Research Article

A study of variations of subclavian artery and its clinical implication

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ABSTRACT

Background: When the right subclavian artery directly arises from the arch of aorta (AOA) distal to the origin of the left subclavian artery, it is known as an aberrant right subclavian artery (ARSCA). It is a most common anomaly of AOA occurs in approximately 0.5–1.8% cases and usually remains asymptomatic. In case of ARSCA, commonly it has a retroesophageal course to reach the right side of the neck. Variations in origin and course of vertebral artery (VA) found in 7% cases, more on the left side than the right side. **Objectives:** To study the origin, course and branching pattern of the subclavian artery and discuss its embryology and histological changes of the variant artery. **Materials and Methods:** The 67 embalmed cadavers were utilized for dissection for MBBS students at various Medical Colleges in Patna, Bihar in the Department of Anatomy. The course and branching pattern of both side subclavian arteries were observed. Histopathological observations of variant arteries were also noted. **Results:** ARSCA with the retroesophageal course along with the right VA (RVA) was originating from the right common carotid artery was noted in one case. The aberrant VA traverse through the foramen transversaria of 5th cervical vertebrae. Histopathological observation of ARSA and RVA showed atherosclerotic changes. **Conclusion:** The knowledge of such variation is important for carrying out surgical procedure and clinically significant during diagnostic and interventional angiographic procedures.

KEY WORDS: Subclavian Artery; Vertebral Artery; Aberrant; Cadaveric Study

INTRODUCTION

Arch of aorta (AOA) is the continuation of ascending aorta, and usually, it gives three branches, namely, from right to left, brachiocephalic trunk, left common carotid artery (LCCA), and left subclavian artery (LSCA). Brachiocephalic trunk further divided into the right CCA (RCCA) and right subclavian artery. When the right subclavian artery directly arises from AOA distal to the origin of LSCA, it is known as an aberrant right subclavian artery (ARSCA). However, when ARSCA variant is present, the brachiocephalic trunk is absent and four large arteries arise from the arch of the aorta arises: The RCCA, the LCCA, the LSCA, and the ARSCA also known as arteria lusoria.[1] ARSCA is a most common anomaly of AOA occurs in approximately 0.5–1.8% cases[1-5] and usually remains asymptomatic. It ascends upward and toward right behind esophagus in 80% cases[6] in between trachea and esophagus in 15% and anterior to both in 5% cases.[7] In case of retroesophageal course of ARSCA, it may compress esophagus from behind causing dysphagia clinically known as dysphagia lusoria.[1,7] The dilated proximal portion of ARSCA is known as Kommerell's diverticulum and in some patient, this diverticulum may become aneurysmal and can lead to distal arterial embolization.[1,7]

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Vertebral artery (VA) arises from the superolateral aspect of 1st part of the subclavian artery and takes a vertical posterior course to enter the foramina transversaria of 6th cervical

vertebrae. It ascents through foramina transversaria of all six cervical vertebrae and enters into cranial cavity through foramen magnum to supply different part of the brain after the formation of a circle of Willis.[8,9] Variations in origin and course of VA found in 7% cases, more on the left side (5%) than the right side (1–3%), and more unilateral (12.4%) than bilateral (0.8%). The patient usually remains asymptomatic unless the VA is involved by atherosclerotic lesion. Any alteration in VA in its origin, course, diameter, duplication, fenestration, tortuosity, elongation, kinking, aneurysmal formation, and associated heredity connective tissue disorder may alter the hemodynamics of brain which can leads to serious complication.[9] In this case, alteration in diameter and beaded appearance of the right VA (RVA) was seen which indicate that there may be possibility of alteration of hemodynamic of brain persists.

Aims and Objective

To study the origin, course, and branching pattern of the subclavian artery and discuss its embryology and histological changes in any variation.

MATERIALS AND METHODS

The study was conducted on 67 embalmed cadavers over the period of 5 years. The cadaver was utilized for routine dissection of head, neck, and thorax region for MBBS 1st year students in the Department of Anatomy, at various Medical Colleges in Patna, Bihar.

The following parameters were observed:

- The origin, course, relations, and branching pattern of both subclavian arteries.
- All the branches traced till its destination.
- Diameter of variant artery along with its normal one with sliding caliper to compare.
- The point of entrance of both VA in foramina transversaria.
- Intracranial course of both VA.
- Histopathological observation of variant artery.
- Course of recurrent laryngeal nerve.

RESULTS

Out of 67 cadavers, 66 cadavers had normal course and branching pattern of both subclavian arteries. In one cadaver following points were noted:

- Four large arteries were arises from the AOA: The RCCA, the LCCA, the LSCA, and the ARSCA.
- The right subclavian artery was originating directly from the left-sided AOA distal to the origin of LSCA and having retroesophageal course to come on the right side. After that, its course and branches were normal in the right upper limb. Kommerell's diverticulum and aneurysm were not seen on both side vessels (Figure 1).
- The RVA was originating from RCCA and followed by a narrowing. Then, it enters into foramen transversaria of 5th cervical vertebrae. The origin and course of the left VA (LVA) showed no variation (Figure 2).
- The diameter of RVA was less (2.2 mm) compared to LVA (5.6 mm) at its origin.
- The intracranial part of RVA showed marked narrowing and beaded appearance as compared to LVA (Figure 3).
- There was no recurrent course of the right recurrent laryngeal nerve. It was descending from the right vagus nerve to reach larynx. Rest all the branches of both SCA took its normal origin, course, and distribution.
- Histopathological observation of ARSCA and VA showed the presence of collected foamy histiocytic, lymphocytes attached, and involve the tunica interna (Figure 4). The dystrophic calcified material also seen in between

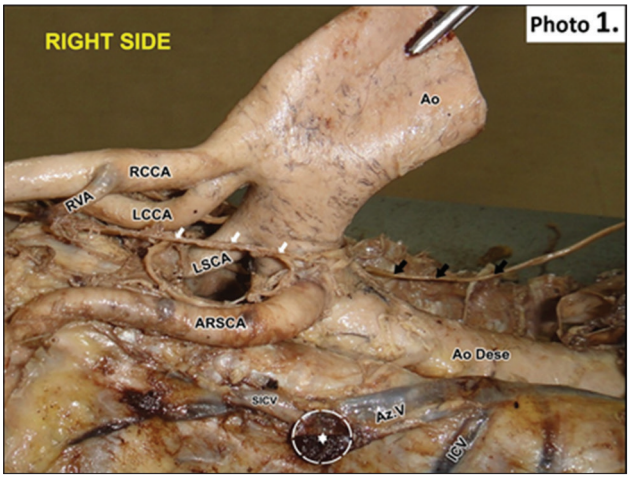

Figure 1: The right side of mediastinum after removal of the heart and uplifting the cut end of the aorta with forceps. Ao Dese - descending aorta, Ao – aorta, ARSCA - aberrant right subclavian artery, LSCA - left subclavian artery, and RVA - right vertebral artery

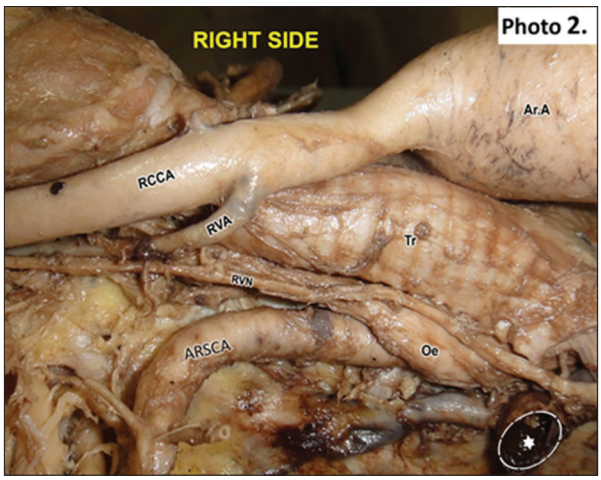

Figure 2: The right side after removal of the anterior chest wall and the strap muscles of the neck region. Ar. A - aorta of aorta, ARSCA - aberrant right subclavian artery, Oe – esophagus, RCCA - right common carotid artery, and RVA - right vertebral

the tunica interna and tunica media. The findings were suggestive of atherosclerotic changes in arteries.

DISCUSSION

Out of the 67 cadavers, in one cadaver we found ARSCA along with aberrant RVA was originating from RCCA. The narrowing of the aberrant RVA with beaded appearance was found in 1st and 4th part of the artery, respectively. The histopathological studies revealed that atherosclerotic changes were the cause of beaded appearance and narrowing of the aberrant RVA.

The patients having ARSCA remains asymptomatic in approximately 80% cases but can produce symptoms in few cases due to elongation of the aorta, formation of an aneurysm, and atherosclerotic changes in the wall of this artery which can compress adjacent structures. Common symptoms which can be present due to AL are dysphagia, dyspnea, wheezing, stridor, recurrent pneumonia, and cyanosis.[1] In this case, due to lack of patient history, it was not known that patient presented any symptom or not. The most common vascular anomalies coexisting with an ARSCA were truncus bicaroticus (19.2%), Kommerell's diverticulum (14.9%), aneurysm (12.8%), and the right-sided aortic arch (9.2%).[1] ARSCA was more common in female than in male and commonly seen in disorders such as Down syndrome, DiGeorge and Edward's syndromes, tetralogy of Fallot, pulmonary atresia, or major aorticopulmonary collateral arteries.[1] Anomaly in branches of the aortic arch is associated with chromosome 22q deletion.[10] Multiple variations in the origin and course of VA have been reported in literature. Other than its normal origin, RVA may arise directly from the AOA from the right common carotid in case of ARSCA (13.7%), external carotid artery, internal carotid artery, and thyrocervical trunk and may have duplicate origins either from the aortic arch and subclavian artery.[1] The duplicated VA is a significant predisposing factor of vertebrobasilar cervical artery dissection due to local histological defect (hypoplasia) or significant hemodynamic alteration. Patient with VA duplication may have symptoms such as vertigo, dizziness, and occipital heaviness due to posterior circular insufficiency.[9] The embryological mechanism of ARSCA with an RVA from the RCCA (VA-CCA) has been explained in several studies. During embryonic period, the first to 6th cervical intersegmental arteries (CIA's) develops into the VA and seventh CIA makes the ARSCA.[11] If the right side longitudinal anastomosis of the CIA's stops between the 6th and 7th CIA, along with obliteration of the right side dorsal aorta, proximal to the 7th CIA, then the ARSCA originating from the left side aorta, distal to the LSCA, and the RVA originating from the RCCA will be formed (Figure 5).[12] Another finding

Figure 3: The intracranial part of RVA showed narrowing as compared to LVA. LVA – left vertebral artery, Py – pyramid, RVA - right vertebral artery, BA - basilar artery, RinCA - right inferior cerebellar artery, and LinCA - left inferior cerebellar artery

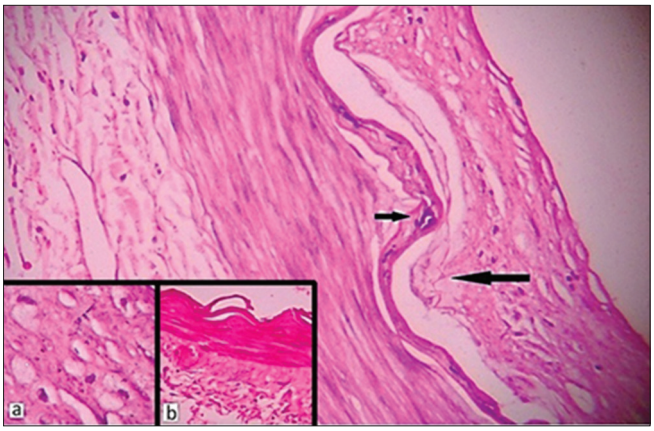

Figure 4: (a and b) Microphotograph of blood vessels shows the presence of collected foamy histiocyte (long arrow), lymphocytes attached, and involve the tunica interna. Dystrophic calcified material (short arrow) seen in between the tunica interna and tunica media (H)

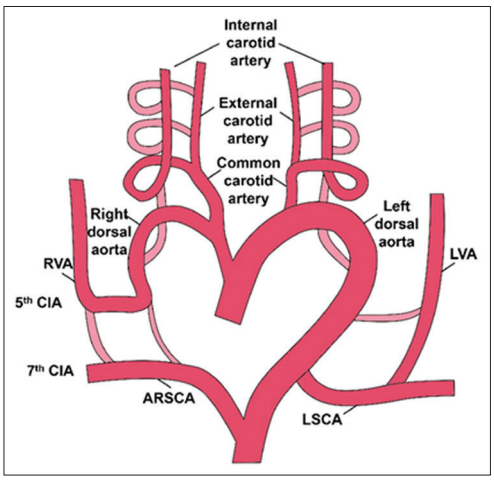

Figure 5: Schematic diagram of the development of aortic arches showing the development of aberrant right subclavian artery with aberrant right vertebral artery. ARSCA - aberrant right subclavian artery, LSCA - left subclavian artery, and RVA - right vertebral artery

in our cases is that right VAs enters the transverse foramen of the C5 vertebra which was also reported by Rieger and Huber (6.6%)[13], Bruneau et al(5.0%)[14] and in Gray's anatomy (5%).[8].

The strength of this study is that such combination of ARSCA and aberrant RVA is rare and this finding was seen in one out of 67 cadavers. A prehand knowledge of such variations may be useful to the clinicians in making correct diagnosis regarding the symptomatic patients, radiologists during interventional procedures/angiography and vascular surgeons while performing surgery in upper thoracic and head and neck region. The narrowing of aberrant RVA was found may be due to atherosclerotic changes. The limitations of the study are that the present study was a cadaveric study where the symptoms could not be well-correlated with the defects. The role of any congenital defect in the narrowing found was not clear. The further studies can be done correlating the defects with the symptoms taking large number of patients.

CONCLUSION

The knowledge of such variation is important for carrying out surgical procedure and clinically significant during diagnostic and interventional angiographic procedures. Hence, it is of great importance to be aware of such possibilities of variations to avoid any serious complications.

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