MORPHOLOGICAL STUDY OF ANATOMICAL VARIATIONS IN THE BRANCHING PATTERN OF HUMAN AXILLARY ARTERIAL SYSTEM

Bashir Ahmad Junjua[1], Khadija, Samina[2], Aftab Ahmad[3]

ABSTRACT

Background: The arterial variations in the upper extremities are quite common and may occur at the level of axilla, arm, cubital fossa and the hand. Knowledge *of* anatomical variations in the branching pattern of axillary artery is very important in medical & surgical practices. **Objectives:** To determine the anatomical variations in the branching pattern of axillary arterial system in cadavers. Secondarily, to avoid the injuries by applying this knowledge during clinical practice. **Material and Methods:** A total of 82 upper limbs of 41 human embalmed cadavers of both sexes (36 Males & 5 Females,) ranging from (45-70 years old) were dissected and examined at the department of Anatomy, Nishtar Medical College, Multan, Army Medical College, Rawalpindi and Sheikh Zayed Medical College, Rahim Yar Khan over a period of four years. Upper limbs were labeled from 1-82 with letters (R) and (L) corresponding to the right or left limbs respectively and letters (M) or (F) corresponding to male or female respectively. Axillary artery (AA) with its normal or variant branches along with brachial plexus with its cords and branches was exposed in each cadaver. The topographic detail of each AA and its branching pattern deviated from the normal pattern was identified and photographed in both upper limbs of each cadaver. **Results:** The anomalous topographic pattern of branches of axillary arterial system was revealed in 14.64 % of the cadavers. Among 41(82 limbs) cadavers, the total anomalous branching pattern of AA were found in 6 (14.64 %) dead bodies, out of which 4 (9.76%) male and 2 (4.88%) female cadavers were seen. The frequency of bilateral variation was found in 1 (2.44%) male and 1 (2.44%) female cadavers but the frequency of unilateral variation was in 3 (7.32%) male dead bodies and in 1 (2.44 %) female cadaver. The study showed that axillary artery of the various cadavers gave origin to anamolous common thoraco- subscapular-circumflex humeral trunk in 5 (6.09 %) limbs, common circumflex humeral trunk in two (2.44%) limbs directly from the third part of the AA, independent branches from the different parts of the axillary artery *(*AA) were found in 4 cadavers i.e. in 6 (7.32 %) limbs and common thoracic trunk got origin from the 1st part of the AA in one (1.22 %) case. **Conclusion:** Our study reports existence of anomalous branches of AA. Knowledge of variation is very important during surgical exploration of the regions like axilla, arm and during flap or reconstructive surgeries. The anomalous branching pattern of AA associated with anomalies of various nerves are of interest to anatomists, surgeons, angiographers and radiologists, so keeping in view such anomalies, it is suggested that before doing any flap or reconstructive surgeries, these anomalies must be evaluated pre-operatively.

Key Words: Axillary artery, variations, anomalies, superior thoracic, thoraco-acromial, lateral thoracic, subscapular, anterior circumflex humeral, posterior circumflex humeral, thoracodorsal.

INTRODUCTION

Variations have been observed commonly in the arterial anatomy of the upper extremities. The prevalence of major arterial variations in upper limb ranges from 11% to 24%.[1] Axillary artery (AA), a continuation of subclavian artery extends from the outer border of first rib to the lower border of teres major where it ends to become the brachial artery.[2] Conventionally, the Anatomy text books describe, six branches from the AA. It is divided into three parts, in relation to pectoralis minor muscle. Proximal part (first part), is above the pectoralis minor, from which superior (highest) thoracic artery arises and the part lying under the muscle is posterior part (second part), which gives thoraco-acromial artery (TAA) and lateral thoracic artery (LTA) and its distal part (third part) is below the muscle, gives origin to the subscapular artery (SSA), anterior circumflex humeral (ACHA)and posterior circumflex humeral arteries (PCHA).[3] Sub scapular artery (SSA) further divides into thoracodorsal artery (TDA) and circumflex scapular artery (CSA). Although, six branches arise from the AA but the number arising independently from it, is a subject to be discussed for its considerable variations.[4] Twenty three different types of axillary arteries have been reported by some researchers [5] since 1928. Greate tendency of this variation was found among the Negroes than in Whites. Sex differences in the branching pattern of AA were also examined by Trottler and her associates [6] in 1930.

During developmental stages, AA arises from the seventh cervical segmental artery, so any abnormality during development may results in the form of an unusual branching pattern, as described by Wollard[7] in 1922. Researchers have reported different anomalies in the arterial anatomy of the upper extremities most commonly seen in 3rd part of the AA.[8,9] It is thought that AA variability results from

1. Sahiwal Medical College, Sahiwal
2. Army Medical College, Rawalpindi
3. Sheikh Zayed Medical College, Rahim Yar Khan

Correspondence: Dr. Bashir Ahmad Junjua, Associate Professor Anatomy Department , Sahiwal Medical College, Sahiwal.

E.Mail: basher.szmc@gmail.com

abnormal embryonic development of the limb bud vascular plexuses, derived from the persistence of more than one cervical intersegmental artery.[10] The largest and the most variable branch of the AA is subscapular artery (SSA), which arises at the distal border of the subscapularis muscle.[11] Two important muscles, the serratus anterior and subscapularis muscles are supplied by the SSA. The serratus anterior is used for free flap for reconstruction surgery by the plastic surgeons.[12] So it is important for, anatomists, cardiovascular, general, plastic and orthopedic surgeons and vascular radiologists to know the accurate knowledge of normal and variant arterial anatomy of the axillary region. Therefore, to get benefit from this vessel and muscle, the vascular variations of this region should be well investigated by ultrasonography and contrast arteriography to know any anomalous pattern of AA before planning any surgery. For this purpose proper evaluation of the axillary arterial system is needed in each individual who is undergoing such types of investigations, intervention and operations. That is why; the present study was carried out to record and evaluate the frequency of anatomical variations in the branching patterns of AA in dissecting room cadavers.

MATERIAL & METHODS

AA with brachial plexuses (BP), from 82 upper limbs of 41 human cadavers of both sexes (36 males and 5 females, embalmed with an embalming fluid) ranging from (45-70 years old) were dissected and examined at the department of Anatomy, Nishter Medical College, Multan, Army Medical College, Rawalpindi and Sheikh Zayed Medical College, Rahim Yar Khan over a period of 4 years. These were labeled from 1-82 with letters (R) and (L) corresponding to the right or left limbs respectively and letters (M) or (F) corresponding to male or female respectively. Exposure of AA with its normal or variant branches along with brachial pluxses (BP) with its cords & branches was achieved, as directed by Cunningham's Manual of Practical Anatomy[13] with special emphasis on the origin of various branches of AA whether normal or variant, from its first, second and third parts. The topographic detail of arteries was examined by proper dissection and anomalies were observed, recorded, photographed and described.

Observations and results:

Out of 82 upper limbs of 41 cadavers, anomalous branching pattern of the AA was found only in 6 cases, four males and two females. The observations were recorded and described by keeping the following parameters, in view regarding the variations of branching pattern of AA,

1. Total number of the branches / trunks from AA whether normal or variant.
2. Site of origin of each normal or variant branch/ trunk.
3. Number and site of origin of each branch from the anomalous trunk.
4. Unilateral or bilateral anomalies.
5. Associated anomalies.

RESULTS

Among 41 (82 limbs) cadavers the total anomalies regarding the anomalous branching pattern of AA were found in six (14.64%) cases. Out of which 4 (9.76%) male and 2 (4.88%) female dead bodies were seen with anomalies while in rest of the cadavers (85.36%) standard configuration of the branching pattern of the AA was found as described in the textbooks of anatomy. The frequency of bilateral variation was found in 1 (2.44%) male and 1 (2.44%) female cadavers but frequency of unilateral variation was in 3 (7.32%) male bodies and in 1 (2.44 %) female cadaver. So among 82 limbs, anomalies were in 8 (9.76%) limbs, out of which 5 (6.09%) limbs were male and 3 (3.66%) limbs were female. The overall anomalies were found in three (3.66%) right limbs and five (6.09%) left limbs.

1. Two to eight branches were observed coming out of the AA of various cadavers in this study.

A). Three branches from AA in body no. 12, left arm, (Fig.I.). 1. (HTA). 2. Delto-pectoro-acromio-clavicular trunk (DPACT).This trunk gave four branches, deltoid, Pectroal, acromial and clavicular. 3.Anomalous common thoraco- subscapulo-circumflex humeral trunk, (ACTSCHT) from 2nd part of AA, above the formation of the main trunk of the median nerve. Lateral thoracic, accessory lateral thoracic, common humeral trunk and subscapular artery were its branches. Subscapular Trunk (SSA) gave Circumflex Scapularl Artery (CSA) and Thoracodorsa Artery (TDA), Circumflex Humoral Trunk (CHT) gave circumflex humeral artery

(ACHA) and (PCHA).

B).Three branches in body no. 18 right arm. 1. Anomalous common thoraco- subscapular-circumflex humeral trunk (ACTSCHT) which gave LTA and circumflex humoral trunk (CSCHT). This trunk further divided into CHT and SSA.SSA then divided into TDA and CSA. 2. Anomalous common delto-pectoro-acromio-thoracic trunk (ADPATT) which gave further four branches, i.e. deltoid, pectoral, acromial, and highest thoracic. 3. Anterior circumflex humeral artery (ACHA). Associated anomaly was the formation of the trunk of the median nerve by three roots.

Fig. I:

Male dead body no 12, left arm. Three branches from AA. 1. HTA. 2. Delto-pectoro-acromio-clavicular trunk (DPACT) with four branches.3. Anomalous common thoraco-subscapulo-circumflex humeral trunk, (ACTSCHT) from 2nd part of AA, giving two branches i.e. LTA, CHT and SSA. SSA gave further CSA and TDA.CHT gave ACHA and PCHA

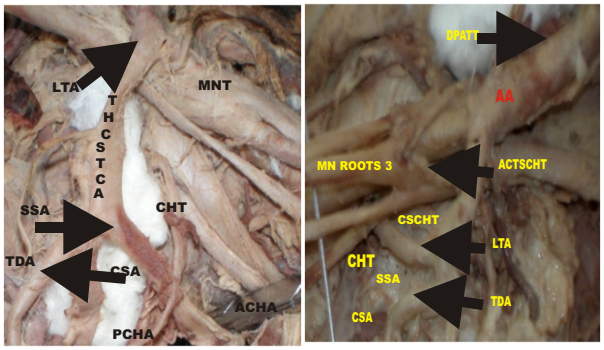


Fig. IIa:

Male body no 29, right arm. Six branches from AA of right arm.1.Highest throracic artery (HTA). 2. Deltiod branch (D.Br).3.Acromial branch (A.Br).4.Thoracic branch (T.Br) Two anomalus trunk were found, arising from the 3rd part of the AA. 5. Common thoraco-subscapular-circumflex humeral trunk (CTSCHT) which gave LTA, PCHA and SSA. SSAthen divided into CSA and TDA. 6. Common humeral trunk (CHT) which divided into ACHA and PCHA. IIb Six branches of AA .1 Highest thoracic (HT). 2.Deltiod branch (Dbr). 3 Acromial branch(ABr).4.Thoraco-pectoral trunk(TPT) was found, coming out from the medial side of the 2nd part of the AA 5. Common scapulo-humoral trunk (CSHT) from its 3rd part giving circumflex scapular, thoracodorsal arteries. 6. Anterior circumflex humoral branch (ACHA)

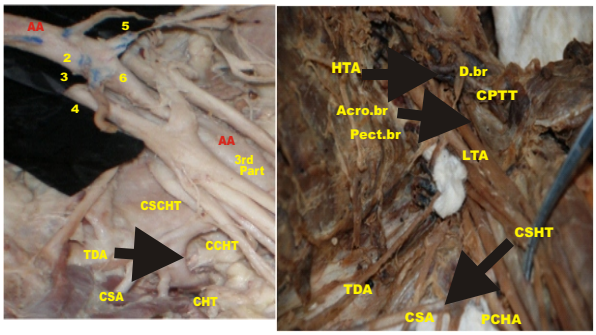
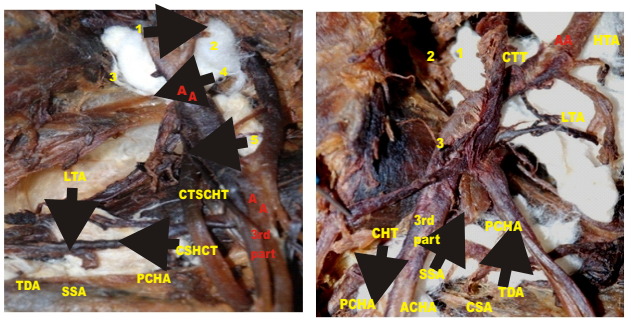


Fig. III:

Right arm female body no 35. Five branches from AA. Common thoracic trunk, from 1st part giving highest thoracic and lateral toracic arteries. 1.Deltiod 2. Pectoral 3. Acromial branches, from 2nd part. Subscapular artery and common circumflex humoral trunk from 3rd part.

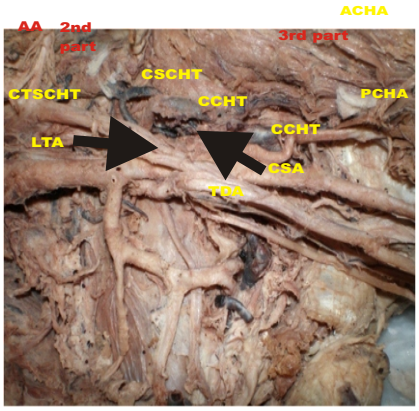


C). Six branches from AA of right arm. Male body no 29**,** right arm. 1. Highest throracic artery (HTA). 2. Deltiod branch (D.Br). 3. Acromial branch (A.Br). 4.Thoracic branch (T.Br) Two anomalous trunk were found, arising from the 3rd part of the AA. 5. Common thoraco- subscapular-circumflex humeral trunk (ACTSCHT) which gave LTA, PCHA and SSA. SSA then divided into CSA and TDA. 6. Common humeral trunk (CHT) which divided into ACHA and PCHA. Six branches of AA, **male body no 29,** left arm. 1.Highest thoracic. 2.Deltiod branch. 3 Acromial 4.Thoraco-pectoral trunk was found, coming out from the medial side of the 2nd part, giving a).pectoral branch and b) lateral thoracic branch 5. Common scapulo-humoral trunk from its 3rd part giving circumflex scapular, thoracodorsal arteries and accessory muscular branches. 6 . Anterior circumflex humoral branch.

Fig. IV:

Male left arm, body no. 39 Anamolous common thoraco scaplo humeral trunk(ACTSCHT) from 2nd part of the axillary artery. This divided into TDA and

CSCHT. CSCHT divided into TDA and CCHT which further dsivided into CSA and PCHT. Two independent branches ACHA and PCHA from 3rd part



D). Eight branches of the AA female body no 30. 1.Highest thoracic, 2. Deltoid 3. Pectoral 4.Acromial 5.Clavicular 6. Lateral thoracic arteries arising independently from 2nd part. 7. Anomalous common subscapulo-humoral trunk (ACSHT) from 3rd part which divided into thoracodorsal artery and common subscapolo-humoral trunk (CSHT). This trunk further divided into circumflex humoral trunk (CHT) and circumflex scapular (CSA) arteries.8.Anterior circumflex humeral artery (ACHA)

E). Left arm female body no.35. Six branches from AA. 1. Highest thoracic artery, from 1st part. Three independent branches (2,3,4) from 2nd part. Two branches from 3rd part. Anomalous common thoraco- subscapulo-humoral trunk (ATCSHT) from 3rd part which divided into lateral thoracic and common subscapolo- circumflex- humoral trunk (CSCHT). This trunk gave posterior circumflex humeral and subscapular branches. Subscapular gave circumflex scapular and thoracodorsal arteries. Anterior circomflex humeral artery (ACHA). Right arm female body no 35, Fig. III. Five branches from AA. Common thoracic trunk, from 1st part giving highest thoracic and lateral toracic arteries.1 Deltiod 2. Pectoral 3. Acromial branches, from 2nd part. Subscapulohumoral trunk which divided into PCHA and SSA which divided into CSA and TDA artery and common circumflex humoral trunk which divided into PCHA and ACHA from 3rd part.

F). Male left arm, body no. 39. Anomalous common thoraco- scaplo- humeral trunk (ACTSCHT) from 2nd part of the axillary artery. This divided into TDA and CSCHT. CSCHT divided into TDA and CCHT which further divided into CSA and PCHT. Two independent branches ACHA and PCHA came out from 3nd part.

2. Anomalous common thoraco- subscapular-circumflex humeral trunk (ACTSCHT) got origin from the AA in five (6.09 %) limbs among 82 limbs. From its 2nd part it was found in three (3.66 %) male limbs above the formation of the main trunk of the median nerve while from its 3rd part, it was present in one male (1.22 %) limb and one female(1.22 %) limb below the formation of the main trunk of the median nerve.

3. Common circumflex humeral trunk (CCHT) got origin from the AA in six (7.32 %) limbs. In two limbs (2.44%) it was getting direct origin from the third part of the AA, while in four (4.88%) limbs it was arising indirectly from 2nd part of the AA via the CTSCHT.

4. Independent branches from the different parts of the AA were found in six (7.32 %) limbs. In two cadavers it was bilateral i.e. in 4 (4.88 %) limbs and unilateral in two (2.44 %) limbs.

5. Common thoracic trunk (CTT) got origin from the 1st part of the AA in one case and divided into highest thoracic and lateral thoracic arteries.

These above mentioned anomalies were accompanied by anomalous formation of median nerve by 3 roots, 5 roots, pectoral nerve loop, a communicating nerve between the medial and lateral cords, arching over the second part of the AA.

DISCUSSION

The arterial variations are quite common in the upper extremities. These anomalies may occur at different levels of the arm. Clinically relevant anomalies may occur due to defective development of the vascular system at any embryological stage.[14] It is important for the anatomists, radiologists, vascular, cardiovascular, and orthopedic surgeons to know the different variations in the origin, course and distribution of the principal arteries of the upper limbs. During developmental stages, it is the 7th

intersegmental artery from which the developing upper limb bud gets the main artery i.e. axis artery.[15] The proximal part of this axial artery is developed into AA, followed by the brachial and interosseus arteries.[16] The anomalies of subclavian-axillary arterial system may occur due to the persistence of channels that normally obliterate. Some times the primitive vascular plexuses may grow at unusual routes resulting in occurrence of various anomalous pattern of AA system as observed in current study. Anatomists, vascular radiologists and cardiovascular surgeons have shown keen attention about the variations in the origin, course and branching pattern of the principal arteries of the upper limbs.[17] The thoracodorsal (TDA) anastomoses with the branches of the subclavian and axillary arteries and those of the thoracic aorta.[12] This important anastomoses gives collateral channel in patients with coarctation of aorta, and post-radiation occlusion of the axillary artery for arterial circulation.

It is usually described that AA gives off six branches, but this number is not always constant, however it may vary because of origin of two or more arteries together instead of their separate origin, or two branches of an artery arise separately instead of, the usual common trunk.[18] Both unilateral and bilateral variations of the branching pattern of the AA have been observed in current study (Fig.3,5), which are in consonance with the results of Saralaya et al[19], and Daniela et al.[20] Saeed et al[14], have reported a bilateral ACSCHT (3.8%) coming from the 3rd part of the AA (branching into the circumflex humeral (CH) and TD and a bilateral thoraco-humoral trunk emerging from the 2nd part of the AA (1.9%) which gave Lateral Thoracic Artery (LT), Common Humeral (CH), SSA and TDA arteries. The study showed that axillary artery of the various cadavers gave origin to three branches in body no 12, left arm, three branches in body no 18 right arm, six branches right arm and six branches left arm in body no 29, 8 branches left arm of a female dead body no 2, six branches from left arm and five from right arm in a female body no. 35 and three branches in body no.39. Regarding every branch getting origin directly from the axillary artery, whether named, unnamed, or common trunk, the number of branches ranged from 3 to 8 in our study which is comparable to the works of Patnaik et al [21] who described the number of branches ranged from 2-9 in their study. Our findings are also in favor and Syed at el who has described eight branches in their study.[22]

Common thoraco- subscapular-circumflex humeral trunk got origin from the AA in five (6.09 %) limbs among 82 limbs. From its 2nd part it was found in three (3.66 %) male limbs (Fig.1) above the formation of the main trunk of the median nerve while from its 3rd part, it was present in one male (1.22 %) limb and one female (1.22 %) limb below the formation of the main trunk of the median nerve.The common thoraco- subscapular-circumflex humeral trunk gave origin to LT, accessory LT, subscapular trunk (SST) dividing into CHT and SSA which then subsequently terminated into ACH and PCH arteries from CHT and CSA and TDA from SSA. This finding is in accordance with the results of Durgun et al[23] who reported a variation where the SSA arose from the second part of the AA as a common trunk and produced the TDA, CSA, and PCHA. The frequency of aberrant branching observed by them was in 12% of cases. In another study where Lee and Kim [24] have reported a large common trunk originated from the second part of the AA and gave origin to the LTA, TDA, CSA, and PCHA. It has been described by DeGaris & Swartley[25], that the SS, both CH and profunda brachii arteries arose frequently from the AA as a common trunk in combination of any of two or more which again favours our study results. The results of study of Swapna et al[26] also favours the results of this current study who found bilateral variation, where a common stem was arising from the second part of right AA which gave off SS and LT arteries and independent branches namely LTA, HT. While LTA and SSA .from its 2nd part and ACH and PCH arteries were arising from its third part. The frequency of the common trunk in their study was observed in 2.4% of cases from which the CSA and TDA with the additional presence of a PCHA in 1.2% of cases. In our study results, a common trunk arising from third part of the AA gave origin to LTA and SST. This SST gave further SSA and PCHA. This result is similar to the study results of Samuel et al[27] who found an abnormal trunk from the third part of the AA which gave to ACH, PCH, and SS arteries.

Common circumflex humeral trunk (CCHT) got origin from the AA in six (7.32 %) cases. In two limbs (2.44%) it was getting direct origin from the third part of the AA, while in four (4.88%) limbs it was

arising indirectly from 2nd part of the AA via the ACTSCHT. These findings are similar to the findings of Lenjek et al[28] who have described the presence of bilateral CHT from 3rd part and THT from 2nd part of AA but have not told about its frequency. Saeed et al[14] have reported the origin of bilateral **A**CSCHT from the 3rd part and a bilateral THT arising from the 2nd part of AA. Indirect origin of the CCHT from AA have been reported by many authors, as also described in current study but no one has reported direct origin of this trunk from the 3rd part of the AA.

People have commonly described six branches of AA, but variable number and site of origin of independently arising arterial branches from various parts of the AA, found in our study is a matter to be discussed. It has been observed in current study that two or more of usual branches may arise by a common trunk or branch or branches of a usually named artery may arise which is in agreement to the study of Hollinshead[29] in 1958, and De Garis & Swartley, in 1928. TAA was absent bilaterally as such but two separate branches like deltoid and acromial, right arm and three individual branches like deltoid, acromial and clavicular, left arm in a male body no 29, were arising from the 2nd part of AA. In a female cadaver, TAA was absent while four independent individual branches like deltoid, pectoral, acromial and clavicular were emerging from the posterior surface of the 2nd part of AA, while in another female cadaver, only two independent pectoral branches, left arm and three independent branches like deltoid, acromial and pectoral, right arm came out from lateral side of the 2nd part of AA. Common thoracic trunk (CTT) got origin from the 1st part of the AA in one case and divided into highest thoracic and lateral thoracic arteries. The frequency of CTT (from the 1st part of the AA) was in (1.22%) limb which divided into HT and LT arteries. This finding of our study is in consonance with the results of Pan[30] who found LTA **w**ith HTA.

CONCLUSION

Our study report the existence of anomalous branching pattern of AA. The knowledge of anomalous branching pattern of AA associated with anomalies of various nerves are of interest to anatomists for basic learning, to angiographers and radiologists for investigations and to surgeons during surgical exploration of the regions like axilla, arm and flap or reconstructive surgeries. It is suggested that before doing any flap or reconstructive surgeries, these anomalies must be evaluated.

REFERENCES

1. Uglietta JP, Kadir S. Arteriographic study of variant arterial anatomy of the upper extremities. Cardiovasc Intervent Radiol. 1989; 12: 145-148.
2. Last RJ. Upper limb. In: Sinnatamby CS, editor. Lasts anatomy: Regional & applied. 10th ed. Edinburgh: Churchill Livingstone; 1999; 48-50, 337.
3. Standring S, Johnson D, Ellis H, Collins R. Gray's Anatomy. 39 Ed. Churchill Livingstone, London, 2005; 856.
4. Hollinshead W H. Anatomy for surgeons in general surgery of the upper limb. The back and limbs. New York, A Heber Harper Book, 1958. 3.290-300.
5. De Garis CF, Swartley WB. The axillary artery in White and Negro stocks. Am J Anat. 1928; 41:353.
6 .Trottler M, Henderson JL, Gass H, Brua RS, Weisman S, Agrecs H, et al. The origins of branches of the axillary artery in whites and in American Negroes Anat Rec 1930; 46:133.
7. Wollard HH. The development of the principal arterial stems in the forelimb of the pig. Contrib Embryol. 1922; 14:139
8. Poynter CWM. Congenital anomalies of the arteries and veins of the human body with bibliography. University Studies, University of Nebraska. 1920; 22: 1-106.
9. Huelke DF. Variation in the origins of the branches of the axillary artery. Anat Rec . 1959; 35: 33-41.
10. Ciervo A, Kahn M, Pangilinan AJ, Dardik H. Absence of the brachial artery: Report of a rare human variation and review of upper extremity arterial anomalies. J Vasc Surg. 2001;33:19 -194.
11. Hollinshead WH. Pectoral region, axilla and shoulder. In: Rosse C, Gaddum-Rosse P, editors. Hollinsheads textbook of Anatomy. 5th ed. Philadelphia (USA): Lippincott-Raven. 1997; 212-216.
12. De-Fontaine S, Decker G, Goldschmidt D. Anomalous blood supply to the serratus anterior muscle flap. Br J Plast Surg. 1994; 47: 505-506.
13. Romans G.J. Cunningham's manual of practical anatomy In: The upper limb; 15th Edn; Oxford University Press, New York, Tokyo: 1999.
14. SaeedM, Amin AR, Salah EE, Muhammad SS. Variations in the subclavian-axillary arterial system. Saudi Medical Journal. 2002; 22 (2): 206-212
15. Hamilton WJ, Mossman HW. Cardiovascular system. In: Human embryology. 4th ed. Baltimore: Williams and Wilkins, 1972; 271- 290.
16. Moore KL, Persaud TVN. The cardiovascular system. In: The developing human, clinically oriented embryology. 6th ed. Philadelphia (PA):WB Saunders; 1998; 335-341
17. Collins P. Embryonic circulation. In: Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE, Ferguson MWJ, editors. Grays Anatomy. 38th ed. Edinburgh (UK): Churchill Livingstone; 1995; 318-319.
18. Ramesh Rt, Shetty P, Suresh R. Abnormal branching pattern of the axillary artery and its clinical significance. Int J Morpho. 2008; 26(2):389-392.
19. Saralaya V, Joy T, Madhyastha S, Vadgaonkar R,

Saralaya s. Abnormal branching of the axillary artery: subscapular common trunk. A case report. Int J Morphol. 2008; 26(4):963-966.

20. Daniela S, Ana D, Julijana H, Iva T. Bilateral arterial and nervous variations in the human upper limb: A case report Annals of Anatomy - Anatomischer Anzeiger. 2007; 189; 3 , 290-294
21. Patnaik VVG, Kalsey G, Singla K. Branching Pattern of Axillary Artery - A Morphological Study J Anat Soc India. 2000; 49(2) 127-132
22. Syed RD, Abu US, Rajendra N W. Variations in the branching pattern of axillary artery with high origin of radial artery. International Journal of Anatomical Variations. 2010; 3; 7677
23. Durgun B, Yucel AH, Kizilkanat ED, Dere F.. Multiple arterial variation of the human upper limb. Surg Radiol Anat 2002; 24:125128.
24. Lee JH, Kim DK.. Bilateral variations in the origin and branches of the subscapular artery. Clin Anat. 2008; 21:783785.
25. DeGaris CF, Swartley WB: The axillary artery in White and Negro stocks. Am J Anat. 1928; 4: 353-397,
26. Swapna Bijuraj, K Gopinathan and KK Krishnamma AIMS,Kochi, Kerala. Variation In The Origin Of The Axillary Artery Branches Journal of the Anatomical Society of India. 2007; 56: 1
27. Samuel VijayaPaul, Vollala VenkataRamana, Nayak Satheesha, Rao Mohandas, Bolla Sreenivasa1928., Pammidi Narendra A rare variation in the branching pattern of the axillary artery Indian Journal of Plastic Surgery. 2006; 39: 2: 222-23
28. Lenjec B, D hem A.Unusual variations of the vasculonervous elements of human axilla. Arch Anat Histol Embryol. 1989;72:57-67
29. Hollinshead W.H.: Anatomy for surgeons. The back and limbs. In: Pectoral region, axilla and shoulder - The axilla Vol.3, Paul B.Hoebar, Inc. Med. Book Deptt. of Harper & Brothers, 49 East, 33rd Street, New York. 1958; 16: 290-300
30. Pan MT. The origin of branches of the axillary arteries in Chinese. American Journal of Physiology and Anthropology. 1940; 27: 269-279.