A bifurcated axillary artery in its 2nd part and clinical implications

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ABSRACT

The case of an axillary artery bifurcating in its second part yielding the superficial brachial and deep brachial arteries in the limbs of a 75-year-old female cadaver is discussed. Unlike other reported axillary artery bifurcation, the case we are reporting is due to a rare branching pattern of branches of the thoracoacromial artery. The four branches of the latter were shared equally between the superficial and deep brachial arteries. The superficial brachial artery direct origins to the deltoid and acromial branches individually, while a clavipectoral trunk shared a common stem of origin with the deep brachial artery, emanating from anterior surface of the axillary artery at the point of bifurcation. The clavipectoral trunk yielded the clavicular and pectoral branches about 2 cm distal to its exiting from the common trunk. Usage of the thoracoacromial artery perforator (TAAP) flap in its pedicle or in the free microvascular variant is an emerging flap for use as a reconstructive option for the head and neck region, often relying on the constancy of the branching pattern of the artery. In the age of increase frequency in the usage of axillary artery in invasive diagnostic and interventional procedures in cardiovascular disease makes knowledge of these patterns of importance to surgeons, interventional cardiologists in guiding the selection of appropriate surgical interventions and in assisting neuroradiologists in the interpretation of images. A "Deep Brachial Steal syndrome" *via* the clavipectoral trunk and its anastomotic vessels with branches from the subclavian artery is proposed in proximal occlusion occurring at the common origin of the deep brachial and the clavipectoral trunk, our reported deep brachial is smaller than its superficial counterpart, Clinically were the deep brachial inadvertently selected for cannulation, this may present with inadequate inflow or failure even with multiple manipulations of the cannula.

Key Words: *Axillary artery bifurcation; Superficial brachial artery; Deep brachial artery; Thoracoacromial artery branching variations; Inadvertent occlusion or ligation; Possible deep brachial steal syndrome (possible DSS)*

INTRODUCTION

The normal axillary artery (AA) begins from the outer border of the first rib and ends at the inferior border of the teres major muscle, divided into three parts, the 1st part (a superopectoral), 2nd part (retro-pectoral) and the 3rd (infrapectoral) part by the pectoralis minor muscle. The typical AA is defined as having six independently arising branches, a branch from its 1st part, two from its 2nd and 3 from its 3rd part; namely the subscapular artery (SSA) and the two circumflex humeral arteries; the artery continuing distally as the brachial artery at the inferior border of the teres major muscle. Variability in the branching pattern of the AA has been extensively reported in surgical, radiological and cadaveric studies. These include (i), an increase in the total number of branches arising from the AA, the artery being the site of origin of other vessels which normally arise elsewhere. ii). A decrease in the total number of branches emanating from the AA as a result of trunk formation or absence of one or more of its usual branches. iii). Variability as a result of any of the standard six branches arising from different parts away from their usual origins, iv) The AA may serve as origins to the radial artery or other vessels which normally originate in the forearm; the brachioradial and brachioulnar arteries, vessels that are classified as located in both arm and forearm. A bifurcation of the AA occurs when the artery splits into two branches of about equal size, yielding a superficial brachial artery (SBA) and a deep brachial artery (DBA). These bifurcations in the AA may occur in any of its three different parts, with varying prevalence. The SBA descend to supply the usual branches to the forearm, and in its course gives very few offsets to the upper arm, while the DBA (most of the times are axillo-brachial trunks) soon divides into branches which are usually given singly from the AA and brachial trunks;; namely, the SSA, both circumflex humeral, the profundal brachii and superior ulnar collateral.

The number of vessels and the branching patterns in DBA trunks tend to vary. The DBA trunk Astik and Urvi reported carried the anterior and posterior circumflex humeral arteries, the subscapular artery (SSA) and arteria profunda brachii and the superficial ulnar collateral artery [1], while George et al. reported had a common circumflex humeral-SSA trunk and profunda brachii artery [2].

The AA bifurcation we are reporting occurred at the 2nd part of the AA. The incidence of the AA bifurcating in the 1st part ranges from 0.29% to 0. 90%. Coulouma and Bastein reported the finding of 1 case in 104 dissections of the AA bifurcating in its first part, and 0.90% incidence [3]. Huelke reported a 0.60% incidence [4].

CASE REPORT

During routine dissection by medical students at our Institution, an unusual unilateral bifurcation of the AA was observed in the left limb of a 75- year-old female cadaver, originating between the 1st and 2nd parts of the AA. The two arteries produced were about equal size, the SBA slightly larger (3.8 mm) and the DBA measured about 2.8 mm in diameter (Figure 1). The SBA issued between the lateral and medial roots of the median nerve (MN) (Figure 1). The DBA originated from the anterior surface of the AA as the lateral branch, sharing a common origin with the clavipectoral trunk, the latter bifurcated shortly yielding the clavicular and pectoral branches of the TAA (Figure 2), the remaining two branches of the TAA, the deltoid and acromial branches arising directly individually from the SBA (Figure 2). The SBA coursed superficially in the brachium superficial to the MN (Figure 1), without giving any branches in the arm, dividing in the cubital fossa to give the ulnar and radial arteries. Following the clavipectoral trunk branching off the DBA, the DBA took a dive inferiorly coursing posterior to the MN and emerging at the medial border of the nerve where it bifurcated yielding the SSA laterally, the main trunk of the DBA coursing distally and inferiorly parallel to the MN as an axillobrachial trunk. This trunk coursed medial to the ulnar artery (Figure 3). The ulnar nerve impinged on the SSA as it courses posterior to the nerve (Figure 1).

The DBA at about 2 cm distal to giving off the SSA, yielded from its anterior surface, the common trunk to the anterior and posterior circumflex humeral arteries. The DBA distal to it's given off the common trunk continued in the arm terminating as the profundal brachii and superior ulnar collateral artery (Figure 1).

The nerves of the brachial plexus were closely arranged around the DBA instead of embracing the SBA (Figure 1). Proximally, the lateral cord of the brachial plexus was observed sandwiched between the SBA and DBA.

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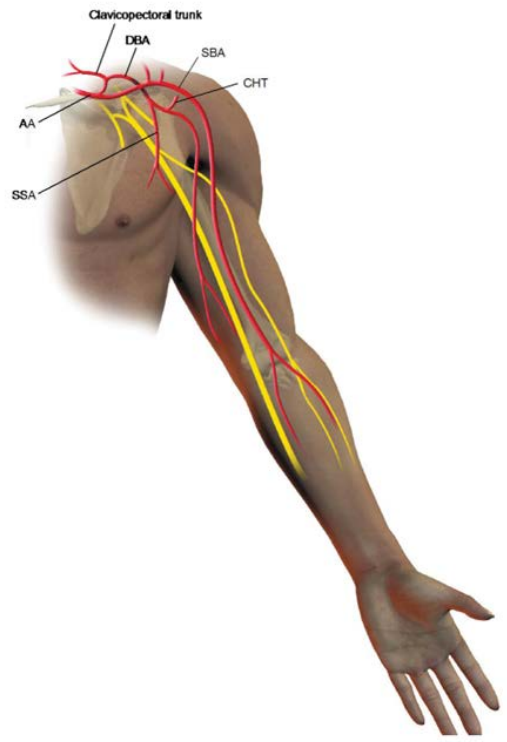

Figure 1) *Illustration of vlavicopectoral trunk, the ulnar nerve impinged on the SSA as it courses posterior to the nerve.*

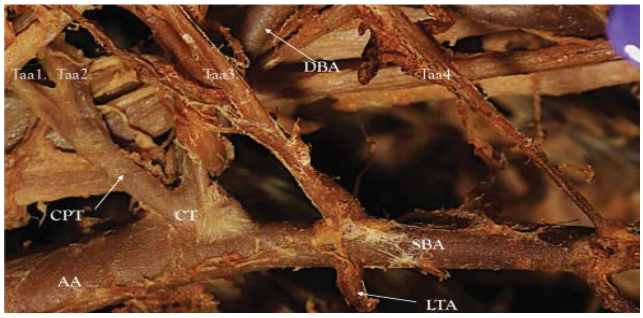

Figure 2) *AA bifurcation-clavicular and pectoral branches of the TAA.*

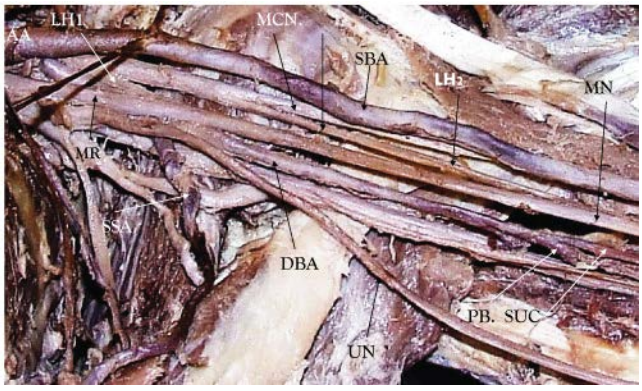

Figure 3) *Proximally, the lateral cord of the brachial plexus was observed sandwiched between the SBA and DBA.*

The lateral cord contributed two roots towards the formation of the MN, a shorter proximal and a much longer and thicker distal root, which joined the medial root in the arm to form the MN (Figure 3), all veins, as well as the flexor muscles of the arm were found normal. The neurovascular branching patterns in the right limb were normal.

DISCUSSION

Variant anatomy of the AA occurs when there is a failure of normal AA development, with such failures resulting in a number of heterogeneous anomalies of the AA and its branches. The findings of Rodriquez-Niedenfuhr et al. suggest that these arterial patterns develop from an initial capillary plexus, by a proximal to distal differentiation, due to maintenance, enlargement and differentiation of certain capillaries and the regression of others [5].

The AA bifurcation we are reporting occurred at the 2nd part of the AA our reported bifurcation is very similar to the one Quain reported, although Quain failed to specify where the bifurcation occurred [6].

Natsis et al. reported an unusual high bifurcation and variable branching of the AA in a Greek male cadave [7]. Some authors have reported racial differences in the branching pattern in AA bifurcation but others reported finding no difference [8]. Cases of high bifurcation into SBA and DBA coursing parallel [9] had been reported as more frequent in African Americans than Caucasians with incidences of 13.4% in African Americans compared to a much lower incidence of 4.6% in Cauccasians [10].

Jujus et al. reported each axilla contained two AA of similar origins but different patterns of branching and fate. In both arteries, proximal to their bifurcation, they both gave off the thoracoacromial arteriy as in the norm. This branching pattern is dissimilar to the one we are reporting as the thoracoacromial branches in our report were split equally between the SBA and DBA. In our variant, the subscapular trunk branched off independently, followed by a common trunk for the circumflex arteries. However, in the case reported by Jujus et al. the subscapular arose with its usual branches, plus a common origin for two additional humeral circumflex arteries [11].

Adachi et al. reported an AA branching in its 3rd part which divided into 2 branches with one of the branches coursing superficial to median nerve from medial to lateral side in the middle one third of the arm and continued in the forearm as radial artery [12]. The other one gave off anterior and posterior circumflex humeral, subscapular and arteria profunda brachii branches coursed deep to the median nerve from lateral to medial side and continued in the forearm as ulnar artery.

The case Paitnak et al. reported we believe is not a true case of a bifurcated AA, as the SBA in typical AA bifurcation yields the radial and ulnar arteries in the forearm [13]. This case, we felt should be classified as a high arising radial artery (the brachioradial) coexisting with a brachio-common interosseous ulnar trunk.

The bifurcated AA we are reporting differs from those previously reported, because of the rarity of the distribution and origins of the different branches of the thoracoacromial artery. The branches were observed shared between the two brachial vessels. The TAA is reported as one of the branches of the AA that tends to be constant. Adachi reported the TAA as an "extraordinarily constant branch and without exceptions originated opposite the upper border of the pectoralis minor" [12]. Several authors have reported variations in the branching patterns of the TAA.

The case Astik and Urvi reported was close to the one being presented except that there was the division of the thoracoacromial into two trunks; deltoacromial and clavipectoral trunks respectively [1]. These were not shared between the brachial vessels, both arising directly from the AA.

Clinically, as a result of the superficial placement of the SBA, this can result in possible inadvertent intra-arterial injection as a result of proximity to venous puncture sites. Cohen reported possible intra-arterial injection of drugs due to proximity of normal vein puncture sites [14] and a predisposition to bleeding from traumatic injury.

Due to its very minimal anatomical anomalous branching pattern, the TAA is a reliable and predictable excellent source of well vascularized soft tissue donor site. A TAA pedicle may be used sometimes as a recipient vessel in head and neck reconstruction. The thoracoacromial artery perforator (TAAP) flap used in its pedicle or in the free microvascular variant is an emerging flap for use as a reconstructive option for the head and neck region

Li et al. reported consistent feasibility of the successful use of the TAAP flap for head and neck reconstructions, resulted in adequate color matching, texture, and pliability in combination with limited anterior chest wall donor site morbidity [15].

Castello also reported the TAA vessels as a valuable option when dealing with extensive defects of the chest wall, especially when local reconstructive options are unavailable [16]. In our reported variant, as a result of the

disruption in the branching pattern of the TAA, such reliability may not be guaranteed. A possible "DBA Steal Syndrome" (DSS) is postulated in instances of an inadvertent ligation or occlusion occurring at the proximal origin to the DBA. A retrograde flow in the clavipectoral trunk from its anastomosis with vessels of subclavian artery origin will help in delivering blood into the many vessels carried by the DBA.

Knowledge of arterial variants of upper limb vessels are important to vascular, orthopedic and Interventional cardiologists in the selection of appropriate surgical procedures and in assisting neuroradiologists in the interpretation of images.

Clinically, an inadvertent usage of our reported DBA in cannulation may lead to an inadequate inflow or a failure due to artery's small size.

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