

# Dangerous course of the brachiocephalic trunk and variations of arteries in the cervical region – a cadaveric case report

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## SUMMARY

The variant anatomy of the branches of the aortic arch is of profound surgical relevance. Altered course of these arteries, if unsuspected, could lead to accidental injury to these vessels and subsequent hemorrhage.

During routine dissection of a sixty-five year old female cadaver of Indian origin, we observed a rare compendium of vascular variations in the anterior cervical region. These included a high arch of aorta, an abnormally wide brachiocephalic trunk overlapping the left half of the cervical trachea, pre-tracheal (sub-isthmic) course of right subclavian and common carotid arteries, unusual origin of the left sided superior thyroid artery from the left common carotid artery and an accessory inferior thyroid artery originating from the aortic arch. The subsequent course of the right subclavian artery, though normal, was higher than would be expected in the supra-clavicular region. The accessory inferior thyroid artery ran dangerously close to the left tracheal border before it entered the lower pole of the left thyroid lobe.

The clinical relevance and probable embryogenesis of such variations have been discussed. We feel it is imperative that the clinician be aware of such arterial deviations.

**Key words:** Aortic arch – Brachiocephalic trunk – Accessory inferior thyroid artery – Superior thyroid artery – Trachea

## INTRODUCTION

The human arterial system of the head, neck and upper thorax develops from six symmetric pairs of pharyngeal arch arteries which develop in conjunction with the branchial pouches. Subsequent involution of some arterial arch components and further development of others is responsible for the final asymmetry and adult configuration of these supra-aortic branches (Rusu and Boşcu, 2010).

Variations of the aortic arch and its branches are associated with chromosome 22q11 deletion (Momma et al., 1999). Most of the reports on such variation have been made interestingly by clinicians who were startled into discovering an unusually placed high pressure vessel, either during surgical approach to the anterior cervical region or, on investigation, as the cause of respiratory distress in a pediatric patient (Prior et al., 1997; Chadha and Chiti-Batelli, 2004; Yalçınbaş et al., 2006; Upadhyaya et al., 2008; Minnerup et al., 2009; Khan and Alzahrani, 2011). The distortion of the normal vascular anatomy

increases the risk of injury to these vessels unless the clinician is aware of such possibilities and exercises great caution especially in per-cutaneous procedures, as these are invasive, semi-blind techniques (Shlugman et al., 2003).

In the present cadaveric case report we describe the atypical course of the brachiocephalic trunk (BCT) and its branches and associated vascular variations. The clinical implications of the same have been discussed and the relevant literature reviewed.

## MATERIALS AND METHODS

A formalin fixed cadaver of a sixty five year old female of Indian origin was routinely dissected at the Department of Human Anatomy, Bharati Vidyapeeth Deemed University Medical College and Hospital, Pune, Maharashtra, India. The medical history or the cause of death was not available.

Anterior cervical dissection revealed an unusual pre-tracheal position of the BCT. Further dissection of the neck and upper mediastinum was done to ascertain the normal course and branching pattern of the vessels of this region. The mediastinum was exposed by cutting through the acromio-clavicular joints and the 1<sup>st</sup> to 9<sup>th</sup> ribs through the costo-chondral junctions and reflecting the sternum downwards onto the anterior abdominal wall. The heart along with its great vessels was observed for any variations.

The maximum diameters of ascending and descending aortae, external diameter of the aortic arch at its summit and of the BCT at its origin were noted using a vernier caliper with an output to the nearest 0.02 mm.

## RESULTS

Routine dissection of an elderly female cadaver revealed a high aortic arch, the summit of which lay level with the jugular notch. The BCT originated from the center of the arch and then ascended vertically upwards, deep to the infra-hyoid strap muscles and over-lapping the left half of the trachea reaching a level midway between the supra-sternal notch and thyroid isthmus (Figs. 1 and 2). It then bifurcated into its terminal branches both of which coursed sharply to the right making an angle of almost 90° with the par-

ent vessel. The initial segments of the right subclavian and common carotid arteries continued to be pre-tracheal, transversely positioned below the thyroid isthmus and closely applied to each other. They deviated at the right edge of the trachea to run their separate paths. Subsequently, the right subclavian artery followed its normal course (albeit higher than is usual, lying 38 mm above the mid-clavicle) and passed deep to the scalenus anterior muscle. The right common carotid artery circumvented the inferior pole of the right thyroid lobe maintaining a distance of 4-6 mm from it and ascended after gaining its normal position (Figs. 1 and 2). The corresponding vessels on the left side (common carotid and subclavian) ran their normal course.

The diameters of the ascending and descending aortae were 31.72 mm and 24.54 mm respectively while that of the arch was 29.1 mm. The BCT measured 19.56 mm.

Co-existing cervical vascular variations in the same cadaver included an unusual origin of the left sided superior thyroid artery and the presence of an accessory inferior thyroid artery. The left superior thyroid artery was a branch of the ipsilateral common carotid artery 6 mm proximal to its bifurcation into its terminal branches. The accessory inferior thyroid artery originated from the aortic arch along with the origin of the left subclavian artery. It then ascended in close relation to left lateral border of the trachea towards the inferior pole of the left lobe of the thyroid gland (Fig. 2).

## DISCUSSION

A pre-tracheal position of a high riding BCT is rare (Yalçınbaş et al., 2006; Upadhyaya et al., 2008; Itevezote et al., 2009; Rusu and Boşcu, 2010). Pre-tracheal course of other high pressure vessels such as the right subclavian artery (Chadha and Chiti-Batelli, 2004) or the right common carotid artery (Conoyer et al., 2008) have also been reported. Such variations are of profound clinical significance.

In a study of 497 cases of per-cutaneous dilatational tracheostomy (PDT), Muhammad et al. (2000) found that although no fatality was reported, the procedure was required to be abandoned in 6 patients. The source of the



Fig. 1. Yellow arrow - arch of aorta; Orange arrow - vertically disposed high riding brachiocephalic trunk; Green arrow - right subclavian artery; Black arrow - right common carotid artery; Red arrow - thyroid isthmus; Purple arrow - left accessory inferior thyroid artery.

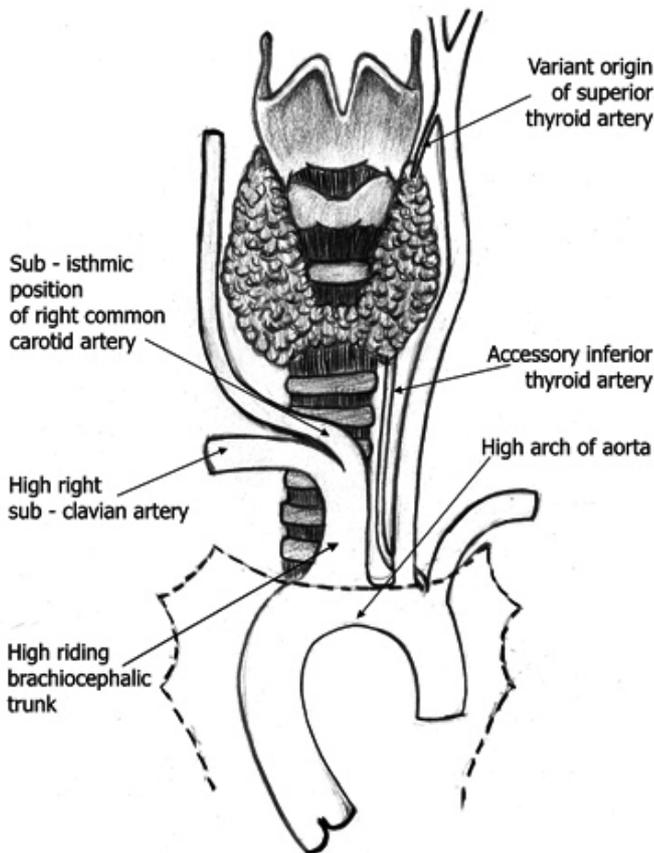


Fig. 2. Diagrammatic representation of the entire spectrum of vascular variations noted in the anterior cervical region of the cadaver.

bleeding in 4 cases was due to unexpected vascular anatomy related to veins. No arterial variants have been mentioned. Fatality due to massive arterial hemorrhage resulting from unusual vascular anatomy have also been reported (Shlugman et al., 2003; Gwilym and Cooney, 2004).

Variations of the course and the different levels of bifurcation of a high riding BCT have been described in literature. While some investigators noted a ‘step like’ morphology of the BCT (Ozlugedik et al., 2005; Upadhyaya et al., 2008; Rusu and Boşcu, 2010), others have described the vessel ascending up to the 2nd tracheal ring (Racic et al., 2005) or to the level of the 4<sup>th</sup> and 5<sup>th</sup> rings (Bertram et al., 1995). Comert et al. (2004) found the BCT arising to the left of the trachea and ascending with a slightly oblique trajectory to reach and bifurcate at the right edge of the trachea level with its 4<sup>th</sup> and 5<sup>th</sup> rings.

Our observations as to the variant course and the external diameter of the BCT are similar with those noted by Iterezote et al. (2009). They found the BCT with an ‘aberrant diameter’ of 19 mm arising in the mid line from the aortic arch, ascending into the neck anterior to the trachea and bifurcating into its terminal branches still pre-tracheal in position. The subsequent course of the right common carotid artery skirting the right lobe of the thyroid gland and closely related to it is also similar to our observation (Fig. 1).

In the present case, the vertically disposed BCT and the sharp transverse pre-tracheal turn taken by its branches would have resulted in a bulky mass of high pressure arteries dangerously positioned in the sub-isthmus portion of the trachea. Coupled with the unusually high course of the right subclavian artery lying 38 mm above the mid-clavicle (Farmery et al. in 2003 reported the mean excursion of the subclavian artery above the clavicle to be 10.4 mm) the lower neck of any patient with similar vascular variations would become a surgically disastrous zone unless approached with great caution.

Digression in the prescribed course of the BCT may not occur in isolation (Rusu and Boşcu, 2010). This corroborates with our findings in the present cadaveric case report of a rare compendium of vascular variations that included a high aortic arch, atypical origin of the left sided superior thyroid artery and an

accessory left inferior thyroid artery arising from the arch of aorta.

The summit of the aortic arch in the present case lay level with the supra-sternal notch. Cervical aortic arch is a congenital anomaly in which the aortic arch is displaced cephalad with respect to its normal position. Since there is great variation in the degree of displacement, no clear-cut line has been established demarcating the normal from the abnormal (Cao et al., 1980). However, cases where the arch reaches the clavicle would be classified as a cervical aortic arch (Mullins et al., 1973). Though only 25 cases have been reported (Shlugman et al., 2003), the frequency of cervical aortic arch in the general population is probably higher than what the reported number suggests (Cao et al., 1980). Several theories are proposed regarding the formation of a cervical aortic arch. A high arch may have been derived from the second or third embryonic pharyngeal arch arteries instead of from the fourth, or there may have been a failure of caudal migration of the fourth pharyngeal arch artery and this might result in the fusion of the third and fourth arches (Jadranka et al., 2012). Though the embryogenesis of the vascular variations noted in the present case is open for interpretation, we feel the development of the arch as a result of fused left sided 3<sup>rd</sup> and 4<sup>th</sup> embryonic pharyngeal arch arteries would explain not only the high arch but also the increased diameter of the vessel. Similarly, the high excursion of the right subclavian artery could be a result of its genesis from a pharyngeal arch artery higher than the conventional right 4<sup>th</sup> one and the high riding BCT would be a result of the consequent upward drag on the ventral aortic sac.

Surgeries of the lower anterior neck involve maximal neck extension which tends to elevate even a normally positioned BCT or the arch itself (Shlugman et al., 2003; Upadhyaya et al., 2008). Thus, for all practical purposes, an arch as high as the one we dissected would, in the extended neck of a living patient, peep into the cervical region and, if inadvertently injured, would cause torrential hemorrhage. Injury to vessels low in the neck can therefore be reduced by not fully extending the neck (Muhammad et al., 2000).

An accessory inferior thyroid artery is rare but must be kept in mind during thyroidectomy (Doll, 2009). Ziolkowski et al. (1994) dissected 276 fetuses without gross abnormali-

ties and found an accessory thyroid artery in 1.08% of cases. In the present case, the origin of this vessel from the junction of the left subclavian artery and the aortic arch, its oblique trajectory deep to the left common carotid artery and its close relationship to the left edge of the trachea before entering the lower pole of the thyroid lobe (Fig. 2), would make this vessel highly vulnerable in anterior cervical and thyroid surgeries.

On the other hand, the origin of the superior thyroid artery from the common carotid artery, as was noted in the present case, is almost common. Anitha et al. (2011) noted this occurrence in 21% of the cadavers dissected by them and similar finding was noted in as many as 47.5% of cases by Lucev et al. (2000). The surgeon must thus be aware of the high frequency of this 'variation' as knowledge of surgical anatomy of this vessel ensures maintaining a bloodless surgical field during radical neck dissection (Anitha et al., 2011).

Scanning the anterior cervical region prior to any surgical intervention has been advocated (Muhammad et al., 2000; Shlugman et al., 2003; Chadha and Chiti-Batelli, 2004; Gwilym and Cooney, 2004). We accept that such an investigation done would decrease the chance of inadvertently causing a catastrophic hemorrhage. However, in places with lack of scanning facilities, a high 'suspicion index' would be crucial. The surgeon must ensure diligent inspection and palpation of the supra sternal region to ascertain whether any pulsatile mass can be detected and, in case of doubt, using a hand held Doppler would be enough to avert a disaster.

We feel an accurate description of these cases is pertinent as the clinician, besides being aware of such possibilities, must be familiar with the frequency of such occurrences. Furthermore, he must be cautious in case a deviant vessel is detected as it may not be a solitary variation. To the best of our knowledge, the spectrum of co-existing cervical vascular variations as noted in the present case has not yet been reported.

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