(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 6, Issue 3 , Page No: 726-742
May-June 2023

IJMSCR

An Observational Study Of Axillary Artery, Its Branching Pattern And Its Variations In Northern Tamilnadu

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Background: The axillary artery is used for arterial cannulation in cardiac surgery, particularly in aortic aneurysmal dissection and in replacement of ascending and arch of aorta. In plastic surgery, the branches are used to prepare pedicle graft in various reconstructive procedures. Improper use of crutches cause thrombosis and may result in axillary arterial aneurysm.The lateral mammary branches of axillary artery are also used for coronary bypass graft. The awareness of variations in the length.extent and branching pattern of axillary artery with its branches will reduce the risk of complications during surgical procedures and will aid in interventional procedures and interpretation of angiograms**.**

Materials And Methodology:After obtaining the due ethical committee approval from our institute, 40 upper limb specimens were studied by conventional dissection method in the Anatomy department and 10 upper limb Computed Tomogram images of the patients were taken in the Department of Radiology.The length, branching pattern and the variations in the origin of axillary artery and its branches were studied were studied.

Results: The length of Axillary artery ranges from 8.9 – 11.5 cm, the most common length of Axillary artery is 11 cm and the average length of Axillary artery is 10.45cm. The branching pattern of the main trunk and of each branch were documented to around 50% to 60%.

Conclusion:The detailed study of axillary artery in the upperlimb of 40 adult cadaveric specimens and 10 radiological images of axillary artery inferred that the branching pattern of the artery varies hugely in our population.

Keywords: Axillary artery, variations, length, extent, branching pattern

Introduction

The axillary artery extends from outer border of the first rib to the lower border of teres major muscle and then continues as brachial artery. The axillary artery is divided by pectoralis minor muscle into three parts. The first part of axillary artery is above, the second part is beneath and third part is below the muscle. First part gives off superior thoracic artery. Second part gives two branches namely lateral thoracic artery and thoraco-acromial artery. Third part gives three branches subscapular artery ,anterior circumflex humeral artery and posterior circumflex humeral artery.[1] [2] The axillary artery is used for arterial cannulation in cardiac surgery, particularly in aortic aneurysmal dissection and in replacement of

ascending and arch of aorta. In plastic surgery, the branches are used to prepare pedicle graft in various reconstructive procedures.[3] Direct blow and blunt injury to the shoulder girdle may produce injuries to axillary artery. Anterior dislocation of shoulder joint may stretch the axillary artery.[4][5] Reduction of shoulder dislocation or fracture of surgical neck of humerus can cause arterial rupture with subsequent thrombosis . Injury to the vessel is increased in patients with atherosclerotic disease. Improper use of crutches cause thrombosis and may result in axillary arterial aneurysm. These patients may present with ischemic fingers and occlusion of radial and ulnar arteries secondary to thrombo-embolism.[4] The lateral mammary branches of axillary artery are also used for coronary bypass graft.[5] Axillary artery has numerous variations in its length,extent and branching patterns.[6-17]The awareness of possible variations in the branching pattern will reduce the risk of complications like bleeding during surgical procedures. The knowledge of anatomical variations in Axillary artery will help to prevent errors in interventional procedures and during interpretation of angiograms.

METHODOLOGY:In the observational study conducted in the Department of Anatomy, after obtaining the due ethical committee approval, 40 upper limb specimens from 20 embalmed adult human cadavers including 15 males and 5 females were studied by conventional dissection method and 10 upper limb Computed Tomogram - angiographic images of the patients were taken for this study in the Department of Radiology, after getting waiver of consent as it was of stored images. The sample size was decided based on the time and resource constraint nature of the study.

A. Conventional Dissection Method:[18]

The dissection was carried out to expose the axillary artery and its branches. The skin incisions were made, skin, superficial fascia, deep fascia over pectoralis major and deltoid was reflected. The attachments of muscles were defined. The clavicular head of pectoralis major below the clavicle was cut and reflected towards its insertion .The branches of lateral pectoral nerve and thoraco acromial artery pierce the clavipectoral fascia to enter into it. The pectoralis major was cut across and reflected. The clavipectoral fascia covering the pectoralis minor muscle was removed. The origin of thoraco acromial artery was noted. The loose connective tissue, fat and lymph nodes were removed to expose the axilla and its contents. The coracobrachialis and short head of biceps were exposed. The axillary artery and the median nerve lie medial to these muscles, and the musculocutaneous nerve enter into the deep surface of the coracobrachialis.Medial to the axillary artery is the axillary vein with medial cutaneous nerve of forearm and the ulnar nerve. The lateral thoracic artery and the long thoracic nerve descend over the serratus anterior to supply it. The smaller tributaries of the axillary vein were removed to get clear view of the nerves in relation with the artery. The origin of all the branches of axillary artery and variations in its branching patterns were observed. The relation of the axillary artery with the axillary vein and brachial plexus were noted and the photographs were taken.

The lengths of all the 40 axillary arteries were measured by keeping the upper limbs in abduction. The length of each artery was measured between the midpoints of the width of the axillary artery from the outer border of the first rib to the midpoint of the width of the artery at the lower border of teres major. After placing ties at these two points, measurements were taken by using the inch tape. The study of axillary artery and its branching pattern along with its variations was selected for analysis under the following parameters: Length and extent of axillary artery.

Course in relation with axillary vein, brachial plexus and adjacent structures to each part of axillary artery.

Number of named branches arising from it.

Origin of superior thoracic artery.

Origin of thoraco acromial artery.

Origin of lateral thoracic artery.

Origin of subscapular artery.

Origin of anterior circumflex humeral artery.

Origin of posterior circumflex humeral artery.

B.RADIOLOGICAL METHOD:[19]

By the use of adult clinical 64 slice Computed Tomogram – angiography. Computed Tomogram – angiographic images of upper limb of 10 patients

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were taken for the study in the Department of Radiology. Their Computed tomogram - angiographic images were collected for studying the variation in the branching patterns.

Results:

Tables:

Table : 1 . Length of axillary artery

No .of named branches	No of specimens (40)	Percentage (%)
9	1	2.5
7	3	7.5
6	24	60
5	9	22.5
4	3	7.5

Table 2: number of named branches from axillary artery

Axillary artery			No.of specimens (40)	Percentage (%)
III part	Direct branch		33	82.5
	Com.trunk	PCHA & SSA	4	10
		ACHA & PCHA	1	2.5
II part	Com.trunk – PCHA & SSA		1	2.5
	Com.trunk – LTA,SSA &PCHA		1	2.5

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Table 3:origin of subscapular artery

Axillary artery			No of.specimens (40)	Percentage (%)
From III part	directly		35	87.5%
	Common trunk	PCHA	4	10%
		SSA & PCHA	1	2.5%

Table 4:Origin of anterior circumflex humeral artery

Axillary artery			No.of specimens (40)	Percentage (%)
III Part	Directly		29	72.5
	Common trunk	SSA & PCHA	4	10
		ACHA & PCHA	4	10
		SSA, ACHA & PCHA	1	2.5
II Part	Common trunk with SSA		1	2.5
	Com. trunk with SSA & PCHA		1	2.5

Table 5: Origin of posterior circumflex humeral artery

1. Length of the axillary artery	
Name of study	Length (cm)
Abdalla MA [20]	10.17
Majumdar S [21]	10.15
Present study	10.45
2. Extent of the axillary artery	

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Name of study	Variation in extent (high division)
Ugur B et al [19]	12.1%
Present study	10%
3. Comparison of studies of six named branches from the axillary artery	
Name of study	Axillary artery with six branches (%)
Huelke DF et al[22]	37.3
Abdalla MA [20]	38.0
Present study	60.0
4. Origin of STA from first part of AA	
Name of study	Origin of STA from first part of AA (%)
. DeGaris CF & Swartley WB[23]	96.9
Huelke DF et al[22]	86.6
Present study	100
5. Origin of thoraco acromial artery from the second part of Axillary artery	
Name of Study	Origin from II part of AA(%)
Huelke DF et al[22]	68.5
Abdalla MA [20]	88.0
Present study	97.5
6. Incidence of absent thoraco - acromial artery & origin of its terminal branches directly from the second part of axillary artery	
Name of study	Absent TAA / direct origin of terminal branches (%)
Astik R,Dave U[24]	10
Present study	2.5
7. Origin of subtrunks from the thoraco acromial artery	
Name of study	Subtrunks from TAA (%)
Astik R,Dave U[24]	5
Present study	5
8. origin of lateral thoracic artery from second part of axillary artery	
Name of study	Origin of LTA from II part (%)

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Huelke DF et al[22]	52.2	
Abdalla MA [20]	82	
Present study	95	
9. Common trunk origin of lateral thoracic artery , subscapular artery and posterior circumflex humeral artery from second part of axillary artery		
Name of study	CT origin of LTA, SSA & PCHA (%)	
Abdalla MA [20]	4	
Present study	2.5	
10. The origin of subscapular artery		
Name of study	Orgin from third part of axillary artery (%)	Origin from second part of axillary artery (%)
. DeGaris CF & Swartley WB[23]	94.1	5.1
Huelke DF et al[22]	79.2	15.7
Abdalla MA [20]	80	16
Present study	95	5
11. Common trunk origin of subscapular and posterior circumflex humeral arteries		
Name of study	Percentage (%)	
Huelke DF et al[22]	15.2	
Johnson & Ellis [25]	30	
Abdalla MA [20]	18	
Majumdar S [21]	1.43	
Present study	10	
12. High origin of subscapular artery with lateral thoracic and posterior circumflex humeral arteries		
Name of study	Percentage (%)	
Saeed et al [26]	1.9	
Mohanty S.R , Mamata S[27]	1.7	
Present study	2.5	
13. Incidence of common trunk origin of subscapular, anterior circumflex humeral and posterior		

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circumflex humeral arteries		
Name of study	Common trunk for SSA,ACHA& PCHA (%)	
Saeed et al [26]	3.8	
Present study	2.5	
14. Origin of anterior circumflex humeral artery from third part of axillary artery		
Name of study	Direct origin (%)	Common trunk origin with PCHA (%)
Huelke DF et al[22]	80.3	11.2
Abdalla MA [20]	80	16
Present study	87.5	10
15. Common trunk origin of ACHA, SSA & PCHA		
Name of study	Percentage (%)	
Saeed et al [26]	3.8	
Present study	2.5	
16. Incidence of two anterior circumflex humeral arteries from third part of axillary artery		
Name of study	Percentage (%)	
Gaur S et al[28]	4	
Present study	7.5	

17. Origin of posterior circumflex humeral artery from third part of axillary artery			
Name of study	Direct origin(%)	Com. trunk with ACHA(%)	Com. Trunk with SCA(%)
Huelke DF et al[22]	78.7	11.2	15.2
Abdalla MA [20]	58	16	18
Present study	72.5	10	10

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Figure 1: Length of axillary artery

Figure 2: Named branches arising from axillary artery

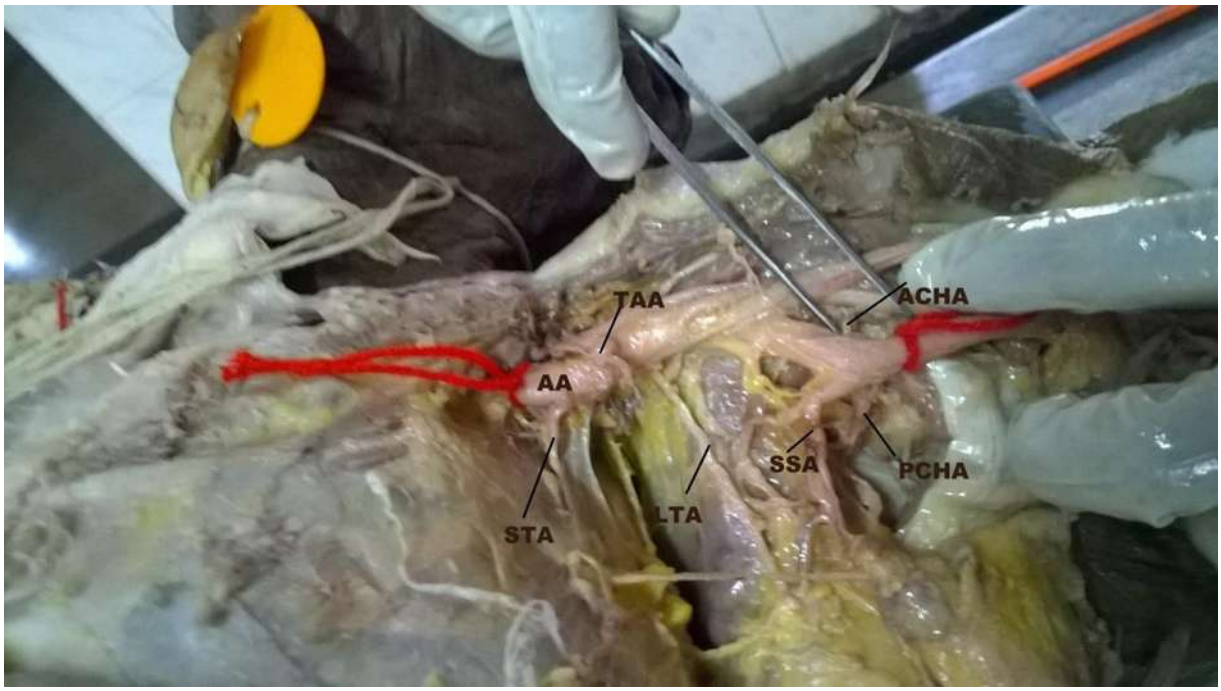

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Figure 3: Origin of superior thoracic artery, thoraco acromial and lateral thoracic artery.

Figure 4: Origin of superior thoracic, thoraco acromial , lateral thoracic, subscapular and posterior circumflex humeral arteries.

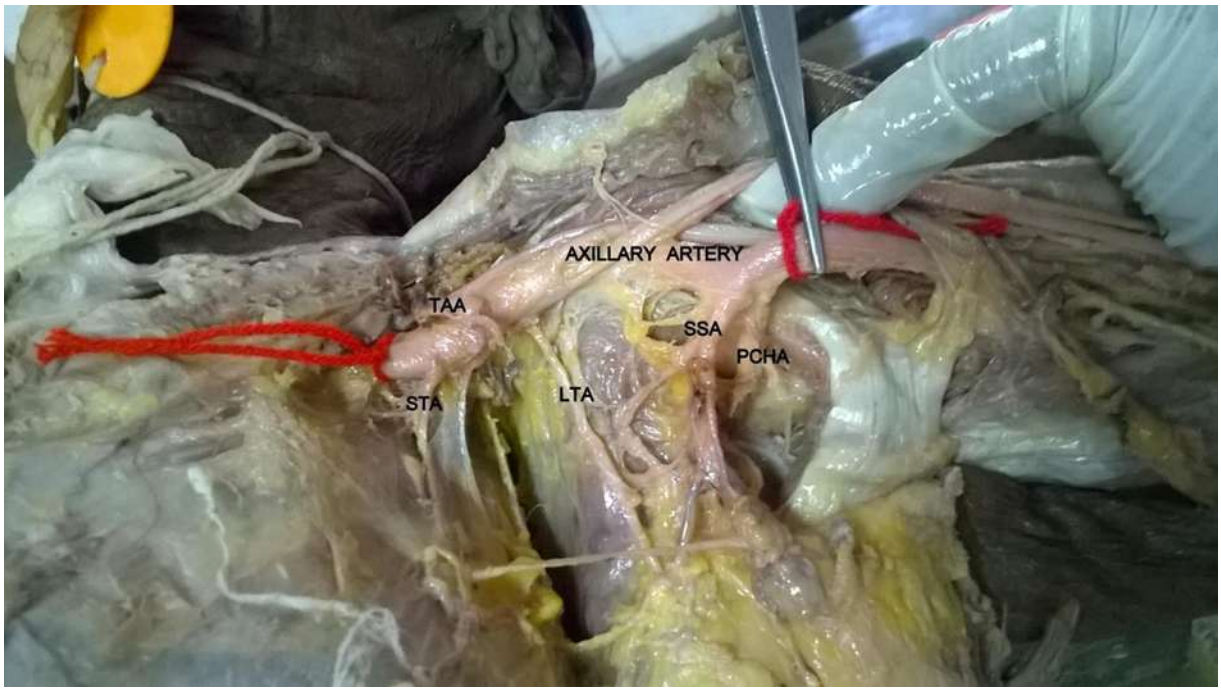

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Figure 5:Thoraco – acromial artery dividing into two subtrunks, clavipectoral and deltoacromial.

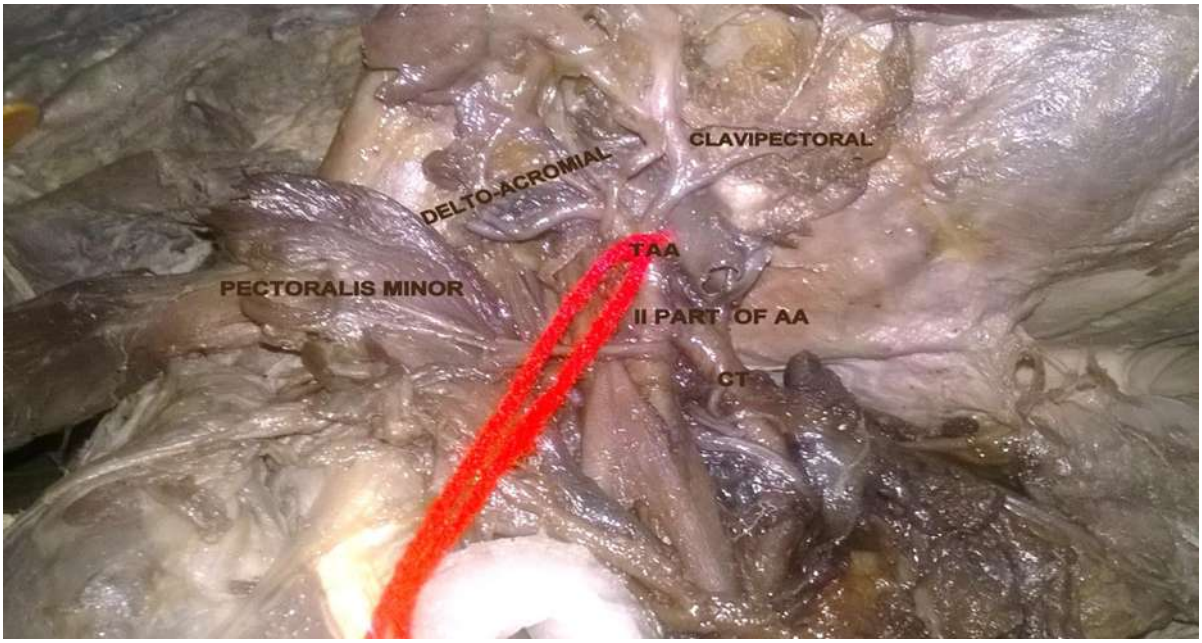

Figure 6:Direct origin of terminal branches of thoraco-acromial artery from axillary artery.

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Figure 7: Origin of lateral thoracic artery

Figure 8:Common trunk origin of LTA, SSA and PCHA from II part of AA.

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Figure 9: Common trunk origin of SCA & PCHA

Figure 10: Common trunk origin of SSA along with ACHA & PCHA

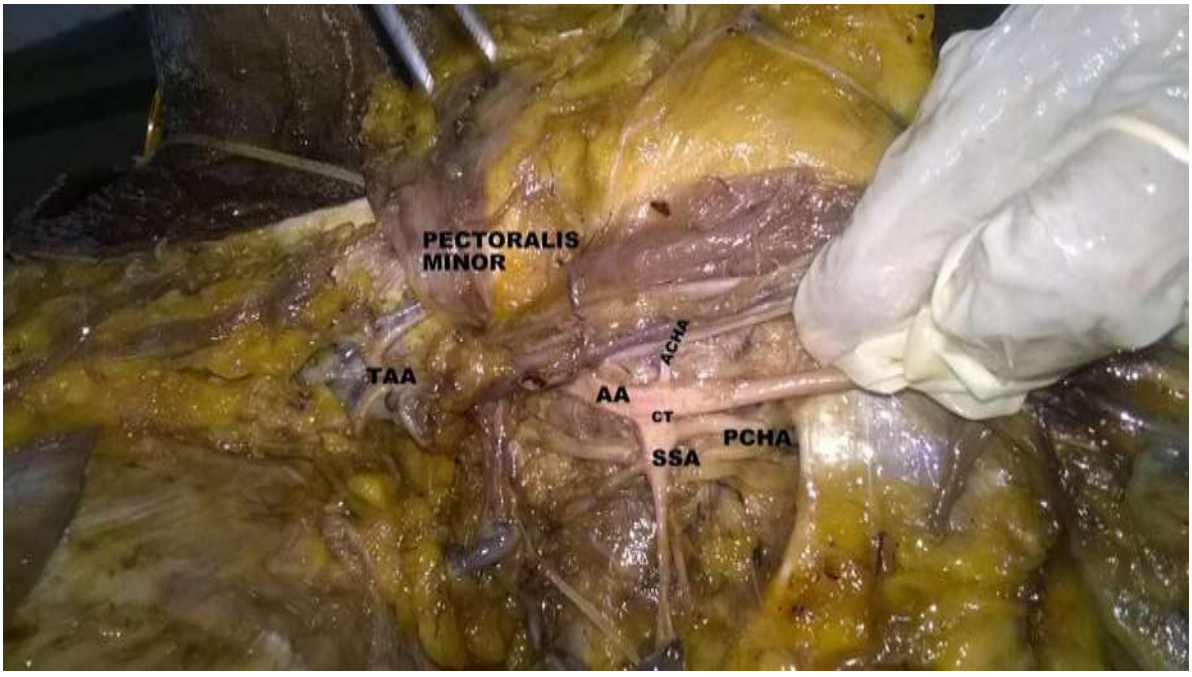

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Figure 11:High origin of common trunk for SSA & PCHA from II part.

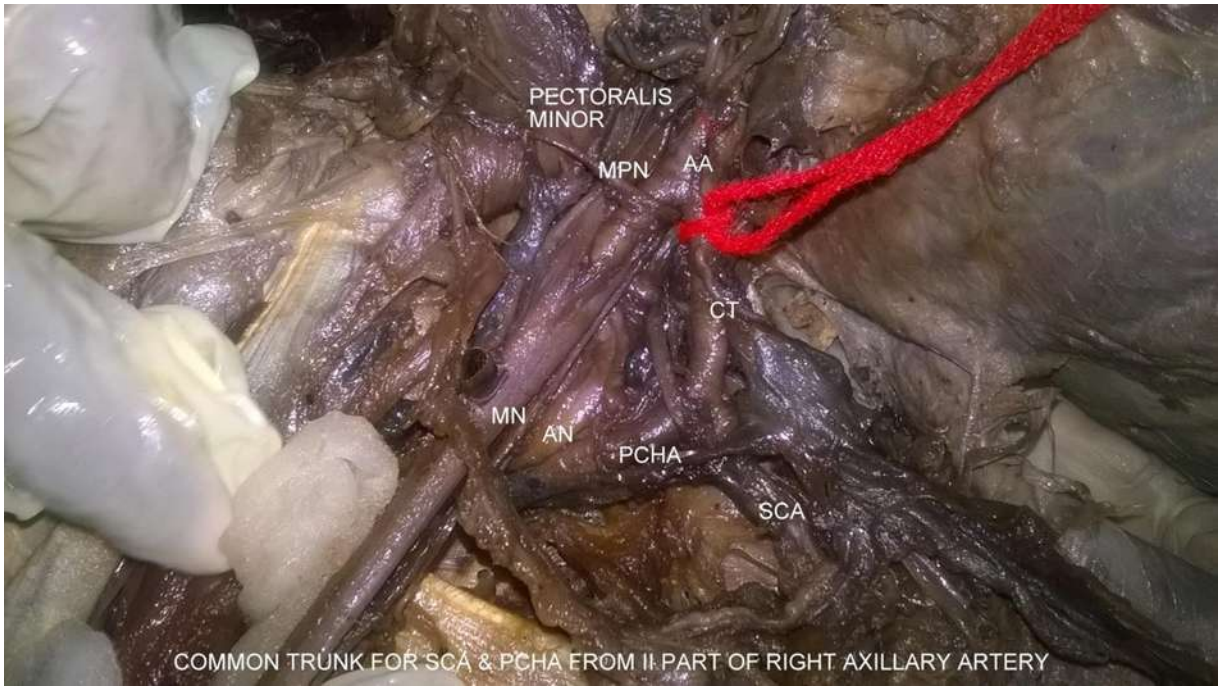

Figure 12: Origin of anterior circumflex humeral artery from third part of AA.

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Figure 13:Common trunk origin of ACHA &PCHA.

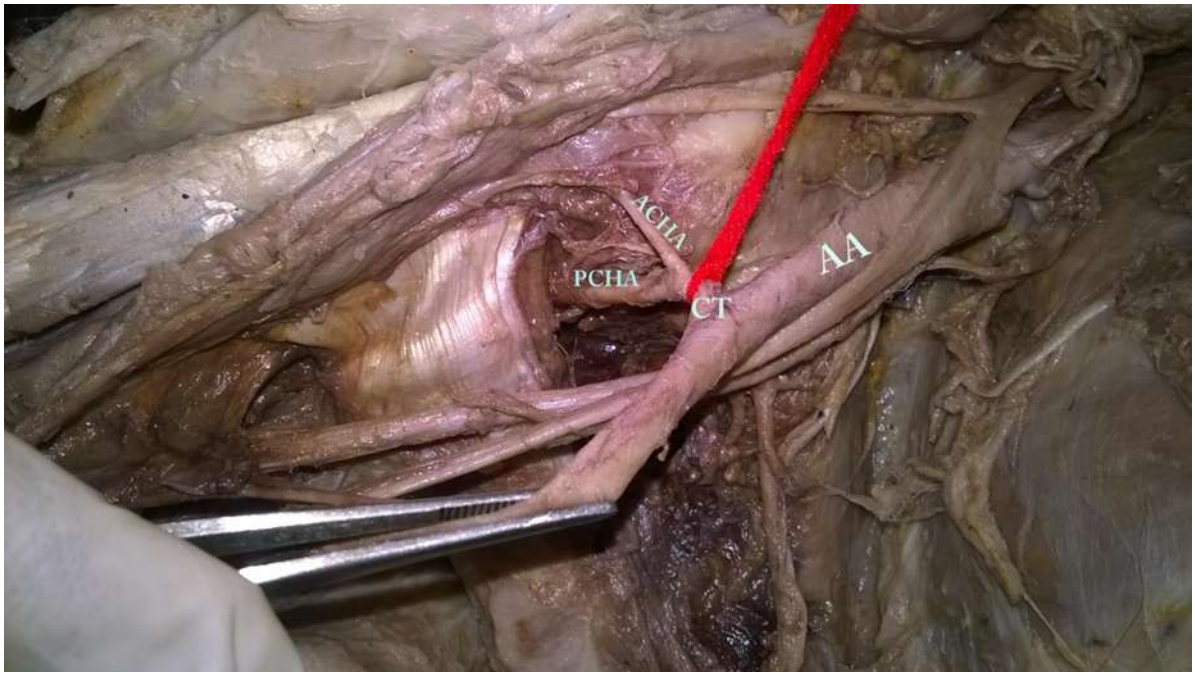

Figure 14:Two anterior circumflex humeral arteries arising from third part of axillary artery.

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Figure 15:Origin of posterior circumflex humeral artery from third part of axillary artery.

A) CONVENTIONAL DISSECTION METHOD:

1. LENGTH AND EXTENT OF AXILLARY ARTERY:

The length of Axillary artery ranges from 8.9 – 11.5 cm, the most common length of Axillary artery is 11 cm and the average length of Axillary artery is 10.45cm [Table 1] [Figure 1]. The axillary artery extends from the outer border of first rib as the continuation of Subclavian artery to the lower border of teres major where it becomes brachial artery in all the specimens (100%) studied.

2. COURSE OF AXILLARY ARTERY IN RELATION WITH AXILLARY VEIN, BRACHIAL PLEXUS AND ADJACENT STRUCTURES TO EACH PART OF THE ARTERY

There was no observable variation in the relation and course of Axillary artery with respect to the Axillary vein and brachial plexus.

3. NUMBER OF NAMED BRANCHES ARISING FROM THE AXILLARY ARTERY:

60% of specimens had 6 named branches arising from the artery representing the normal anatomy.40% showed variations [Table 2] [Figure 2].

4. ORIGIN OF SUPERIOR THORACIC ARTERY:

Superior thoracic artery was present in 39 specimens (97.5%)and it was absent in 1 specimen (2.5%).In all the 39 /40 specimens, the superior thoracic artery originates from the first part of axillary artery (97.5%) [Figure 3].

5. ORIGIN OF THORACO ACROMIAL ARTERY [Figure 3-6]:

The presence of the thoraco acromial artery is 39 specimens (97.5%) and it arises from the second part of axillary artery and in one specimen (2.5%) it was absent.

Branching pattern of thoraco acromial artery:

In 37/40 (92.5%) specimens the artery arises directly from the second part of axillary artery and then it divides into four terminal branches namely deltoid , acromial , clavicular and pectoral .In 2 /40 (5%) specimens the artery divides into two trunks, the delto- acromial and clavi - pectoral . Then each trunk further divide into two named branches .In 1/40 specimen (2.5 %) , the thoraco acromial trunk is absent and the four terminal divisions of the artery, namely deltoid, acromial , clavicular and pectoral branches arise from the second part of axillary artery individually .6. ORIGIN OF LATERAL THORACIC ARTERY [Figure 7, 8]: In the 40 upper limb specimens studied, the lateral thoracic artery is

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present in 39/40 cases (97.5%).In 1/40 specimen (2.5%) it is absent. Out of the 39 specimens, the artery arises directly from the second part of the axillary artery in 38 cases (95%).In one specimen (2.5%) it arises as a large common trunk from the second part of the axillary artery for subscapular and posterior circumflex humeral arteries.

7. ORIGIN OF SUBSCAPULAR ARTERY [Table 3] [Figure9-11]:

Out of 40 specimens, the subscapular artery is present in all the specimens (100%) .In 38/40 of specimens (95%), the subscapular artery arises from the third part of axillary artery. The subscapular artery branches directly from the third part in 33/40 specimens (82.5%).In 4/40 (10%) of specimens it arises from the common trunk for subscapular and posterior circumflex humeral artery. In 1/40 (2.5%) specimen, it arises in common with anterior circumflex humeral and posterior circumflex humeral arteries.

8. ORIGIN OF ANTERIOR CIRCUMFLEX HUMERAL ARTERY [Table 4] [Figure 12-14]:

87.5 % of the specimen showed direct origin of ACHA from third part of axillary artery. 12.5 % showed immense variations such as arising from second part or as a common trunk from third part.

9. ORIGIN OF POSTERIOR CIRCUMFLEX HUMERAL ARTERY [Table 5] [Figure 15]:

72.5 % of the specimen showed direct origin of ACHA from third part of axillary artery. 27.5 % showed significant variations such as arising from second part or as a common trunk from third part.

B) RADIOLOGICAL METHOD [Figure 16]:

High division of Axillary artery into radial artery and ulnar artery was observed in 10 % of the Observed sample.

Discussion

The upper limb buds are formed during the fourth week of intra– uterine life. Many small arteries arise from the dorsal aorta and pass through the limb buds to form capillary network. Out of which only one arterial trunk remains as the axis artery of the upperlimb.[14] It represents a branch of seventh cervical intersegmental artery. Axis artery grows along ventral axial line and runs deeper to flexor muscle mass. It terminates into superficial and deep capillary plexuses in developing hand.[15] The proximal part of axis artery forms axillary artery and brachial artery. The distal part of artery gives rise to anterior interosseous artery and deep palmar arch. The radial and ulnar arteries appear later. [16,17]The radial artery arises proximal to ulnar artery. The ulnar artery joins with the capillary plexus of palm, which becomes superficial palmar arch. Median artery regresses or decreases in size. In the middle of the arm, the axis artery gives proximal radial artery which joins with a branch from axis artery to form permanent radial artery. Proximal part of radial artery above this level disappears.[20,21] The radial artery joins with deep capillary plexus of hand and forms the deep palmar arch. In our study, the Axillary artery length and branches showed variations in the cadaver which would attribute to the variation in the establishment of the proximal segment of the upper limb axis artery, whereas the variation in the radiological observation in which direct branching of radial and ulnar artery signifies the variation in both the proximal and distal part of the axis artery. The differences in genetic expressions of VEGFR1,VEGFR2,AER-FGF axis genes and the VEGF,Notch 1,D81,hox, pax, wnt signaling pathways may have played a significant role in the morphological and morphometrical variations in the vasculature we observed.[23,27] The variations in the length, extent and branches of the axillary artery may be attributed to the ethnic and geographical differences of the population studied. Comparison between different studies signifies the differences observed [Table 6].The inference is that the range of length and extent does not vary significantly but the number of branches and the branching pattern of axillary artery vary in different populations, indicating the importance of documenting the vascular variations as much as possible.[24,25]

Limitations

Evaluation of the parameters would have provided better normative range of values, if the study sample was accurately calculated. Due to time and resource constraint, the study was limited with the observed samples.

Conclusion

The detailed study of axillary artery in the upperlimb of 40 adult cadaveric specimens and 10 radiological

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images of axillary artery inferred that the branching pattern of the artery varies hugely in our population and the Knowledge of it is important during antegrade cerebral perfusion in aortic surgery, in treating the axillary artery thrombosis ,medial arm skin flap, in reconstruction of axillary artery in case of traumatic injury and in axillary coronary bypass shunt procedures .

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