AXILLARY ARTERY- A STUDY ON BRANCHING PATTERN AND VARIATIONS
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ABSTRACT

BACKGROUND
Study of variations in the branching pattern of axillary artery is of considerable importance. There may be variations in the origin of branches, additional branches or 2 or more from common trunk or the artery may arise separately. The anomalous branching pattern can be correlated to the developmental defects of vasculature during embryonic life. The axillary artery is a part of axis of upper limb. Morphological variations of axillary artery of upper limb is very important for vascular surgeons, cardiologists, anaesthetists, radiologists and orthopaedic surgeons. Present study is aimed at finding out the branching pattern of axillary artery, clinical significance and to correlate its embryological basis.

MATERIALS AND METHODS
The present study was conducted on 20 formalin fixed cadavers (40 limbs), which were allotted to the undergraduate, postgraduate students and BDS students of Government Medical College, Kottayam. Cadavers were numbered 1-20 and the axillary artery and its branches were dissected on both sides following the classical incision and dissection procedure taking care to preserve all branches. The artery was studied under the following headings- 1. Origin of all branches; 2. Course and variation.

RESULTS
In the present study, it was observed that the branching pattern of axillary artery showed variations in 80% of cases. 8 upper limbs showed normal pattern of distribution (20%). The branches revealed different levels of origin and distribution from the normal pattern. The most common variations observed in the origin of subscapular artery and anterior and posterior circumflex humeral arteries together constitute 40%. The remaining 40% of variations were observed in superior thoracic (17.5%), thoracoacromial (12.5%) and lateral thoracic (10%). These observations in the arterial variations highlights the awareness during regional surgeries and other interventional procedures.

CONCLUSION
Variations observed in this study are similar to that of other studies, which have been conducted elsewhere across the globe. A clear knowledge of such variations were very essential for the operating surgeons, cardiologists and interventional radiologists to avoid undesirable complications during the interventional surgical procedures in the upper limb region.

KEYWORDS
Axillary Artery, Common Trunk, Subscapular Artery, Superior Thoracic Artery, Circumflex Humeral Arteries, Lateral Thoracic Artery.

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BACKGROUND
The axillary artery is the continuation of subclavian artery at the outer border of first rib and ends at the lower border of teres major muscle where it continues as brachial artery. Pectoralis minor muscle divides it into 3 normal parts. The 1st part is cranial to the muscle, 2nd part is posterior to the muscle and 3rd part is caudal or distal to it. Branches from 1st part are thoracocervical and lateral thoracic and from the 3rd part are subscapular, anterior circumflex humeral and posterior circumflex humeral artery.1 In this study, it was observed that the normal pattern of distribution is seen in 20% of specimens and the rest of 80% specimens showed variations in the origin, branching pattern and distribution. The majority of variations were observed in 3rd part of axillary artery and its branches. The anastomosis around scapula reveals a communication between first part of subclavian artery and third part of axillary artery and this acts as a collateral pathway when one of these arteries are blocked. Axillary artery aneurysm can present as a pulsatile swelling in axilla and can compress the brachial plexus.

Aims and Objectives
The significance of this study is helpful for vascular surgeons, plastic surgeons, anaesthetists to avoid iatrogenic injury during surgical procedures.2 The knowledge of branching pattern of axillary artery is necessary during
antegrade cerebral perfusion in aortic surgeries treating axillary artery thrombosis using medial arm skin flap. The anomalous branching pattern of axillary artery can be correlated to differing modes of transformations of the primary vessels during embryonic life. In the surgical approaches to axilla, a sound knowledge of the normal anatomy and variations of axillary artery is important. In reducing old shoulder dislocations, care should be taken as the artery maybe adherent to the capsule.

MATERIALS AND METHODS
40 limbs of 20 cadavers provided for routine dissection for 1 MBBS, 1 BDS, PG students where duly embalmed limbs were dissected retaining continuity with the trunk. Axillary artery and its branches were dissected following classical incision dissection procedure according to Cunningham’s manual of practical Anatomy (Romanes 1992) in the Department of Anatomy, Government Medical College, Kottayam, by taking care to preserve all branches. The variations were noted, photographed and data analysed.

Inclusion Criteria- 20 cadavers from Department of Anatomy.
Exclusion Criteria- Deformed or traumatised upper limb.

RESULTS
In the present study of 40 specimens, it was found that 80% cases showed variations in the branching pattern. During dissection, all branches of axillary artery were looked for and eight specimens were showed normal pattern (20%) and 32 cases (80%) showed variations, Table 1 and Chart 1.

<table>
<thead>
<tr>
<th>Number of Specimens Showing Variations</th>
<th>First Part</th>
<th>Second Part</th>
<th>Third Part</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32</td>
<td>7</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>

| Table 1. Showing Number of Specimens with Variations and Percentage |

<table>
<thead>
<tr>
<th>Superior Thoracic Artery</th>
<th>Double from Subscapular Artery</th>
<th>Give Origin to Lateral Thoracic Artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 cases</td>
<td>2 cases</td>
<td>1 case</td>
</tr>
<tr>
<td>10%</td>
<td>5%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

| Table 2. Showing Variations of Superior Thoracic Artery and its Percentage |

<table>
<thead>
<tr>
<th>Thoracoacromial Artery</th>
<th>Lateral Thoracic Artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tripodal Division</td>
<td>Bipodal Division</td>
</tr>
<tr>
<td>2 cases</td>
<td>2 cases</td>
</tr>
<tr>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

| Table 3. Showing the Variations of Branches of Second Part |

It was observed that the first part of the axillary artery give rise to double superior thoracic artery in 4 limbs (10%) Figure 1 and superior thoracic artery from subscapular artery in 2 cases (5%) Figure 2. Superior thoracic artery gave 2-3 lateral thoracic artery (2.5%), Table 2 and Chart 2. The thoracoacromial artery divides into pectoral, acromial and clavicular branch (tripodal) in 2 case Figure 3 and acromial and clavicular (bipodal) Figure 4 in 2 cases and all the branches originate from second part of the artery separately in one specimen Figure 5, Table 3 and Chart 3. The second part of the axillary artery gives off multiple lateral thoracic branches, which are seen arising from subscapular artery in 4 cases (10%), Figure 6. The third part of axillary artery give rise to subscapular artery, anterior and posterior circumflex humeral artery. It was observed that about 40% of variations of branching pattern of axillary artery were in the third part. The subscapular artery takes origin from the 2nd part in 4 specimens (10%) and it also give origin to posterior circumflex humeral and anterior circumflex humeral artery Figure 7. The anterior circumflex humeral and posterior circumflex humeral artery arised from subscapular artery of the third part of axillary artery in 8 specimens (20%) Figure 8. The common trunk origin of anterior and posterior circumflex humeral arteries were seen arising from the third part of axillary artery was observed in 4 cases (10%), Figure 9, Table 4 and Chart 4. All these observations highlights the significance of the arterial anatomy while performing regional surgical procedures.
Table 4. Showing Variations of Branches of Third Part

<table>
<thead>
<tr>
<th>Subscapular from Second Part</th>
<th>Anterior and Posterior Circumflex from Subscapular</th>
<th>Anterior and Posterior Circumflex from Common Trunk</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 cases</td>
<td>8 cases</td>
<td>4 cases</td>
</tr>
<tr>
<td>10%</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Chart 4. Showing Variations of Branches of Third Part

Figure 1. Double Superior Thoracic Artery (ST) from First Part of Subclavian Artery and Multiple Lateral Thoracic (LT) Branches

Figure 2. Superior Thoracic Artery (STA) from Subscapular Artery (SSA) of Axillary Artery (AA)

Figure 3. Showing Trifurcation of Thoracoacromial Artery (TAA)
Figure 4. Showing Bifurcation of Thoracoacromial Artery (TAA) Multiple LTA (Lateral Thoracic Artery)

Figure 5. Separate Origin of Branches of Thoracoacromial Artery (TAA)

Figure 6. Multiple Lateral Thoracic Branches (LT)

Figure 7. Showing Subscapular Artery (SSA) Arising from the Second Part of the Axillary Artery
DISCUSSION

The anomalous branching pattern of axillary artery can be correlated to differing modes of transformations of the primary vessels during embryonic life. The variations are due to defects in embryonic development of the vascular plexus of upper limb bud. During various stages of arterial development, arrest can occur anywhere along its course. Defects in embryonic development of vascular plexus of upper limb due to arrest at any stage followed by regression, retention or reappearance. Accurate knowledge of the normal and variations of arterial anatomy is important for clinical procedures in the axilla, operating surgeons, cardiologists and interventional radiologists to avoid undesirable complications during the interventional surgical procedures in the upper limb region.

Branches of axillary artery are used for coronary bypass and flap for reconstructive surgery. A sound knowledge is essential for surgical attempt to reduce old shoulder dislocations especially if the artery is adherent to the arterial capsule. In the present study, it was found that 80% cases showed variations in the branching pattern during dissection and 20% cases showed normal pattern.

Variations in branching pattern of axillary artery should be kept in mind while performing bypass between axillary artery and subclavian artery in subclavian artery occlusion. The common trunk, subscapular artery and lateral thoracic artery as in the present study may be used for bypass. Saeed et al reported common subscapular circumflex humeral trunk from 3rd part of axillary artery divided into subscapular, anterior circumflex humeral and posterior circumflex humeral in 3.8% cases. In the present study, subscapular artery, anterior and posterior circumflex humeral arteries arise as common trunk in 4 cases (10%) Figure 8. Magden et al reported unusual branching pattern of axillary artery in which first part gives a separate branch to serratus anterior muscle, while lateral thoracic and thoracodorsal arise as common trunk from 3rd part of axillary artery and circumflex scapular artery arise directly from 3rd part of axillary artery. In this study, it was observed that superior thoracic artery takes origin from subscapular artery, which in turn takes origin from second part (5%). Anterior circumflex humeral and posterior circumflex humeral artery from a common trunk in 8 cases (20%). In the present study, it was also observed that more than one variations were noticed in the same specimen on both sides with slight predominance on the right side. The axis artery of upper limb is derived from lateral branch of 7th cervical intersegmental artery and proximal part of it forms axillary and brachial artery. Ramesh et al reported a case in which common trunk gave rise to many branches such as the thoracoacromial artery, lateral thoracic, posterior circumflex humeral artery and subscapular artery. The anterior circumflex humeral artery was found to arise from the 3rd part. Variations can occur due to arrest at any stage of development of vessels of upper limb. According to Arrey, unusual blood vessels were due to either choice of unusual path in the primitive vascular plexus or persistence of vessels, which are normally obliterated and disappearance of vessels, which are normally
Konarik et al reported a case with a coincidental variation of the axillary artery with a brachioradial artery and an aberrant posterior humeral circumflex artery passing under the tendon of the latissimus dorsi muscle. The knowledge of branching pattern is very essential while treating the cases of axillary artery thrombosis using medial arm skin flap reconstruction procedures. In the surgical intervention of fracture, upper end of humerus and shoulder dislocation, the variation of the regional arteries including the axillary artery should be considered.

CONCLUSION
The prevalence of variations of axillary artery is very high among the population in both sexes. Variations obtained in the present study are similar to that done elsewhere, but with slight predominance on the right side. Surgeons should have a sound knowledge of variations of axillary artery in conducting surgical procedures to avoid untoward surgical mishaps.

REFERENCES