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Original Research Article

A study of anatomic variations of the arterial system of the upper limbs in Nepalese cadavers

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Abstract

The arteries supplying the upper limb exhibit lots of variations. The present study was conducted on 102 upper limbs of 51 Nepalese cadavers (30 males and 21 females). The objective was to find out the variations, if any, in the branching pattern of arteries of the upper limbs in the Nepalese population. The study showed that the superior thoracic artery was absent in 63.7% of all cases. Superior thoracic artery arose from the thoracoacromial artery in 3.9% cases. At the palmar level the superficial palmar arch was formed by the ulnar artery alone in 31.3% cases. Along with these arterial variations of the upper limbs their clinical implications are discussed herewith.

Keywords: Upper limb; Arterial variation; Axillary; Arm; Forearm; Palmar level

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1. Introduction

Variations in the origin, branching and course of the principal arteries of the upper extremities have long received the attention of anatomists, surgeons, cardiologists and particularly vascular specialists. The arterial pattern of the human upper limbs shown in textbooks is rarely encountered, with major and minor variations being well documented. Often the arterial system of upper limbs found in cadavers is very confusing to students because of the great variations from the descriptions and illustrations in text books and atlases. Findings from a series of dissections have been recorded but without uniformity of results.

Normality in anatomy consists of a range of morphologies that are mostly typical and others less frequent, which are called variations and not considered abnormal.[1] In the normal arterial system of the upper limb, the sub-clavian artery continues as the axillary artery from the outer surface of the first rib. The axillary artery gives off the sufperior thoracic artery during the first part of its course, thoracoacromial and lateral thoracic from the second part and the subscapular, anterior and posterior circumflex humeral from the third part of its course. Then it

becomes the brachial artery when it crosses the lower border of the teres major muscle. Brachial artery gives off the profunda brachii, radial and ulnar collateral arteries in the upper arm. The brachial artery ends in the cubital fossa dividing into radial and ulnar arteries. The radial artery gives off the radial recurrent artery and ulnar artery gives off the common interosseous and the ulnar recurrent arteries in the cubital fossa. The ulnar artery forms the superficial palmar arch of the hand along with the superficial palmar branch of the radial artery; whereas the radial artery forms the deep palmar arch with the deep branch of the ulnar artery.[2]

Many authors have published multiple reports about arterial anomalies of the upper extremities. This article is based on studies of anatomic variations of the arterial system of 102 upper limbs in Nepalese cadavers.

2. Materials and methods

One hundred and two dissected upper limbs belonging to 51 Nepalese cadavers (30 males; 21 females) were studied in the Anatomy Department of Manipal College of Medical Sciences and B. P. Koirala Institute of Health Sciences during May 2008-March 2012. Observations were made and detailed findings of the arterial systems, either normal pattern or variations, were noted down. The observations were made at four levels: axillary level, arm level, forearm level and palmar level.

3. Results

The types of variations and their frequency in percentage following the observation of 102 upper limbs are depicted in Table 1 and 1a. The study showed that the superior thoracic artery was absent in 63.7% of all cases. Superior thoracic artery arose from the thoracoacromial artery in 3.9% cases. The common trunk arising from the second part of the axillary artery and giving of the lateral thoracic artery, subscapular artery and posterior circumflex humeral artery in 18.7% cases. The posterior circumflex humeral artery arose from subscapular artery in 1.8% cases. The lateral thoracic artery was found from The thoracoacromial artery in 0.9% cases; subscapular artery from second part of the axillary artery in 0.9% cases; lateral thoracic artery from the subscapular artery in 0.9% cases. At the arm level high division of the brachial artery into the radial and ulnar arteries was found in 4.9% cases. Absence of collateral arteries and profunda brachii continuation as muscular branch was seen in 0.9% cases. At the forearm level communication between the radial and ulnar arteries existed in 0.9% cases. In 12.7% cases the common interroseous artery arouse from the radial artery. The superficial ulnar artery was observed in 1.8% cases. Presence of the median artery was seen in 0.9% cases. At the palmar level the superficial palmar arch was formed by the ulnar artery alone in 31.3% cases. In 0.9% cases the deep palmar arch got no contribution from the ulnar artery.

4. Discussion

Variations in the arterial anatomy of the upper extremities are quite common.[3-6] Muhammad Saeed et al. observed in 3.8% cases a bilateral common subscapular-circumflex humeral trunk emerging from the 3rd part of the axillary artery and branching into the circumflex humeral and thoracodorsal arteries and in 1.9% cases a bilateral thoracohumeral trunk arising from the 2nd part of the axillary artery and branching into the lateral thoracic, circumflex humeral, subscapular and thoracodorsal arteries.[7] Durgun et al. also observed, on the right side, the subscapular artery gave rise to a large posterior circumflex humeral artery in addition to the thoracodorsal and circumflex scapular arteries.[8] In the study by Trottler et al. on 384 arms it was found that the superior thoracic and the thoracoacromial originated from the axillary in all but five arms; in four of these which were right arms (two white males, one African male and one African female), the superior thoracic originated from the thoracoacromial and the lateral thoracic arose from the subscapular in

five white-male axillae (6 percent), in 10 African male axillae (11percent), in two white-female axillae (2 percent), and seven African female axillae (8 percent), lateral thoracic arose from the thoracoacromial in 3 white-male axillae

Types of variations	Male, 60 arms				Female, 42 arms				Total, 102 arms
	On both sides	Right side	Left side	Total	On both sides	Right side	Left side	Total	
A. Axillary level									
Absence of superior thoracic artery	28(46.6%)	3(5%)	4(6.6%)	35(58.2%)	25(59.5%)	2(4.7%)	3(7.2%)	30(71.4%)	65(63.7%)
Superior thoracic arising from thoracoacromial artery	--	1(1.6%)	1(1.6%)	2(3.2%)	--	1(2.3%)	1(2.3%)	2(4.6%)	4(3.9%)
Common trunk giving of lateral thoracic, subscapular and continuation as posterior circumflex humeral artery(Fig. 1)	--	5(8.3%)	4(6.6%)	9(14.9%)	--	6(14.2%)	4(9.2%)	10(23.4%)	19(18.6%)
Posterior circumflex humeral artery from subscapular artery	--	--	1(1.6%)	1(1.6%)	--	1(2.3%)	--	1(2.3%)	2(1.8%)
Lateral thoracic from thoracoacromial artery	--	--	1(1.6%)	1(1.6%)	--	--	--	--	1(0.9%)
Thoracoacromial and lateral thoracic from first part of	--	1(1.6%)	--	1(1.6%)	--	--	--	--	1(0.9%)
Subsapular artery from second part of axillary artery	--	--	--	--	--	1(2.3%)	--	1(2.3%)	1(0.9%)
Lateral thoracic from subscapular artery	--	1(1.6%)	--	1(1.6%)	--	--	--	--	1(0.9%)
B. Arm level									
High division of brachial artery into radial and ulnar arteries (Fig. 2)	2(3.4%)	1(1.6%)	--	3(5%)	1(2.3%)	--	1(2.3%)	2(4.6%)	5(4.9%)
Absence of radial collateral and profunda brachii ending as muscular branch	--	--	--	--	--	1(2.3%)	--	1(2.3%)	1(0.9%)

Table 1: Types of upper limb arterial system variations

Types of variations	Male, 60 arms				Female, 42 arms				Total, 102 arms
	On both sides	Right side	Left side	Total	On both sides	Right side	Left side	Total	
C. Forearm level									
Communication between radial and ulnar arteries	--	--	1(1.6%)	1(1.6%)	--	–	--	–	1(0.9%)
Common interroseous from radial artery	3(5%)	2(3.3%)	4(6.6%)	9(14.9%)	1(2.3%)	2(4.6%)	1(2.3%)	4(9.2%)	13(12.7%)
Presence of superficial ulnar artery	--	--	1(1.6%)	1(1.6%)	1(2.3%)	–	1(2.3%)	1(2.3%)	2(1.8%)
Presence of median artery	--	1(1.6%)	--	1(1.6%)	--	–	--	–	1(0.9%)
D. Palmar level									
Superficial palmar arch by ulnar artery alone	10(16.6%)	4(6.6%)	2(3.3%)	16(26.5%)	8(19%)	3(7.2%)	5(11.9%)	16(38.1%)	32(31.3%)
Deep palmar arch by radial artery alone	--	1(1.6%)	–	1(1.6%)	--	–	--	–	1(0.9%)

Table 1a: Types of upper limb arterial system variations

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Fig. 1: Common trunk from third part of axillary artery giving rise to lateral thoracic, subscapular and continuing as posterior circumflex humeral artery
(AA– Axillary artery; PM– Pectoralis minor muscle; ST– Superior thoracic artery; TA– Thoracoacromial artery; AV– Axillary vein; LT– Lateral thoracic artery; MB(SA)– Muscular branch to serratus anterior muscle; SSA– Subscapular artery; TD– Thoracodorsal artery; TDN– Thoracodorsal nerve; PCH– Posterior circumflex humeral artery; CS– Circumflex scapular artery; LD– Lattisimus dorsi muscle; BA– Brachial artery; MN– Median nerve; BIB– Biceps brachii muscle; ABSJ– Articular branch to shoulder joint)

.Fig. 2: Higher division of brachial artery into radial and ulnar arteries
(UA– Ulnar artery; RA– Radial artery; BA– Brachial artery; MN– Median nerve; UN– Ulnar nerve; BB– Biceps brachii muscle)

and in one African female axilla (1%). When the posterior circumflex came from the subscapular (in 51 axillae), the lateral thoracic arose from the subscapular also in four white- male axillae (8%), in five African male axillae (10 %), and in three African female axillae (6%); and from the thoraco-acromial in three white-male axillae (6%), in three African male axillae (6%), and in one African female axilla (2%).[9] Bergman et al. also found the axillary artery giving rise to a common trunk for the subscapular, anterior, and posterior humeral circumflex, profunda brachii and ulnar arterial collateral arteries.[10] Anson et al. reported origin of superior thoracic artery from the thoracoacromial artery and also observed the origin of the subscapular artery from the second part of the axillary artery.[11] Gardner et al. observed origin of the thoracoacromial artery from either first or second part of the axillary artery.[12] Origin of the lateral thoracic artery from the thoracoacromial or subscapular arteries is also reported in text book of anatomy written by Hollinshead and Rosse.[13] Patnaik et al. in their study of 50 upper limbs of 25 cadavers, reported the absence of the superior thoracic artery in 10% cases.[14] De Garis and Swartley found 23 varieties of axillary artery. They observed greater tendency in the Africans than in Whites towards clumping of the branches, with two or more arising in common, and that there is also a greater variety of patterns in the Africans than in the Whites.[15]

The present study showed that the superior thoracic artery was absent in 63.7% of total cases, superior thoracic artery arose from the thoracoacromial artery in 3.9% cases; with the common trunk arising from the second part of the axillary artery and giving off the lateral thoracic artery, subscapular and posterior circumflex humeral artery in 18.7% of cases. The posterior circumflex humeral artery arose from subscapular artery in 1.8% cases. The lateral thoracic artery was found arising from the thoracoacromial artery in 0.9% cases. The subscapular artery arising from the second part of the axillary artery was seen in 0.9% cases and the lateral thoracic artery from the subscapular artery was found in 0.9% cases. Durgun et al.

also found that the radial and ulnar arteries arose from the brachial artery at the level of the arm and also observed the arciform anastomosis between the radial and ulnar arteries.[8] Jurjus et al. in a case report, found no collateral arteries and the profunda artery terminated as muscular branches.[16] Kumar reported a large median artery arising from the main trunk of the ulnar artery proximal to the origin of the common interosseous artery.[17] Karlsson and Niechajev observed a high origin of the radial artery in 3.47% of patients and in 0.43% of patients the ulnar artery had a high origin from the brachial artery.[18] In the present study, high division of the brachial artery into the radial and ulnar arteries at the arm level was found in 4.9% cases, absence of collateral arteries and continuation of profunda brachii as the muscular branch was seen in 0.9% cases; communication between the radial and ulnar arteries existed in 0.9% cases. Udyavar reported a case of common interosseous artery arising from the radial artey.[19] In the present study we also reported the radial artery giving rise to the common interosseous artery in 12.7% of cases. Fadel et al., Yazar et al. and Yildrim et al. reported the presence of a superficial ulnar artery.[20-22] In the present study it was observed in 1.8% cases. Colman and Anson studied the pattern of arterial arches of the hand and found incomplete superficial palmar arches in 21.5% cases and in 3% cases there were incomplete deep palmar arches. The deep palmar arch has been found to be comparatively less variable than the superficial palmar arch.[23] In the present study superficial palmar arch was formed by the ulnar artery alone in 31.3% of cases and in 0.9% of cases the deep palmar arch was formed by the radial artery only. This study also showed that the superficial palmar arch was more variable than the deep palmar arch in line with Colman and Anson.

A thorough knowledge of the vasculature of the axilla and upper limb is of crucial clinical importance. The upper limb is frequently the site of trauma and other pathologies such as abscess formation in the axilla, space infection of the palmar spaces, and various joint diseases involving the joints of the upper limb which require interventions that demand proper anatomical knowledge, especially of the regional blood vessels and lymphatics as well as their possible variations. Axillary lymph node dissection is an important part of many cancer operations, particularly those involving removal of the breast.[24] Surgeons should make every effort to preserve and protect the axillary artery and vein. Anomalous origin and distribution of the arteries of the upper limbs makes them more vulnerable to trauma during surgery. These variations may cause difficulty for cardiologists in catheterization of arteries, radiologists in making radiological diagnosis, surgeons especially during raising the myocutaneous flap for surgical reconstruction and orthopaedic surgeons while dealing with trauma and disease of the joints and bones of the upper limbs.[25,26] Therefore both the normal and variant anatomy of the region should be well known for accurate diagnosis, better treatment and avoidance of iatrogenic injuries during interventional vascular procedures.

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