Multiple Unilateral Upper Limb Neurovascular Variations

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Abstract

A high bifurcation of the brachial artery, double axillary vein and median nerve muscular branches to the brachialis muscle in the upper limb is a rare combination. The median nerve was interposed between the radial and ulnar arteries given off by the high bifurcation of the brachial artery. The double axillary veins had a venous connection approximately 5cm before the termination of the lateral axillary vein into the medial axillary vein forming a single subclavian vein. The cephalic vein drained into the lateral axillary vein. These unique combination of variations were observed in the left upper limb of an adult black Kenyan male cadaver during routine dissection in the anatomy department, Mount Kenya University. They were then recorded and photographed. Knowledge of neurovascular variations in the upper limb is important due to risk of inadvertent injury to the neurovascular structures during lymph node dissection in breast cancer surgery, and in diagnostic procedures such as arteriography. Therefore, knowledge of this unique combination of anomalies is relevant to anatomists, clinicians and surgeons.

Key words: high bifurcation, double axillary vein, median nerve

Introduction

Vascular variations in the upper limb have been of special interest to orthopedic surgeons, cardiologists, anatomists and various vascular specialists at all levels of competence due to their high incidence (Bergmann et al., 1988; Dartnell et al., 2007; Nakatani et al.,1996; Yang et al.,2008). Variations of the brachial artery have been frequently reported (Atahan, Cetius & Yasmin, 2005; Cavolli et al., 2007; Nakatani, Tanaka & Mizukami, 1997; Yang et al., 2008). Occasionally, the brachial artery gives rise to a superficial brachio-ulnar artery which is defined as an ulnar artery with a high origin in the arm and which courses over the superficial muscles of the flexor compartment of the forearm (Rodriguez-Niedenfuhr et al., 2001; Al-Fayez et al., 2010).

The brachial artery is a continuation of the axillary artery; it extends from the lower border of teres major and bifurcates at the neck of the radius bone at the apex of the cubital fossa (Standring, 2008). At the cubital fossa it is useful for blood pressure measurement. Clinicians place the riva rocci cuff on the patient’s arm and it is inflated using a rubber bulb to pressures above that of the arterial systolic pressure. The radial pulse is then palpated to ensure complete block of blood flow. A stethoscope is then placed on the skin over the cubital fossa for auscultation of the brachial artery for auditory appreciation of

korotkoff sounds during deflation of the cuff. Four korotkoff sounds are attributable to systolic and diastolic blood pressures which are determined by observing the sphygmomanometer’s readings.

A high bifurcation of the brachial artery will result in absence of the korotkoff sounds over the cubital fossa. Therefore, it is vital to perform an arteriogram to determine the pattern of bifurcation of the brachial artery. It was observed to bifurcate at mid-arm level in 1.2% of 162 upper limbs dissected in a cadaveric study at the department of Human Anatomy, University of Nairobi, Kenya (Pulei et al., 2012). Majority of the dissected upper limbs (79%) showed the classical pattern of bifurcation over the neck of the radius bone at the apex of the cubital fossa (Pulei et al., 2012). We report a high bifurcation of the brachial artery at mid-arm level with the median nerve interposed between the radial and ulnar arteries at the department of Human anatomy, Mount Kenya University, Kenya. However, this variation was coupled with a double axillary vein and the median nerve gave muscular branches to brachialis muscle.

The lateral axillary vein was noted to drain into the medial axillary vein forming a single subclavian vein at the level of the outer border of the first rib. The cephalic vein drained into the lateral axillary vein. We report that the brachial plexus showed the conventional anatomy as described in Gray’s anatomy. A study by Kutiyanawala, Stotter and Windle (1998), described a case of a double axillary vein associated with a brachial plexus having only two cords. This article describes a previously unreported combination of upper limb neurovascular variations and attempts to give an embryological basis for the variations observed.

**CASE**

During routine dissection at the department of human anatomy, Mount Kenya University, an embalmed male cadaver was detected to have a double axillary vein, high bifurcation of the brachial artery at mid-arm level with median nerve interposed between radial and ulnar arteries giving muscular branches to the brachialis muscle in the left upper limb. The double axillary veins were noted to be a continuation of the brachial veins. The lateral axillary vein received the cephalic vein as a tributary and it was crossed anteriorly by a muscular branch of the Musculocutaneous nerve supplying the coracobrachialis (Figure 1). It drained into the medial axillary vein by arching over a muscular branch of the brachial artery supplying the pectoralis minor thus fusing into a single subclavian vein (Figure 1). The medial and lateral axillary veins were connected by a venous communication approximately 5cm below the commencement of the subclavian vein (Figure 1-A). The venous communication was crossed anteriorly by the median nerve and a muscular branch of the Musculocutaneous nerve supplying the biceps brachii muscle (Figure 1). The ulnar nerve passed deep to the venous communication (Figure 1). The axillary artery was noted to be interposed between the median nerve and the lateral axillary vein (Figure 2). It passed deep to the venous communication. It continued as the brachial artery between lateral brachial vein and median nerve (Figure 1-B). The median nerve gave muscular branches to the brachialis muscle (Figure 3). It then passed between the ulnar and radial arteries given off by the high bifurcation of the brachial artery (Figure 1-3).
**Figure 1:** C- Cephalic vein, L.A.V- Lateral axillary vein, M- Median nerve. M.A.V- Medial axillary vein. M.C- Musculocutaneous nerve, P.Major- Pectoralis Major, P.Minor- Pectoralis Minor, T- Termination of lateral axillary vein into medial axillary vein, U- Ulnar nerve, V.C- Venous connection between lateral and medial axillary vein.

**Figure 2:** L.B.V- Lateral brachial vein, M- Median nerve (muscular branches to brachialis muscle), M.B.V- Medial brachial vein, B- Brachial artery (high bifurcation)
DISCUSSION

The neurovascular anomalies detected in this cadaver have a hitherto unreported combination. The double axillary veins, high bifurcation of the brachial artery with median nerve interposed between the radial and ulnar arteries giving muscular branches to brachialis muscle in the same upper limb have previously not been reported in literature.

During the fifth week of embryological development the cardinal veins, draining the body of the embryo proper can be distinguished as vascular plexuses of the limb buds. The lateral tributary of the seventh cervical intersegmental vein becomes dilated as the axial vein of the upper limb (Prakash et al., 2006). Digital veins form a capillary plexus which terminates in the axial vein. It first forms the interosseous vein, the brachial, axillary and then the subclavian vein. The persistence of the lateral tributary of more than one cervical intersegmental vein (seventh, eighth, or ninth) may dilate to form a double axis. Another plausible theory is that

Figure 3: High bifurcation of the brachial artery with median nerve interposed between the ulna and radial artery. M.A.V- medial axillary vein, L.A.V- lateral axillary vein.
union of vascular plexuses of the arm buds into two axial veins may progress into two axillary veins (Prakash et al., 2006).

According to Jayasabarinathan et al. the most common variation of the brachial artery is the high division at mid-arm level. High division of brachial artery has been described to have different patterns of termination (Al-Fayez et al., 2010; Cavolli et al., 2007; Jayasabarinathan et al., 2013). According to Yang et al. the high division of brachial artery terminated as a superficial and deep branch. The deep branch continued as an interosseous complex in the forearm. In our study, the radial and ulnar arteries had a superficial course in the forearm.

The axis artery of the upper limb bud is developmentally derived from the lateral branch of the seventh cervical intersegmental artery. The axillary, brachial and anterior interosseous arteries are systematically derived from the axis artery in a proximo-distal fashion (Jayasabarinathan et al., 2013). The terminal branches are radial and ulnar arteries in the forearm, the radial artery is given off more proximally than the ulnar in the arm, anterior to the median nerve. It then reconnects with the main trunk in the forearm at the point of origin of the ulnar artery. The proximal portion of the radial artery normally regresses and thus both ulnar and radial arteries arise in the forearm at the same level. Failure of regression of the proximal part of the radial artery and reconnection with the main trunk results in a high division of the brachial artery (Jayasabarinathan et al., 2013).

According to Pulei et al. the high origin of radial artery is the most common variation of the termination of the brachial artery. The proximal radial artery is often superficial to the median nerve (Pulei et al., 2012). In our study, the median nerve was straddled between the radial and ulnar artery in the arm. The median nerve gave off muscular branches to supply the brachialis muscle. Brachialis muscle is normally innervated by musculocutaneous and radial nerve. The muscular branches from median nerve may be a developmental deviation where median nerve branches may run with musculocutaneous nerve or the median nerve sends branches to the musculocutaneous (Standring, 2008).

Clinical significance

The high bifurcation of the brachial artery results in difficulties in interpreting arteriograms of the arm and detecting korotkoff sounds while measuring blood pressure. The superficial radial and ulnar arteries in the arm are prone to iatrogenic injury during venipuncture. The median nerve between the radial and ulnar arteries is vulnerable to accidental puncture. Double axillary veins may be injured during lymph node dissection in breast cancer operations. Thoracic outlet syndrome interventions, trans-axillary catheterization and flap surgeries may require knowledge of axillary variations. This knowledge will prevent inadvertent injury to the neurovascular structures and provide better therapeutic approach in vascular procedures.

REFERENCES


