

Tracheal Compression by Aberrant Brachiocephalic Trunk Accompanying Variant Origin of the Vertebral Artery

Compresión Traqueal por un Tronco Braquiocefálico Aberrante Acompañado de una Variación en el Origen de la Arteria Vertebral

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SUMMARY: The aorta is the main arterial trunk in the human body, however, its variation was extremely variable. During an educational dissection, aberrant branching pattern of aortic arch was found in a Korean cadaver. The brachiocephalic trunk (innominate artery) originated from the aortic arch at the left side of the trachea. It crossed the trachea and divided into the right common carotid and subclavian arteries. The left vertebral artery originated from the aortic arch between the origins of the left common carotid artery and the left subclavian artery, then the left vertebral artery coursed upward to the transverse foramen of the C7. The author describes this previously novel case report with aberrant brachiocephalic trunk and left vertebral arteries and discusses the clinical implications of such a variant.

KEY WORDS: Aberrant brachiocephalic trunk; Aortic arch; Tracheal compression; Variation; Vertebral artery.

INTRODUCTION

The aortic arch, located in the superior mediastinum, gives rise to three classical branches, namely the brachiocephalic trunk (BT), the left common carotid artery (LCCA) and the left subclavian artery (LSA). Because there is no brachiocephalic artery for the left side, LCCA and LSA come directly from the aortic arch. The vertebral artery (VA) arises from the superior surface of the first part of the subclavian artery medial to the scalenus anterior muscle.

Variations in the aortic arch branches have previously been investigated by many authors (Gluncic *et al.*, 1999; Cagli *et al.*, 2005). This frequent variation in aortic arch can occur due to altered development of primitive aortic arch of the embryo during the early gestation period. Increasing activity of cardiovascular intervention requires deeper understanding in the anatomy of the aortic arch (Mahmutyazicioglu *et al.*, 1998; Natsis *et al.*, 2009; Vucurevic *et al.*, 2012). Therefore, many studies about the branch of aortic arch were performed by radiological approaches, however, there was few reports about this variation in Korean cadaver (Shin *et al.*, 2008).

In this article, we report variant origins of BT and

VA and discuss the clinical significance of this variation. And the origin of BT was also analyzed in 30 cadavers to clarify its morphology. This knowledge may help clinicians in performing invasive procedures and surgery.

CASE REPORT

During a routine dissection of the branches of the aortic arch of a 73-year-old female cadaver at the School of Medicine, Keimyung University, unique variation of aortic arch was found. The cadaver was formalin-fixed. The anterior neck and thoracic cavity was opened after removal of the skin, superficial fascia, deep fascia, and muscles. Both lungs were removed, then, the superior vena cava and brachiocephalic veins were confirmed. And the pericardium was opened to expose the aortic arch. Fatty tissue and other tissues were also removed to clarify the branches of the aortic arch and variations in branching pattern observed.

Aortic arch begun at the level of the upper margin of the second sternocostal articulation of the right side, and

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run upward to cross the trachea on the left side of the fourth thoracic vertebral level. And then, it gave off four branches, BT, LCCA, left VA (LVA), and LSA (Fig. 1). BT was originated from 13.1 mm left of the mid-vertebral line, and then, it crossed the trachea and continued 43 mm more. Finally, it divided into RCCA and RSA. LCCA, LVA, and LSA were

originated sequentially next to BT. LCCA and LSA showed normal course. LSA run upward and passed between anterior and middle scalene muscles. LVA continued upward and entered deep to the transverse process at the level of the 7th cervical vertebrae. We cannot find any vascular disease and clue for haemodynamic change in cadaver.

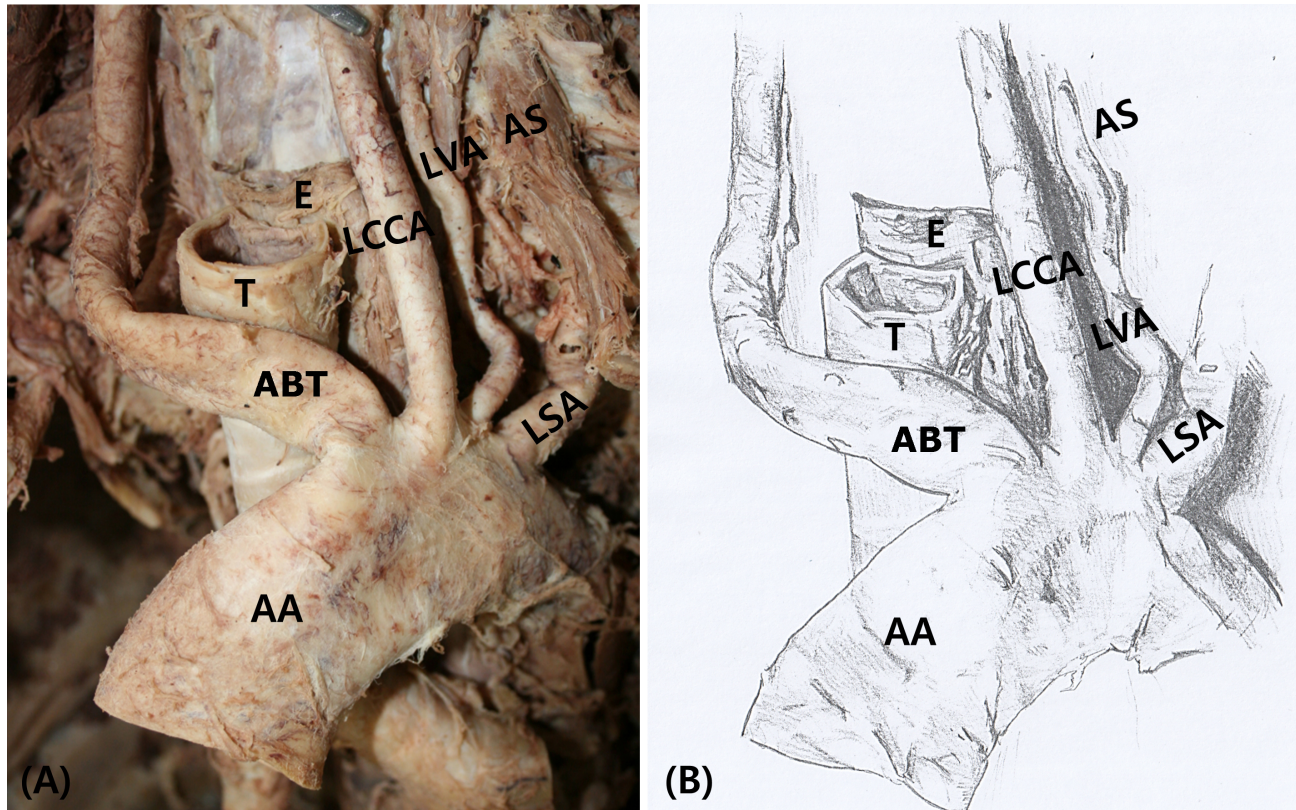


Fig. 1. Photograph (A) and schematic drawing (B) of the variation in the aortic arch. An aberrant brachiocephalic trunk (ABT) originated from the aortic arch (AA) at the left side of the trachea (T). The left vertebral artery (LVA) originated from the aortic arch between the origins of the left common carotid artery (LCCA) and the left subclavian artery (LSA). AS, anterior scalene muscle; E, esophagus.

DISCUSSION

The aortic arch generally gives three branches, as BT, LCCA, and LSA. Variations of BT were frequently reported and its clinical significances were also suggested (Mahmutyazicioglu *et al.*; Gluncic *et al.*; Cagli *et al.*; Natsis *et al.*; Vucurevic *et al.*). Though the official name for BT is the brachiocephalic trunk from Nomina Anatomica 1998, its variation and pathologic condition still continues to refer as aberrant BT (ABT) and BT compression syndrome (BTCS), respectively (Padget, 1948). Present report showed an aortic arch gave off left-shifted ABT and LVA. This normal arrangement of the aortic arch was shown in about 60-70% of cadavers by many authors (Natsis *et al.*; Vucurevic *et al.*). Frequently reported variants were LCCA originating from the BT, right common carotid artery and right

subclavian artery originating individually from the aortic arch. Additionally, the left brachiocephalic trunk (Double brachiocephalic trunk) gave off LCCA and LSA. The left vertebral artery (LVA) may also arise from aortic arch, between the LCCA and LSA. Previous studies demonstrated that the origin of the LVA was extremely various such as from the thyrocervical trunk, BT, the common carotid artery, the external carotid artery, and a common carotid trunk for LSA and LVA (Nonami *et al.*, 1998).

However, left-shifted ABT was rare, moreover, it has a significant and clinical implication by crossing the trachea (Berdon *et al.*, 1969; Strife, *et al.*, 1981). Previous study showed that BT originated from the mid-vertebrae line with a right side deviation of an average of 0.92 mm (right 19.2 mm- left 11.8 mm), almost in the mid-vertebrae area (Shin *et al.*). The origins of LCCA and the LSA were deviated to

the left by an average of 12.3 mm and an average of 22.8 mm, respectively. In present report, the origin of ABT was 13.1 mm left to the mid-vertebral line and similar case report demonstrated a 22 mm left-deviated ABT. Moreover, LVA originated directly from the aortic arch in our case. These combined variations have not been reported anywhere and have clinical and embryological significances.

To contribute to knowledge of BT variation, we measured the origin of BT in 30 Korean cadavers. The BT originates from the mid-vertebral line with a right side deviation of an average of 1.23 ± 5.6 mm. This varied from right 17.5 mm to left 13.1 mm and this deviation was more distal than that in previous study (11.8 mm) (Shin *et al.*). Therefore, our case was extremely deviated ABT case with LVA variation. This anomalous branching pattern of the aortic arch can alter the cerebral haemodynamics, which in turn can lead to cerebral abnormalities (Nonami *et al.*). To avoid iatrogenic injury, clinicians and surgeons should be aware of aortic arch variations.

In the present report, we showed a right deviated BT crossing the trachea with a variation in the VA. The knowledge of development of anomalous LVA is well known, especially, in cases of LVA originating between LCCA and LSA (Gluncic *et al.*). Briefly, this variation may be due to the persistence of the left 6th inter-segmental instead of left 7th inter-segmental artery as the first part of vertebral artery. However, left-deviation of BT has not been reported frequently, therefore, there was no embryological hypothesis for this variation. Further study should be required to clarify the development of these variations.

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RESUMEN: La aorta es el tronco arterial principal del cuerpo humano, sin embargo, su variación es extremadamente variable. Durante una disección de rutina de un cadáver coreano, se encontró un patrón de ramificación aberrante del arco aórtico. El tronco braquiocefálico se originaba del arco aórtico en el lado izquierdo de la tráquea. Cruzaba la tráquea y se dividía en las arterias carótida común y subclavia derecha. La arteria vertebral izquierda se originó a partir del arco aórtico entre los orígenes de la arteria carótida co-

mún izquierda y la arteria subclavia izquierda, luego la arteria vertebral izquierda ascendió hacia el foramen transversal de la séptima vértebra cervical. Se describe un caso de tronco braquiocefálico aberrante y la correspondiente arteria vertebral izquierda y se discuten las implicaciones clínicas de tal variante.

PALABRAS CLAVE: Tronco braquiocefálico aberrante; Arco aórtico; Compresión traqueal; Variación; Arteria vertebral.

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