

# Variations in branching pattern of the axillary artery: a study in 40 human cadavers

*Variações na ramificação do padrão da artéria axilar: um estudo em 40 cadáveres humanos*

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## Abstract

**Background:** Variations in the branching pattern of the axillary artery are a rule rather than an exception. The knowledge of these variations is of anatomical, radiological, and surgical interest to explain unexpected clinical signs and symptoms.

**Objective:** The large percentage of variations in branching pattern of axillary artery is making it worthwhile to take any anomaly into consideration. The type and frequency of these vascular variations should be well understood and documented, as increasing performance of coronary artery bypass surgery and other cardiovascular surgical procedures. The objective of this study is to observe variations in axillary artery branches in human cadavers.

**Methods:** We dissected 80 limbs of 40 human adult embalmed cadavers of Asian origin and we have studied the branching patterns of the axillary artery.

**Results:** We found variations in branching pattern of axillary artery in 62.5% of the limbs. Anatomical variations included: origin of lateral thoracic artery from the subscapular artery; absent thoracoacromial trunk and all its branches arose directly from the second part of the axillary artery; division of thoracoacromial trunk into deltoacromial and clavicular trunks, which were divided into all branches of thoracoacromial trunk; origin of subscapular, anterior circumflex humeral, posterior circumflex humeral and profunda brachii arteries from a common trunk from the third part of the axillary artery; and origin of posterior circumflex humeral artery from brachial artery in addition to third part of the axillary artery.

**Conclusions:** The study was carried out to show important variations in the branching pattern of axillary artery, in order to orient the surgeons performing angiography, coronary bypass, and flaps in reconstructive surgeries.

**Keywords:** angiography; axillary artery; cardiovascular surgical procedures; coronary artery bypass; median nerve.

## Resumo

**Contexto:** As variações no teste padrão de ramificação da artéria axilar são preferencialmente uma regra do que uma exceção. O conhecimento destas variações é de interesse anatômico, radiológico e cirúrgico para explicar os sinais e sintomas clínicos inesperados.

**Objetivo:** O grande percentual de variações no padrão de ramificação da artéria axilar deve ser levado em consideração. O uso crescente de procedimentos invasores e intervencionistas em procedimentos cirúrgicos cardiovasculares e em cirurgias reconstrutivas da região axilar faz com que seja mais importante que o tipo e a frequência destas variações vasculares sejam entendidos e documentados.

**Métodos:** Oitenta membros de 40 cadáveres adultos embalsamados de origem asiática foram dissecados, e os testes padrões de ramificação da artéria axilar foram estudados.

**Resultados:** Foram encontradas variações no padrão de ramificação da artéria axilar em 62,5% dos membros. Variações anatômicas incluíram: origem da artéria torácica lateral da artéria subescapular; tronco toracoacromial ausente e todos os ramos surgiram diretamente a partir da segunda parte da artéria axilar; divisão do tronco toracoacromial em troncos deltoacromial e clavicular, que foram divididos em todos os ramos do tronco toracoacromial; origem do subescapular umeral circunflexo anterior, umeral circunflexo posterior e artérias braquiais profundas a partir de um tronco comum da terceira parte da artéria axilar; e origem da artéria umeral circunflexa posterior da artéria braquial, além de terceira parte da artéria axilar.

**Conclusões:** O estudo foi realizado para mostrar as importantes variações no teste padrão de ramificação da artéria axilar para orientar os cirurgiões que realizam angiografias, pontes de safena e retalhos em cirurgias reconstrutivas.

**Palavras-chave:** angiografia; artéria axilar; procedimentos cirúrgicos cardiovasculares; revascularização; nervo mediano.

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## Introduction

The axillary artery is a continuation of the subclavian one from outer border of the first rib to lower border of teres major muscle that continues further distally as brachial artery. It is classically divided into three parts by the pectoralis minor muscle. It is conventionally described as giving of six branches. The branches vary considerably, in up to 30% of the cases, the subscapular artery can arise from a common trunk with the posterior circumflex humeral artery. Occasionally, the subscapular, anterior circumflex humeral, posterior circumflex humeral, and profunda brachii arteries arise in common. The posterior circumflex humeral artery may arise from the profunda brachii artery, and pass back below the teres major to enter the quadrangular space<sup>1</sup>.

The number of branches that arose from the axillary artery showed considerable variations: two or more of usual branches may arise by a common trunk or named artery viz. deltoid, acromial, clavicular or pectoral branch may arise directly from axillary artery<sup>2</sup>.

Accurate knowledge of the normal and variant arterial anatomy of the axillary artery is important for clinical procedures in this region<sup>3</sup>. Branches of axillary artery are used for coronary bypass and flaps in reconstructive surgeries. Sound knowledge of variation in branching pattern is important for surgeons' attempting to reduce old dislocations, especially when the artery is adherent to the articular capsule<sup>1</sup>.

## Methods

This study was approved by the Ethics Committee from the GSL Medical College, institution in which this study was carried out, under the protocol of GSLMC/Ethics/05/20122009.

The axillary arteries belonging to 80 upper limbs of 40 cadavers of Asian origin (34 males and 6 females) were selected to dissect for routine educational purposes in the department of anatomy.

The cadavers were embalmed immediately after death. The embalmed cadavers were labeled from 1 to 40, right and left limbs were labeled R and L, respectively. The limbs were dissected retaining continuity with the trunk. Exposure of the axillary artery and its branches were achieved following classical incisions and dissection procedures as provided by Cunningham's manual of practical Anatomy (Romanes, 1992)<sup>4</sup>, taking care to preserve all arteries, sacrificing venae comitantes and resecting the muscles that come in their way. The branching pattern of the axillary artery was studied under the following headings: origin of all branches,

their courses and variations if present, and photographs were taken for recording.

Statistical comparisons between percentages were performed by the  $\chi^2$  test;  $p < 0.05$  was regarded as statistically significant.

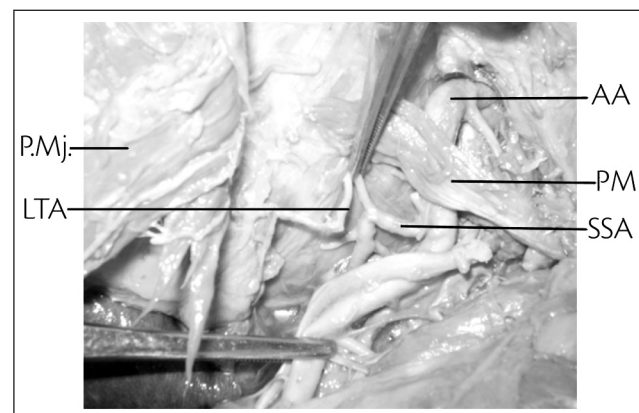
For the dissection of the cadavers, investigations and materials were used in the study, the required permissions were taken from appropriate firms within the institute, and all the methods were followed in-line with international ethics and values.

## Results

We found variant branching pattern of the axillary artery in 43 out of 68 limbs (63% limbs) in males and 7 limbs out of 12 limbs (58% limbs) in females. The variant branching pattern was found in 26 male cadavers (76.4%), unilaterally in 9 cases (five right, four left) and bilaterally in 17. It was found in four female cadavers (66.7%), with one unilateral case on the right side and three bilateral. Consequently, the total incidence of variant branching pattern of the axillary artery was 30 out of 40 cadavers (75%) or 50 out of 80 upper limbs (62.5%).

Our results showed six different arterial variations of the axillary artery. Each of them was separately analyzed in the following paragraphs.

We found the origin of lateral thoracic artery from subscapular artery in eight male cadavers (23.5%), unilaterally in two cases on the right side and bilaterally in six (Figure 1). Lateral thoracic artery arose from subscapular artery in one female cadaver (16.7%) bilaterally. Thus, the total incidence of origin of the lateral thoracic artery from subscapular artery was 9 out of 40 cadavers (22.5%) or 16 out of 80 upper limbs (20%). The  $\chi^2$  test did not show any statistically



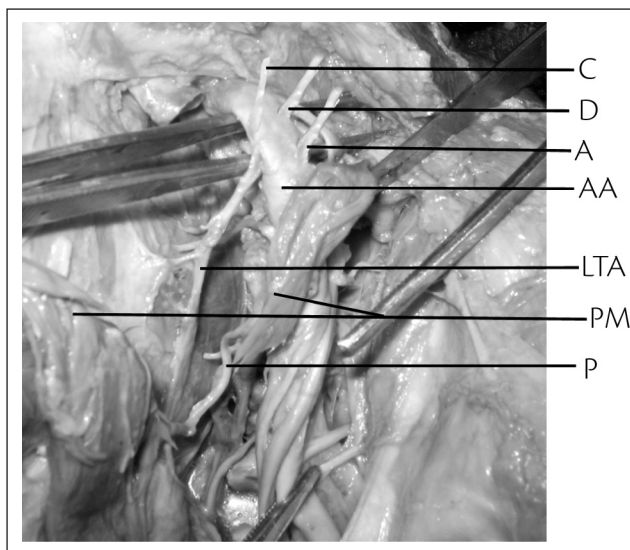
**Figure 1.** Lateral thoracic artery arising from subscapular artery on the left side. Thoracoacromial trunk and its branches are absent. AA: axillary artery; PM: pectoralis minor; P.Mj: pectoralis major.

significant differences between males and females ( $\chi^2=1.44$ ,  $p>0.05$ ), or right and left sides ( $\chi^2=0.542$ ,  $p>0.05$ ).

We found absent thoracoacromial trunk and origin of its all branches directly from the axillary artery, bilaterally in three male cadavers (8.8%). Absent thoracoacromial trunk and absence of its all branches were found in one female cadaver (16.7%), bilaterally (Figure 2). Absent thoracoacromial and its all branches were found in one male cadaver (2.9%), on the right side (Figure 1). Consequently, the total incidence of the absent thoracoacromial trunk was 5 out of 40 cadavers (12.5%) or 9 out of 80 upper limbs (11.25%). The  $\chi^2$  test did not show any statistically significant differences between males and females ( $\chi^2=1.026$ ,  $p>0.05$ ), or right and left sides ( $\chi^2=0.147$ ,  $p>0.05$ ).

A division of the thoracoacromial trunk into deltoacromial trunk and clavipectoral trunk was found in three male cadavers (8.82%), unilaterally on the right side in two cases and bilaterally in one case (Figure 3). We did not find such variation in any female cadavers. Consequently, the total incidence of origin of deltoacromial and clavipectoral trunks from thoracoacromial trunk was 3 out of 40 cadavers (7.5%) or 4 out of 80 upper limbs (5%). The  $\chi^2$  test did not show any statistically significant differences between right and left sides ( $\chi^2=1.282$ ,  $p>0.05$ ).

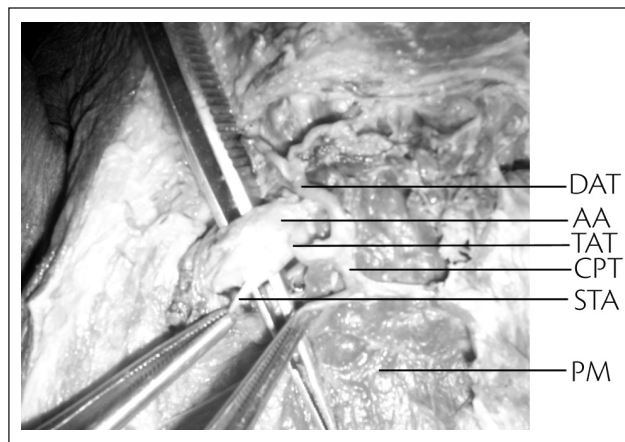
From the third part of the axillary artery, a common trunk gave origin to anterior circumflex humeral, posterior circumflex humeral, subscapular, and profunda brachii arteries in five male cadavers (14.7%), unilaterally in two cases (one right, one left) and bilaterally in three (Figure 4).



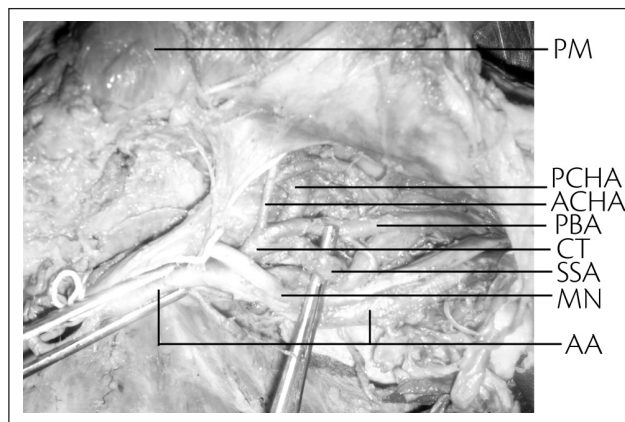
**Figure 2.** Thoracoacromial trunk is absent on the left side. Clavicular (C), deltoid (D), acromial (A), and pectoral (P) branches arising directly from the second part of the axillary artery. AA: axillary artery; LTA: lateral thoracic artery; PM: pectoralis minor.

We did not find such variation in any female cadavers. Consequently, the total incidence of such variation was 5 out of 40 cadavers (12.5%) or 8 out of 80 upper limbs (10%). The  $\chi^2$  test did not show any statistically significant differences between the right and left sides ( $\chi^2=0$ ,  $p>0.05$ ).

The common trunk from third part of axillary artery gave origin to anterior circumflex humeral, posterior circumflex humeral, and profunda brachii arteries in five male cadavers (14.7%), unilaterally on right side in one cadaver and bilaterally in four. Such variation was found in two female cadavers (33.3%), unilaterally on the right side in one cadaver and bilaterally in one cadaver. Therefore, the total



**Figure 3.** Thoracoacromial trunk arising from the second part of the axillary artery on the left side and dividing into deltoacromial trunk (DAT) and clavipectoral trunk (CPT). DAT dividing into deltoid (D) and acromial (A) branches, and CPT dividing into clavicular (C) and pectoral (P) branches. AA: axillary artery; STA: superior thoracic artery; TAT: thoracoacromial trunk.



**Figure 4.** A common trunk (CT) arising from the third part of axillary artery on the left side. Anterior and posterior humeral artery, subscapular artery and profunda brachii artery arising from CT. Median nerve (MN) is crossing CT instead of the axillary artery. AA: axillary artery; ACHA: anterior circumflex humeral artery; PCHA: posterior circumflex humeral artery; SSA: subscapular artery; PBA: profunda brachii artery; PM: pectoralis minor.



incidence of such variation was 7 out of 40 cadavers (17.5%) or 12 out of 80 upper limbs (15%). In one limb of the left side, the medial root of median nerve was crossing the third part of axillary artery from posteriorly (Figure 5). The  $\chi^2$  test showed statistically significant differences between males and females ( $\chi^2=9.483$ ,  $p<0.05$ ); however, it did not show statistically significant difference between the right and left sides ( $\chi^2=0.45$ ,  $p>0.05$ ).

Double posterior circumflex humeral arteries were found, one from the third part of axillary artery and the other from brachial artery; both arteries were passed in the quadrangular space of scapula (Figure 6). Such variation was found on the left side (1.25%) of one male cadaver (2.94%). The  $\chi^2$  test did not show any statistically significant differences between males and females ( $\chi^2=2.98$ ,  $p>0.05$ ), or right and left sides ( $\chi^2=1.257$ ,  $p>0.05$ ).

In the remaining 37.5% limbs (30 limbs), the course and branching pattern of the axillary artery were found as per described in the standard textbook of anatomy.

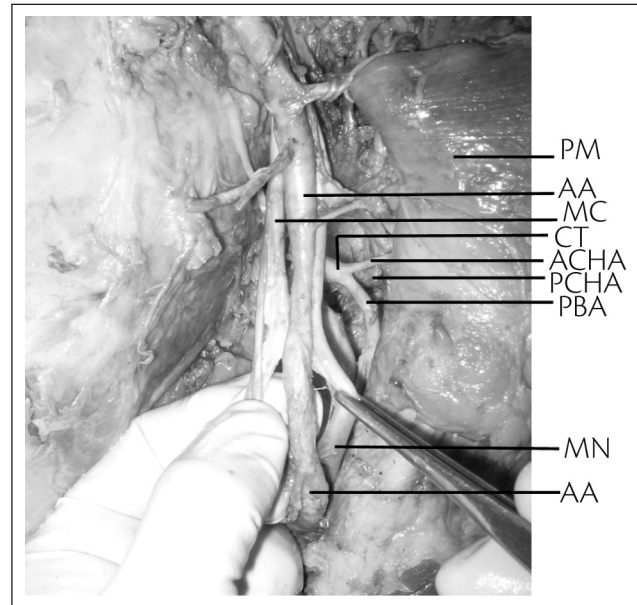
## Discussion

Due to clinical importance of axillary artery and its branches, a more definitive study seemed appropriate and necessary to provide additional data to coeval anatomical literature.

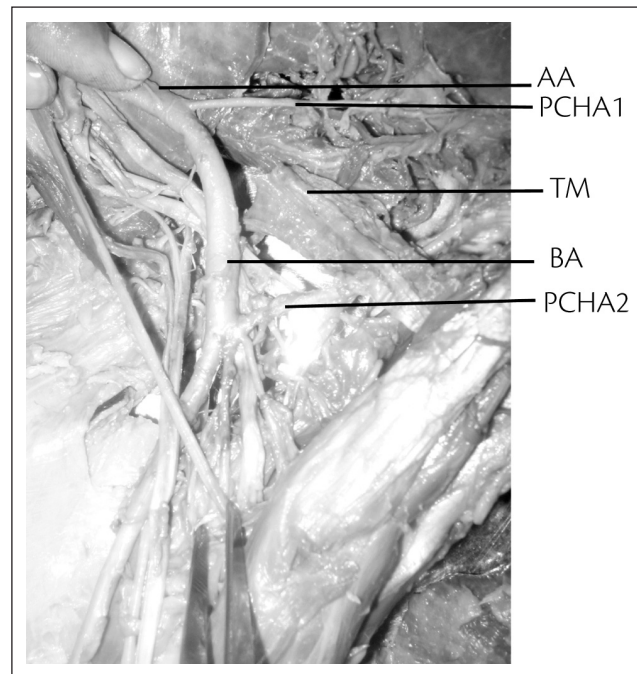
We found four to eight branches that arose from the axillary artery. DeGaris and Swartley<sup>5</sup>, in their study, found 5 to 11 branches arising directly from the axillary artery, the most common number the 8. Heulke<sup>6</sup> in his study found two to seven branches that arose from the axillary artery.

Subscapular artery from the third part of axillary artery gave origin to lateral thoracic artery in 14.6, 1, 23.4 and 26.4% in previous studies<sup>6-9</sup>. We found origin of lateral thoracic artery from the subscapular artery in 20% limbs, which matches with previous studies, except Pellegrini's (Figure 1).

The thoracoacromial trunk was a direct branch of second part of the axillary artery<sup>7-9</sup>. Pandey and Shukla<sup>10</sup> described variations in origin of the branches of thoracoacromial trunk, more on the right side, and divided these variations into three groups. In the first group, deltoacromial and claviopectoral subtrunks arose directly from the second part of the axillary artery, and the thoracoacromial trunk was absent. In the second group, only clavicular branch of thoracoacromial trunk arose from the second part of axillary artery whereas the remaining three were arising from thoracoacromial trunk. In the third group, all classical branches of thoracoacromial trunk arose directly from the second part of axillary artery and thoracoacromial



**Figure 5.** A common trunk (CT) arising from the third part of axillary artery on left side. Anterior and posterior humeral artery and profunda brachii artery arising from CT. Medial root of the median nerve is crossing the third part of the axillary artery in a posterior position instead of the anterior one. AA: axillary artery; ACHA: anterior circumflex humeral artery; PCHA: posterior circumflex humeral artery; PBA: profunda brachii artery; MC: medial cord of brachial plexus; MN: median nerve; PM: pectoralis minor.



**Figure 6.** Two posterior circumflex humeral arteries on the left side. One artery (PCHA 1) arising from the third part of axillary artery, passed with axillary nerve and appeared in the quadrangular space. The other artery (PCHA 2) arising from the brachial artery and passed below the teres major (TM) muscle to appear in the quadrangular space. AA: axillary artery; BA: brachial artery; PCHA: posterior circumflex humeral artery.

trunk was absent. We did not find thoracoacromial trunk in 10% of the limbs and all the classical branches of it were directly arising from the second part of the axillary artery (Figure 2). In 1.25% of the limbs, thoracoacromial and its all branches were absent (Figure 1), we did not find this type of variation in earlier literature. In 5% of the limbs, thoracoacromial trunk divided 1.2 cm after its origin into deltoacromial and clavipectoral subtrunks, which were divided into deltoid and acromial, clavicular and pectoral branches, respectively (Figure 3).

Axillary artery may give origin to a common trunk from its third part from which anterior circumflex humeral, posterior circumflex humeral, subscapular and profunda brachii arteries may arise<sup>11</sup>. Saeed et al.<sup>12</sup> reported the origin of a common subscapular-circumflex humeral trunk from the third part of axillary artery, which divided into subscapular, anterior circumflex humeral and posterior circumflex humeral arteries in 3.8% of cases. Ramesh et al.<sup>13</sup> reported unusual origin of a common trunk from the third part of the left axillary artery, which gave origin to subscapular, anterior circumflex humeral, posterior circumflex humeral, profunda brachii, and ulnar collateral arteries. Vijaya et al.<sup>14</sup> observed a common trunk from the third part of the axillary artery, which gave origin to anterior circumflex humeral, posterior circumflex humeral, subscapular, radial collateral, middle collateral and superior ulnar collateral arteries with absent profunda brachii artery. Cavdar<sup>3</sup> reported division of axillary artery in third part into deep and superficial brachial arteries: deep brachial artery divided into anterior circumflex humeral, posterior circumflex humeral, subscapular and profunda brachii arteries, so it may be similar to common trunk as we found; and the superficial brachial artery was divided into radial and ulnar arteries in cubital fossa. We found a common trunk from the third part of axillary artery in 25% of the limbs; in 10%, the common trunk gave origin to anterior circumflex humeral, posterior circumflex humeral, subscapular and profunda brachii arteries (Figure 4), and in 15% limbs the common trunk gave origin to anterior circumflex humeral, posterior circumflex humeral and profunda brachii arteries (Figure 5). Bhargava<sup>15</sup> considered this common trunk as an original axillary brachial trunk, which failed to develop in early fetal life and became obstructed. Subsequently, an apparent axillary brachial trunk developed for supplying the distal part of the limb. This was probably a vasa aberrans, which sometimes arose from the brachial artery. This type of arrangement gives a good blood supply to the limb through profunda brachii if axillary artery or brachial artery was connected distally to the origin of this common trunk.

Daimi et al.<sup>16</sup> found two trunks of posterior circumflex humeral arteries arising from the third part of the axillary artery: one artery continued laterally together with axillary nerve and appeared in the quadrangular space; the other one passed medially piercing teres minor muscle and appeared on the dorsal surface of scapula. We found double posterior circumflex humeral arteries in 1.25% of the limbs: one artery arose from the third part of axillary artery, passed with the axillary nerve and appeared in the quadrangular space; the other artery arose from the brachial artery and passed below the teres major muscle to appear in the quadrangular space (Figure 6). We did not find data to compare our findings in earlier literature.

Variations in branching pattern of axillary artery are due to defects in embryonic development of the vascular plexus of upper limb bud. This may be due to an arrest at any stage of development of vessels followed by regression, retention or reappearance, thus leading to variations in the arterial origin and course of major upper limb vessels. Such anomalous branching pattern may represent persisting branches of the capillary plexus of the developing limb buds and their unusual course may be a cause for concern to the vascular radiologists and surgeons, and may lead to complications in surgeries involving the axilla and pectoral regions<sup>17-19</sup>.

Knowledge of branching pattern of axillary artery is necessary during antegrade cerebral perfusion in aortic surgery<sup>19</sup>, while treating the axillary artery thrombosis<sup>20</sup>, using the medial arm skin flap<sup>21</sup>, reconstructing the axillary artery after trauma, treating axillary artery hematoma and brachial plexus palsy, considering the branches of the axillary artery for the use of microvascular graft to replace the damaged arteries, creating the axillary-coronary bypass shunt in high risk patients, catheterizing or cannulating the axillary artery for several procedures, during surgical intervention of fractured upper end of humerus, and shoulder dislocations. Therefore, both the normal and abnormal anatomies of the axillary artery should be well known for accurate diagnostic interpretation and surgical intervention.

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 Final approval of the article\*: RA, UD  
 Statistical analysis: RA, UD  
 Overall responsibility: RA

\*All authors have read and approved the final version submitted to J Vasc Bras.