shotgun, forming the arch's second 3.7-cm-long portion, this time separated by aponeurotic tissue. Finally, the third portion shows both fascicles fused, giving rise to the common arcus axillaris muscle mass and measuring 5.7 cm × × 0.5 cm in width.

In order to insert into the pectoralis major the common muscle mass becomes a thin triangular 1.1-cm-high aponeurotic layer, whose upper base is 1.3 cm. It is inserted in the posterior face of the pectoralis major U-shaped distal tendon. The triangle's vertex is inferior and 0.3 cm wide.

As regards AA innervation, according to our study, it would originate in the intercostobrachialis nerve (Fig. 2) [11, 26], which passes behind the AA and can therefore be compressed by movements narrowing the AA, except for one case where the nerve adopted an anterior arrangement, without innervation of the muscle (Fig. 5). In this case, we could not find the innervation of the AA. In the bilateral case, on the left side, the nerve passes between the two AA origin muscle fascicles.

DISCUSSION

We share the notion that the AA is the most frequent muscle variation of the axilla [8, 9, 11, 12, 17, 18, 24–26, 29].

Out of the 78 axillae dissected in our study (Table 1) 9 AAs were found, amounting to an 11.54% occurrence likelihood, higher than that reported by other authors. Four AAs were found on the right side and five on the left. With respect to Testut's classification, in the complete type the AAs found in the left side predominate (left: 4 cases; right: 2 cases). In the incomplete type those on the right predominate (right: 2 cases; left: 1 case) (Table 3).

Except in the case of one cadaver, the findings were unilateral. The bilateral case (Fig. 1) represents 1.28% of the total number, close to the proportion found by Mérida-Velasco et al. [16] (1.56%; n = 64). On the other hand, some authors also report cases of bilateral AA, although no statistics are provided. Perre and Zoetmulder [19] found it during surgery, while Ko et al. [13] also described a bilateral AA finding observed in mammography.

As regards the embryological origin of the AA, Besana-Ciani et al. [3] established that the arcus axillaris develops from the panniculus carnosus, a remainder of an aponeurotic fascia associated with the axillary muscles and situated in the plane between the superficial fascia and the subcutaneous cellular tissue, from which other muscle variations, including the pectoralis quartus, intermedius and sternalis [3, 4, 5, 27, 28], can be derived. According to Wilson [27], it corresponds to the humeral portion of the panniculus carnosus. In lower mammals the panniculus carnosus is highly developed and enables the pectoral region muscle bundle to form. However, this structure has involuted in man, since during evolution the upper limb muscles have acquired greater functional importance. This, and the reduced frequency of intermuscular attachments in man (common in animals), would be a natural strategy based on independent muscle contractions, giving rise to segmented and precise movements.

Regarding Testut's [24] description of the AA as "complete" and "incomplete", the difference between the two types lies in their distal insertion. While the complete type is distally inserted in the pectoralis major tendon, the incomplete type has been reported to end in different sites, for example in muscles such as the coracobrachialis, biceps brachii and triceps long portion, as well as the coracoid process [2, 12, 16–18, 20, 26]. Table 3 compares complete and incomplete cases found in our study and other investigations. Out of the total number of 9 AAs 6 complete-type cases (66.67%) were found, among them the bilateral AA, and 3 incomplete-type cases (33.33%). The findings of Dharap [9] and Turgut et al. [25] stand out, as they found an incomplete AA, whose distal insertion corresponded to the coracoid process.

With respect to innervation, it is worth mentioning other opinions that refer to innervation through the lateral pectoral nerve [4], medial pectoral nerve [16, 28, 29] and pectoralis minor [23]. Finally, some authors consider innervation through the thoracodorsal [12, 16, 17, 25, 29], supporting the idea that the AA derives from the latissimus dorsi [9, 12]. The brachial plexus ansa pectoralis has also been considered [1].

In clinical examination discovery of the loss of the axillary fossa and the perception of a mass upon palpation [11, 16, 23] can lead to suspicion of the presence of an AA, and this can be demonstrated by echography, computed tomography, magnetic resonance imaging [3, 11, 13] and mammography [13]. In the presence of this variety, movements of the upper limb, such as abduction and elevation of the arm, may result in pain and signs of neurovascular compression [3, 11, 16, 20, 23, 25, 26, 29].

During surgical procedures the AA can be mistaken for the coracobrachialis muscle medial border [24] and may also extend the finding of the biceps brachii long portion [2, 12]. Moreover, as the AA crosses the axillary artery just below the site used for the application of the artery's ligature, this surgical procedure can be hindered if this type of muscle variation is ignored, the muscles hampering access to the axillary fossa and also, perhaps, leading to compression of the brachial plexus terminal branches [10].

It is also important to be aware of the AA for oncological surgical procedures, breast cancer and sentinel node biopsy [6, 8]. During surgery the potential presence of the AA hinders the exposure of the axillary structures, creating difficulty and confusion at the time of staging and lymphadenectomy of the axilla, which may compress and injure the axillary vessels and nerves [8, 26]. In these cases, the axillopectoral muscle may mislead the surgeon, resulting in incomplete lymph removal [3, 11, 25]. This is also important for axillary approaches in the repair of scapulohumeral joint pathology or exploration of the axillary nerve or other neurovascular elements in the region [11, 15].

We conclude that knowledge of the existence and arrangement of the axillary arch is essential for the safe and successful development of surgical procedures in the axillary region [11]. Development of a dissection system, such as the one described here, is crucial in making a deliberate search for the axillary arch, as opposed to finding it accidentally.

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