DOI: 10.7860/IJARS/2022/55932.2811

Original Article

Anatomy Section

Role of Axillary Arch Muscle in Neurovascular Compression: A Cadaveric Study in the Western Region of Maharashtra, India

PRASHANT MOHAN MOOLYA[1], RAHUL RAJARAM CHOPADE[2], SHAILENDRA PATIL[3]

ABSTRACT

Introduction: The Axillary Arch Muscle (AAM), is a rare anomalous finding in the axilla also known as langer's muscle. In the literature, it is explained as a narrow muscular slip that extends from the latissimus dorsi to the pectoralis major. Variations of this muscular anomaly have been observed. The abduction and external rotation like simulation of the arm in the cadaver suggest the possibility of neurovascular compression by the AAM. The AAM causing compression is considered an etiology of thoracic outlet syndrome by some authors. The symptoms generated by neural or vascular compression can be differentiated clinically. The purpose of this article was to compare the potential role of AAM in causing neural or vascular compression and discussion with the clinical studies which showed varied results.

Aim: To find out the possible anatomy of axillary arch muscle and its relation with neurovascular structures.

Materials and Methods: The descriptive cadaveric study was conducted in the Department of Anatomy at Seth G.S.M.C. and KEM hospital, Mumbai, India from November 2012 to November 2014. Study included 120 axillae of 60 embalmed cadavers (60 right and 60 left axilla). Axillary arch muscles were identified and their relations with neurovascular structure in an abducted position of the arm were noted and photographed. The simple statistical method of calculating percentages (%) of the collected data was applied to the study.

Results: The dissection of the axillary region was carried out in 120 axillae which included 53 male and 7 female cadavers. The axillary arch muscles were identified in the three male axillae unilaterally. Its extent and relations with the neurovascular structure were different in all three cases. Its medial attachment was on the lateral border of latissimus dorsi, fascia over the latissimus dorsi, or the subscapularis muscle, while the lateral attachment was on fascia over coracobrachialis or biceps brachii. All the cases showed close relations with neural as well as vascular structures with the potential of causing compression in varied numbers.

Conclusion: Though the existence of this muscle is rare, the findings of the present study will help clinicians, surgeons, and physiotherapists to be vigilant in diagnosing the cases with AAM amongst the individuals frequently adopting hyperabduction maneuvers in their occupations or sports thereby causing neurovascular compression.

Keywords: Abduction, Axilla, Latissimus dorsi, Sports

INTRODUCTION

Axillary arch muscle was described by Ramsay in 1795 but was truly confirmed by Langer in 1864 and later many authors described its different form [1-3]. The Axillary Arch Muscle (AAM) is very well known by different names such as langer's muscle, axillopectoral muscle, or the "achselbogen muskel" [1-3]. It is a muscular anomaly that extends from the lateral edge of the latissimus dorsi to the tendon of insertion of the pectoralis major and along its course, it crosses the axillary vessels and the distal brachial plexus [4]. The frequency of existence of this muscle is about 7%. However, variation of this muscular anomaly has been observed in other studies with a range of 0.25-37.5% [1,4]. The common variations were at the insertion point which included the muscles adhering to the coracoid of the scapula, medial epicondyle of the humerus, teres major, long head of the triceps brachii, coracobrachialis or biceps brachii, and pectoralis minor [5].

The embryological basis of the existence of AAM is uncertain, though few theories suggest its association with the development of panniculus carnosus. According to those theories, the panniculus carnosus include those group of muscles between subcutaneous fat and superficial fascia. In lower animals like rodents and cats, the panniculus carnosus is widely distributed to form a pectoral group of muscles. In humans, due to wider upper limb mobility, this panniculus carnosus has been regressed to remain as AAM, the common variant among panniculus carnosus of a pectoral group. Being a vestigial structure the AAM has lost its functional significance [2].

Though the AAM lacks functional significance, it is found important in clinical syndrome and various surgical aspects. AAM is associated with brachial plexus impingement, thoracic outlet syndrome, hyperabduction syndrome, and venous obstructive compression. During lymphadenectomy surgery for Breast carcinoma, AAM may hide the proper visualisation of lymph nodes resulting in incomplete clearance [2].

Various cadaveric and clinical studies have been performed showing the incidence and morphology of the axillary arch muscle [1-7], however, very few studies explained the relations of each AAM with the neurovascular structures [8-10]. The present study has combined the study of incidence and morphology of AAM along with the detailed cadaveric observation of the potential role of AAM in causing neural and vascular compression in the western region of Maharashtra, India. The results were discussed with the observation of various clinical studies performed in this regard.

MATERIALS AND METHODS

The descriptive cadaveric study was done after Ethical Clearance [EC/199/2012] in the Department of Anatomy at the Seth G.S Medical College and KEM Hospital, Mumbai, India over two years from November 2012 to November 2014.

Inclusion criteria: The cadavers available in the Department of Anatomy irrespective of age and sex were used for the study.

Exclusion criteria: Damaged anatomy of the axillary region due to fibrosis of tissues or trauma were excluded.

The 120 axillary regions of 53 male and 7 female embalmed cadavers (60 right and 60 left axilla) were dissected stepwise by taking skin incision followed by careful separation of fascia particularly in the axillary region. The vasculature and neural structure in close relation to AAM were preserved using the standard dissection manual [11]. The axillary arch muscles were identified and their relations with neurovascular structure in an abducted position of the arm were noted. Axillary arch muscles crossing the neurovascular structure nearby were identified as having the potential for compression. Those axillary arch muscles causing neural compression and vascular compression were tabulated separately [Table/Fig-1].

Sr. no.	Side	Gender	Potential of causing Neural compression (100%)	Potential of causing vascular compression (66.6%)
1.	Left	Male	Yes (posterior cord)	Yes (subscapular artery and vein)
2.	Right	Male	Yes (entire brachial plexus)	Yes (Axillary artery and vein)
3.	Right	Male	Yes (posterior cord)	No

[Table/Fig-1]: Axillary arch muscle with the potential for neurovascular compression.

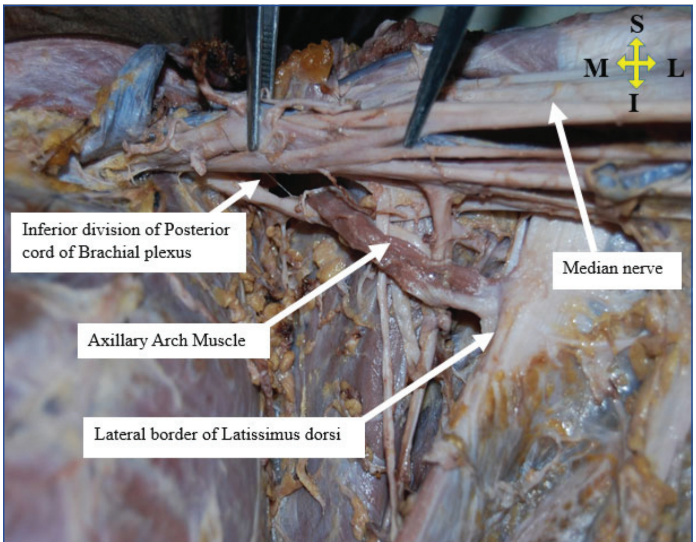
STATISTICAL ANALYSIS

Simple statistics in the form of a percentage (%) were applied by filling the data in Excel sheet.

RESULTS

The axillary region dissection was done on 53 male and 7 female embalmed cadavers. Axillary arch muscles were identified in three axillae out of 120 axillae dissected 2.5%. All the axillary arch muscles were present unilaterally in male cadavers.

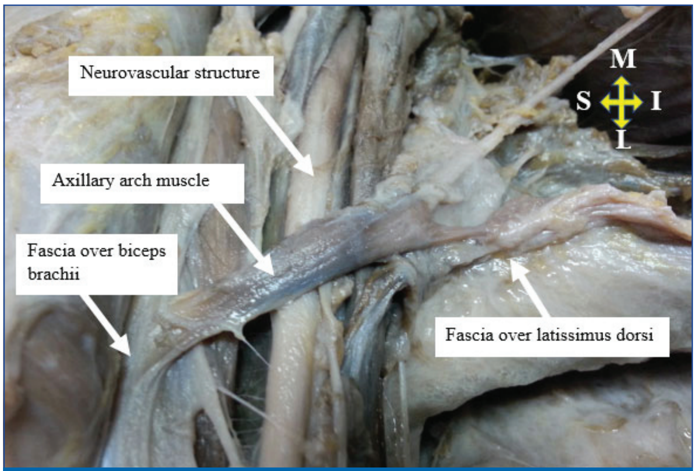
The first axillary arch muscle was present in the left limb of a male cadaver, its medial end was attached to the lateral border of the latissimus dorsi while the lateral end was attached to the fascia over the coracobrachialis muscle. On its way, it was dividing the posterior cord into superior and inferior divisions. The vascular structures like the axillary artery and vein were safe, but the subscapular artery and vein were closely related to the medial end of the muscle with the potential of causing compression [Table/Fig-2].



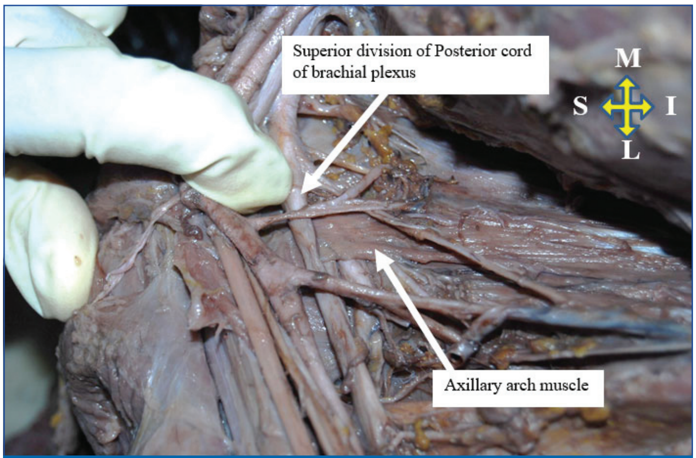
[Table/Fig-2]: Axillary arch muscle passing through the posterior cord of brachial plexus in the left axilla.

The second axillary arch muscle was present in the right limb of a male cadaver, its medial end was attached to the fascia over the lateral border of the latissimus dorsi, while the lateral end was attached to the fascia over biceps brachii and coracobrachialis. This muscle was crossing over all the cords of the brachial plexus, axillary artery, and axillary vein [Table/Fig-3].

The third axillary arch muscle was present in the right limb of a male cadaver, its medial end was arising within the subscapularis muscle, while the lateral end was attached to the fascia over the coracobrachialis muscle. The muscle was dividing the posterior cord into superior and inferior divisions. No vascular relation with the potential of compression was noted [Table/Fig-4].



[Table/Fig-3]: Axillary arch muscle crossing neurovascular structure in right axilla.



[Table/Fig-4]: Axillary arch muscle arising from subscapularis muscle in right axilla.

The above findings were tabulated separately to find out the AAM contribution in causing neural and vascular compression. The present cadaveric study of AAM shows 100% of cases of neural compression and 66.6% of cases of vascular compression [Table/Fig-1].

DISCUSSION

The present study was done in the Indian population of the Maharashtra region which showed the prevalence of such variation in 2.5% of cadavers. The potential role of AAM in causing neural compression was found to be more than vascular compression. Axillary arch muscle is considered a common variation in the axillary region, with the incidence being variable from 0.25-37.5%. The highest number of such variations was found amongst the chinese population [6]. The origin, course, and insertion of this muscle were variable in different studies [5,6]. Due to this variation, many authors [1,5,6] have classified this muscle as a complete and incomplete type of AAM. Complete being those taking origin from latissimus dorsi and insertion on pectoralis major, the incomplete form was taking origin from latissimus dorsi and insertion on the axillary fascia, coracobrachialis muscle, biceps brachii muscle, pectoralis minor muscle, or coracoid process [6].

Considering the relations of neurovascular structure with AAM, Georgiev GP et al., (2007) suggested a new classification of a superficial and deep group of AAM. The superficial group extended from latissimus dorsi to the anterosuperior part of the humerus, there by crossing the neurovascular bundle with a maximum potential of obstructing the vein. The deep group comprises the structures situated deeper along the posterior axillary wall, such a group of arch muscles crossed a few parts of neurovascular bundles with the possibility of compression of axillary and radial nerves. The author stated that in clinical practice such classification will have a greater role to determine nerve and vessel compressed [6]. In the present study, two cases of the deep group and one case of the superficial group of AAM with findings similar to Georgiev GP et al., [6]. were found. Further study in the radiological view will help the clinician to predict the probable diagnosis of neurovascular compression.

Different theories have been proposed by various authors regarding its phylogenetic origin. The commonest view proposed was the axillary arch muscle being a remanent of panniculus carnosus [12,13]. Limb muscles develop from the mesenchyme of the somatic layer of the lateral plate mesoderm. Cihak (1972) has described 4 phases in the development of muscle patterns. Muscle anomaly could have developed during phase 3 of the ontogenesis of muscle in the axilla. During phase 3 some muscle primordia combine to form a single mass of muscle, while other groups of muscle primordia degenerated through cell death [12]. The existence of muscular slip in the present study could be due to the remanent cells between those developing muscles. The teres major and latissimus dorsi show functional and anatomical similarities [12,13]. The muscular slip found probably could also be the developmental remanent of these two muscles.

The clinical significance of the axillary arch muscle was described in three forms by Georgiev GP et.al, which includes identification of axillary arch muscle by physical examination or imaging techniques, surgical intervention of axillary arch in the axilla, entrapment of axillary vessels and nerves by axillary arch muscles [6]. The findings of physical examination to diagnose the axillary arch muscle include loss of concavity, firm mass on palpation, the fullness of the axilla [1,14]. Those patients showing signs of axillary vein obstructions by axillary arch muscles include swelling, discoloration, and lymphedema [4]. Sometimes axillary masses may be wrongly diagnosed as enlarged lymph nodes or a soft tissue tumour, hence the existence of axillary arch muscle should be taken into consideration which can be confirmed with imaging [2]. Different imaging modalities in the form of Magnetic Resonance Imaging (MRI), magnetic resonance axillography, and phlebography have been used to diagnose the existence of axillary arch muscles [6].

Clarys JP et al., reported that the use of echography in diagnosing AAM could be the cheapest and non invasive mode [15]. The knowledge of axillary arch muscles is very important for the operating surgeon, as the existence of this variation may confuse the identification of the medial border of the coracobrachialis [1], the long tendon of biceps brachii [3]. In radical mastectomy surgery, the aim is to eliminate all cellular and nodal tissue. There is a tendency for few lymph nodes hidden behind the axillary arch muscles in this region. The AAM may hinder the complete clearance in this region leading to the local recurrence [2,14].

The axillary arch muscle has been the important etiology for the neurovascular compression in the cervico axillary region [14,15]. Many authors have reported a case of venous thrombosis due to the existence of the anomalous muscle in the axillary region [9,10,16,17]. Axillary arch muscle's existence could be the cause of thoracic outlet syndrome [15]. In the current study Clarys JP et al., through the cadaveric arm motion simulation demonstrated that the compression of neurovascular structure occurs in the abducted and externally rotated arm. He stated a few aggravating factors responsible for the symptoms, which include: strongly developed biceps brachii and or coracobrachialis, prismatic space enclosed by the arch filled with adipose tissue in obese patients, enlarged axillary lymph nodes, short type of arch, strong fibrous type of arch instead of being weak or muscular [15].

Sachatello CR suggested that the AAM could be stretched by the abduction and elevation of the arm or by placing the hand behind the head [16]. This maneuver may compress the neurovascular bundle, thereby causing a circulatory deficiency, paraesthesia, and chronic pain in the arm, forearm, and hand [10,16,18]. The existence of AAM causing entrapment of the neurovascular bundle could be treated by excision [6,9,10,17].

Various clinical studies were done highlighting the compression of the vascular structures [6,9,19-26], however, comparison of the studies of axillary arch muscle [Table/Fig-5] [4,8-10,14,15,19-23,25,26] signifies, the predominant involvement of neural structure followed by the vascular structure in the cadaveric study. The existence of AAM increases the blood flow velocity in the axillary artery in the abduction and external rotation of the arm, which could be determined by measuring the peak systolic velocity of the axillary artery [26]. It is postulated that the presence of AAM will reduce the axillary space during abduction of the arm and external rotation will translate forward the head of the humerus further reducing the axillary space. Many cadaveric studies have demonstrated the close relations of neurovascular structure with AAM, which have the potential for

Author/Year/Place of study	No. of upper limbs	No. of AAM	Neural compression	Vascular compression	Type of study
Boontje AH (1979) Netherlands [10]	1 (case report)	1	No neurological symptom	Axillary vein	Clinical findings followed by phlebography and Surgery
Karacagil S et al., (1987) Sweden [19]	1 (case report)	1	-	Axillary artery	Surgery
Serpell JW and Baum M, (1991) England [14]	2000	4	Branches of brachial plexus	Axillary vessel	Surgery
Clarys JP et al., (1996) Belgium [15]	2642	188	Ulnar nerve and medial cutaneous nerve of forearm (1 case report)	Axillary artery (1 case report)	USG
Merida VJR et al., (2003) Spain [9]	64	4	Cords and branches of brachial plexus(3), only radial nerve (1)	Subscapular artery (3)	Cadaver
Turgut HB et al., (2005) Turkey [20]	52	1	Axillary nerve	Subscapular artery	Cadaver
Van Hoof T et al., (2008) Belgium [8]	1280	26	Median and ulnar nerve	-	USG
Sellon JL et al., (2010) USA [21]	1 (case report)	1	Cords and branches of brachial plexus	Axillary vessels	CT
Hafner F et al., (2010) Austria [22]	1 (case report)	1	-	Axillary vein	Surgery
Guy MS et al., (2011) Athens [4]	1109	71	Cords and branches of brachial plexus	Axillary vessels	MRI images retrospective study
Magee C et al.,(2012) UK [23]	1 (case report)	1	-	Axillary vein	MRI
Upasana et al., (2015) Punjab, India [25]	50	2	-	Axillary vein	Surgery
Scafoglieri A et al., (2015) Belgium [26]	312	25	-	Axillary artery (25)	USG/ in vivo palpation
Present study	120	3	Brachial plexus (1) and posterior cord (2)	Subscapular artery and vein, Axillary artery and vein	Cadaver

[Table/Fig-5]: Comparison of study of axillary arch muscle causing neurovascular compression by various authors [4,8-10,14,15,19-23,25,26].

compression, but clinically fewer cases are noted or reported. The probable cause for this could be the abduction and external rotation of the arm that provokes the compression. Hence the existence of AAM in an individual unless stretched remains asymptomatic. This article has opened an avenue for clinicians or physiotherapists to work in this area by considering the individuals who routinely do the hyperabduction of the arm in their professions or sports.

The present study has shown the result of the existence of AAM and its potential in causing neural compression (100%) and vascular compression (66.6%). This data signifies that early diagnosis and excision of AAM is of utmost importance in individuals who are frequently engaged in abduction and elevation of the arm. The players involved in different sports like basketball, bowlers in cricket, javelin throw, shot put throw, badminton and tennis frequently adopt this maneuver while playing, the existence of such anomalous muscle in these players may predispose them to such symptoms due to prolonged compression and may reduce their performance. The knowledge of this anomaly will help the sports physiotherapist with its early diagnosis and treatment. The players involved in such sports could be advised for ultrasonography of the axilla in the view of diagnosis of AAM as the prophylactic measure.

Limitation(s)

The data is obtained from a cadaver, so does not directly represent the symptom generation due to neurovascular compression by AAM.

CONCLUSION(S)

The existence of the axillary arch muscle is rare but is noteworthy for its symptom generation. The present study has clarified the potential role of the axillary arch muscle in causing neural and vascular compression by a significant percentage. Though its existence in an individual may remain asymptomatic, it should be thoroughly investigated in an individual engaged in abduction and elevation of the arm as part of occupation or sport. The current study lacks patient data on symptom generation. But this article will help clinicians and physiotherapists to do further study in this regard.

Acknowledgement

The author would like to acknowledge the support rendered by Dr. P.S. Bhuiyan, Professor and Head Department of Anatomy, Dr. Lakshmi Rajgopal, Additional Professor of Department of Anatomy, Seth G.S. Medical College and K.E.M Hospital Mumbai, and Dean Seth G.S. Medical College and K.E.M Hospital Mumbai for carrying out this study.

REFERENCES

[1] Loukas M, Noordeh N, Tubbs RS, Jordan R. Variation of the axillary arch muscle with multiple insertions. Singapore Med J. 2009;50(2):e88-90.

[2] Besana-Ciani I, Greenall MJ. Langer's axillary arch: anatomy, embryological features and surgical implications. Surgeon. 2005;3(5):325-27.

[3] Tubbs RS, Shoja MM, Loukas M. Bergman's comprehensive encyclopedia of human anatomic variation. John Wiley & Sons 2016; p.266-68.

[4] Guy MS, Sandhu SK, Gowdy JM, Cartier CC, Adams JH. MRI of the axillary arch muscle: prevalence, anatomic relations, and potential consequences. AJR Am J Roentgenol. 2011;196(1):W52-7.

[5] Rolfe B, Simon M Lambert. Pectoral girdle and upper limb. In: Standring S, eds. Gray's anatomy: The anatomical basis of clinical practice. 41st ed. Edinburgh: Elsevier 2016; p.822.

[6] Georgiev GP, Jelev L, Surchev L. Axillary arch in Bulgarian population: clinical significance of the arches. Clin Anat. 2007;20(3):286-91.

[7] Douvetzemis S, Natsis K, Piagkou M, Kostares M, Demesticha T, Troupis T. Accessory muscles of the anterior thoracic wall and axilla. Cadaveric, surgical and radiological incidence and clinical significance during breast and axillary surgery. Folia Morphol (Warsz). 2019;78(3):606-16.

[8] Van Hoof T, Vangestel C, Forward M, Verhaeghe B, Van Thilborgh L, Plasschaert F, et al. The impact of muscular variation on the neurodynamic test for the median nerve in a healthy population with langer's axillary arch. J Manipulative Physiol Ther. 2008;31(6):474-83.

[9] Merida-Velasco JR, Rodriguez Vasquez JF, Merida Velasco JA, Sobrado Perez J, Jimenez Collado J. Axillary arch: potential cause of neurovascular compression syndrome. Clin Anat. 2003;16(6):514-19.

[10] Boontje AH. Axillary vein entrapment. Br J Surg. 1979;66(5):331-32.

[11] Romanes GJ editor. Cunningham's Manual of Practical Anatomy. 15th edition. Oxford New York Tokyo: Oxford University Press, 1986; 1: 22-32.

[12] Pillay M. & Jacob S. Bilateral presence of axillary arch muscle passing through the posterior cord of the brachial plexus. Int. J. Morphol. 2009; 27(4):1047-050.

[13] Herring SW, Sola OM; Huang X. Zhang G. & Hayashida N. Compartmentalization in the pig latissimus dorsi muscle. Acta Anat. (Basel) 1993;147(1):56-63.

[14] Serpell JW & Baum M, Significance of langer's axillary arch in axillary dissection. Aust. NZ. J. Surg 1991;61(4):310-12.

[15] Clarys JP, Provyn S, Cattrysse E, Snoeck TH, Van Roy P. The role of the axillary arch (of Langer) in the management and the kinesiology of the overhead shoulder mobility. J Sports Med Phys Fitness. 2008;48(4):455-65.

[16] Sachatello CR. The axillopectoral muscle (Langer's axillary arch): a cause of axillary vein obstruction. Surgery. 1977;81(5):610-12.

[17] Tilney ML, Griffiths HJ, Edwards EA. Natural history of major venous thrombosis of the upper extremity. Arch. Surg. 1970;101(6):792-96.

[18] Kalaycioglu A. Gumusalan Y. Ozan H. Anomalous insertional slip of latissimus dorsi muscle: arcus axillaris. Surg. Radiol. Anat. 1998;20(1):73-75.

[19] Karacagil S, Erikson I. Entrapment of the axillary artery by anomalous muscle. Acta Chirurgica Scandinavica. 1987;153(10):633-34.

[20] Turgut HB, Peker T, Gulekon N, Anil A, Karakose M. Axillopectoral muscle (Langer's muscle). Clin Anat. 2005;18(3):220-23.

[21] Sellon JL, Murthy NS, Schmit GD, Spinner RJ. Wire-guided resection of muscular axillary arch causing neurovascular compression. J Surg Orthop Adv. Winter 2010; 19(4): 229-33.

[22] Hafner F, Seinosta G, Garya T, Tomkab M, Szolarc D, Brodmanna M. Axillary vein compression by Langer's axillary arch, an aberrant muscle bundle of the latissimus dorsi. Cardiovasc Pathol. 2010;19(3):e89-90.

[23] Magee C, Jones C, McIntosh S, W Harkin D. Upper limb deep vein thrombosis due to Langer's axillary arch. J Vasc Surg. 2012;55(1):234-36.

[24] Hong HJ, Choi NJ, Han DH, Ahn MI. Axillary arch: detailed ultrasonographic images with multiplanar CT correlation. J Med Ultrason (2001). 2015;42(1):121-25.

[25] Upasna, Kumar A, Singh B, Kaushal S. Muscular variations during axillary dissection: a clinical study in fifty patients. Niger J Surg. 2015;21(1):60-62.

[26] Scafoglieri A, De Maeseneer M, Debondt A, Boulet C, Tresignie J, De Mey J, Clarys JP. Evidence of increased axillary blood flow velocity without increased handgrip strength and endurance in persons with a fibromuscular axillary arch. Folia Morphol 2015;74(4):486-92.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Anatomy, B.K.L.Walawalkar Rural Medical College, Sawarde, Chiplun, Maharashtra, India.
2. Associate Professor, Department of Community Medicine, B.K.L.Walawalkar Rural Medical College, Sawarde, Chiplun, Maharashtra, India.
3. Associate Professor, Department of Anaesthesia, B.K.L.Walawalkar Rural Medical College, Sawarde, Chiplun, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Prashant Mohan Moolya,
217/1/2 Sumohan Nivas, Behind Hotel Janata, Budhwarpeth,
Madhavnagar-416406, Sangli, Maharashtra, India.
E-mail: prashantmmoolya@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Mar 04, 2022
- Manual Googling: Mar 16, 2022
- iThenticate Software: Apr 05, 2022 (10%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval Obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Feb 27, 2022**
Date of Peer Review: **Mar 16, 2022**
Date of Acceptance: **Apr 05, 2022**
Date of Publishing: **Jul 01, 2022**