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Case Report

VARIATIONS OF BRANCHES OF AORTIC ARCH- REPORT OF TWO CASES

***Santosh Kumar Sahu[1], Mousumee Saikia[1], Prabahita Baruah[2] and Pradipta Ray Choudhury[2]**
[1]Department of Anatomy, Jorhat Medical College & Hospital, Jorhat, Assam, India
[2]Department of Anatomy, Silchar Medical College & Hospital, Silchar, Assam, India
**Author for Correspondence*

ABSTRACT
Variations of branches of aortic arch are significant for both diagnostic and surgical procedures. The most common branching pattern of aortic arch is brachiocephalic trunk, left common carotid artery, left subclavian artery. Two heart specimens are reported here with variations of the branching pattern of aortic arches. In one specimen, brachiocephalic trunk continues as right common carotid artery with absence of right subclavian artery. In the other specimen, brachiocephalic trunk and left common carotid artery have common site of origin from the arch of aorta.

Keywords: *Brachiocephalic Artery, Left Common Carotid Artery, Left Subclavian Artery*

INTRODUCTION
The aortic arch is a continuation of the ascending aorta, being located in the superior mediastinum. The most common branching pattern of aortic arch in human's comprises of three great vessels; first the brachiocephalic trunk (BT), then the left common carotid artery (LCCA) and finally the left subclavian artery (LSA) (Patil *et al.,* 2012). This classical branching pattern of arch of aorta was reported to occur in 74.0% - 89.4% cases in radiological investigations (Jakanani and Adair, 2010; Natsis *et al.,* 2009; Boyaci *et al.,* 2015) and 63.5% to 77.3% in cadaveric studies (Budhiraja *et al.,* 2013; Ogeng'o *et al.,* 2010; Patil *et al.,* 2012).
The variations of vessels arising from the aortic arch are numerous (Natsis *et al.,* 2009). The most common variant branch observed is the common trunk of brachiocephalic trunk and left common carotid artery having a prevalence of 7.2% to 21.1% (Lale *et al.,* 2014; Celikyay *et al.,* 2013). The second most common variant branch is the direct aortic arch origin of left vertebral artery with a reported incidence of 2.8% to 5.8% (Lale *et al.,* 2014; Uchino *et al.,* 2013).
A variant of origin and course of a great vessel arising from the aortic arch is of great clinical value, because lack of knowledge of these variations may lead to serious surgical complications during procedures occurring in the superior mediastinum and the root of neck.
Variations in the branching pattern of the arch of aorta are likely to occur as a result of the altered development of certain aortic arch arteries during the embryonic period of gestation (Patil *et al.,* 2012).

CASES
Two heart specimens were found during dissection classes of undergraduate medical students in the Department of Anatomy. There were variations in the branches of the aortic arches of the two specimens. It was verified that there were no cardiothoracic surgical interventions of the cadavers from where the heart specimens were collected.
Specimen 1: in this specimen, there were LCCA and LSA arising from the arch of aorta separately. But the BT, though originated from arch of aorta, continue as right common carotid artery without giving right subclavian artery (Figure 1A).
On removal of the heart, the right subclavian artery (RSA) was found to originate from descending aorta and then crossed the midline to reach the right side (Figure 1B). Thus, there was abnormal origin of RSA.
Specimen 2: BT in this specimen divided into right common carotid and right subclavian artery. LSA originated from arch of aorta separately. But LCCA and BT were originated from same site of arch of aorta. Thus LCCA and BT having common site of origin (Figure 2).

DISCUSSION

The anatomical variations in the branching pattern of aortic arch are significant for diagnostic and surgical procedures in the thorax and neck (Budhiraja *et al.*, 2013).

Natsis *et al.*, (2009) proposed one classification of branching pattern of aortic arch according to the incidences recorded and they classified branching pattern from I to VIII, with type I being the most and type VIII being the least frequent.

Type I: brachiocephalic trunk (BT), left common carotid artery (LCCA), left subclavian artery (LSA).
Type II: BT with LCCA and LSA.
Type III: BT, LCCA, left vertebral artery (LVA), LSA.
Type IV: right subclavian artery (RSA), carotids in common, LSA.
Type V: carotids in common-LSA, RSA.
Type VI: carotids and subclavians in common.
Type VII: RSA, right common carotid artery (RCCA), LCCA, LSA.
Type VIII: BT, thyroidea ima, LCCA, LSA.

Thus, according to above classification, the first specimen was type VII and second specimen was type II of branching pattern of aortic arch (Figure 1A, B and 2).

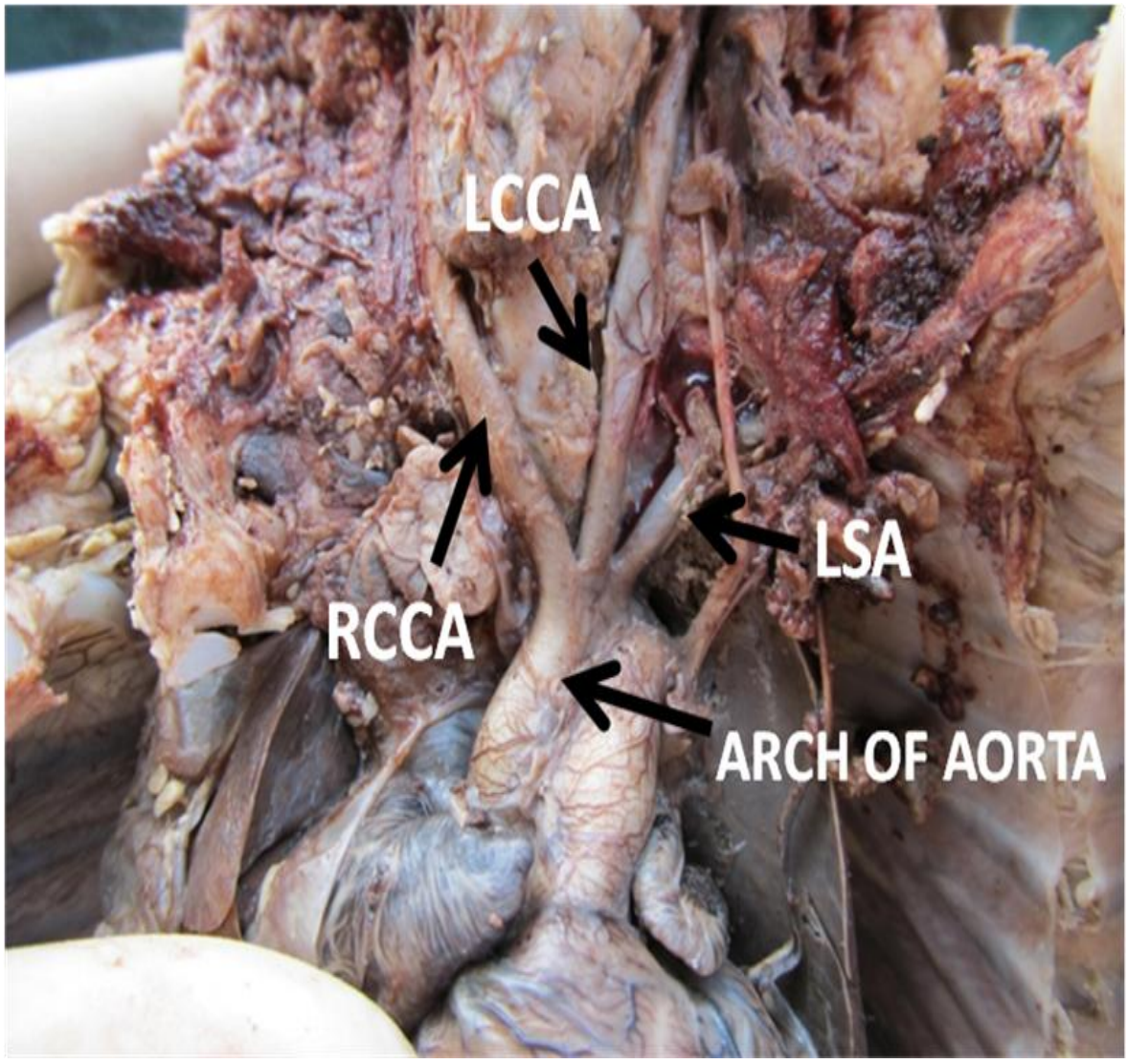

Figure A

Case Report

B

Figure 1: Showing variation in branching pattern of arch of aorta with brachiocephalic trunk (BT) continues as right common carotid artery (RCCA) without giving right subclavian artey (RSA) (A). RSA originates from descending aorta and crosses midline to supply right arm (B)

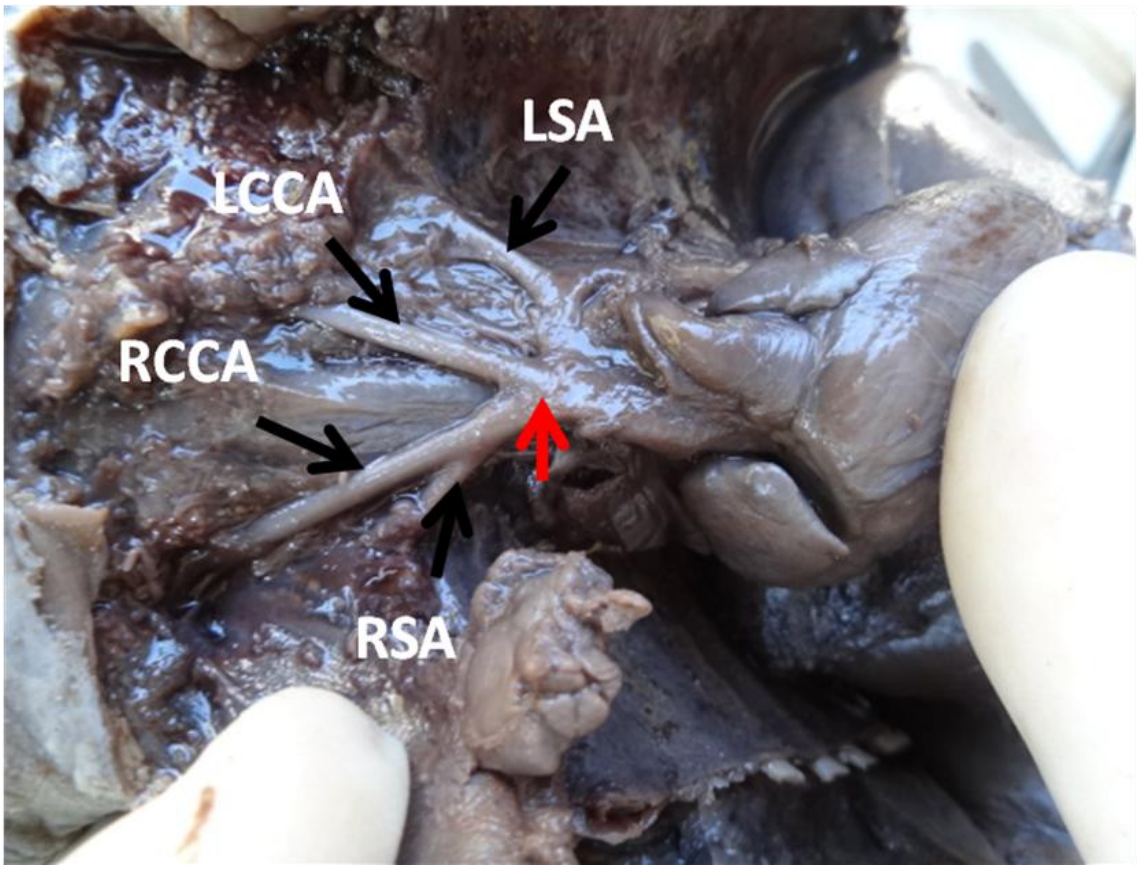

Figure 2: Showing common site of origin of brachiocephalic trunk (BT) and left common carotid artery (LCCA) from arch of aorta (red arrow)

Vucurevic *et al.*, (2013) also proposed classification of branching pattern of aortic arches, according to specific origin, arrangement, and relationship of the mentioned branches. There are also eight types of branching pattern.

Type I: usual branching pattern: the BT, LCCA, and LSA.
Type II: two branches, BT, common origin of LCCA and LSA.
Type III: IIIa- LCCA and BT shared the same site of origin.
IIIb- LCCA originated from a typical BT.
IIIc- LCCA arose from a shorter BT.
The LSA in all the subgroups originated from the aortic arch as the most distal branch.
Type IV: aortic origin of RCCA, LCCA, RSA and LSA.
Type V: aortic origin of RCCA, LCCA, RSA and LSA.
Va- with a double aortic arch, RCCA and RSA arise on right side, and LCCA and LSA on left side.
Vb- with a right-sided arch, LSCA and RSCA as the most distal aortic branches. RCCA and LCCA are proximal branches.
Vc- with a right-sided arch, LCCA and RCCA as the most distal aortic branches. RSA and LSA are proximal branches.
Type VI: BT, LCCA, LVA, LSA.
Type VII: BT, LCCA, LSA, right vertebral artery.
Type VIII: BT, LCCA, LSA, thyroidea ima artery.

According to the above classification, first specimen of heart was type IV and second specimen was type IIIa of branching pattern of aortic arch (Figure 1A, B and 2).

The variations in the branches of arch of aorta are usually associated with abnormalities of the heart and persistent fetal conditions. These variant branches that arise from the aortic arch are due to the changes in the extent of the fusion process and absorption of some of the aortic arch into aortic sac (Nayak *et al.*, 2006). The left limb of the aortic sac normally forms the part of the arch that intervenes between the origin of the brachiocephalic trunk and the left common carotid arteries. If the aortic sac fails to bifurcate into right and left limbs, then the left common carotid artery will connect to the aortic sac directly. That results in common origin of brachiocephalic trunk and left common carotid artery (Nayak *et al.*, 2006). This is, thus, the embryological basis of the second specimen of the present case reports. Abnormal origin of the right subclavian artery occurs when the right fourth aortic arch and the proximal part of the right dorsal aorta are obliterated. With shortening of the aorta between the left common carotid and left subclavian arteries, the origin of the abnormal right subclavian artery finally settles just below that of the left subclavian artery. Because its stem is derived from the right dorsal aorta, it must cross the midline behind the esophagus to reach the right arm (Sadler, 2014). This is the embryological basis of the first specimen of present case reports.

It has been reported that anomalies of the aortic arch branching pattern could lead to cerebral abnormalities by altering the pattern of flow in cerebral vessels (Paraskevas *et al.*, 2008).

Conclusion

Variations of the branches of the aortic arch, are interesting from an anatomical and embryological aspect. They are, however, more important for cardiothoracic surgery.

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