A Case of the Right Subclavian Artery as the Last Branch of the Aortic Arch

By

AKIMICHI TAKEMURA, MASAKI MATSUMOTO and TADAAKI MORI

Department of Anatomy, Osaka Dental University, Osaka 540

(Director : Prof. Y. Ohta)

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Summary. An anomalous case of the right subclavian artery arising from the aortic arch as the last branch, of which the first branch was the bicarotid trunk and the second the left subclavian artery, was found in a 73 year old female among cadavers for student dissection in 1978. This case belonged to type H of Adachi-Williams-Nakagawa's classification. In addition, the right recurrent laryngeal nerve was not found but there were minor variations in the azygos venous system. Based on a reexamination of many original reports concerning such variations, a table was prepared.

Findings

Cadaver: a Japanese, medium nourished, 73 year old female, cause of death unknown, subject for student dissection in 1978.

In this case, the right subclavian artery arose from the aortic arch as the last branch and passed behind the esophagus. This case belonged to type H of Adachi-Williams-Nakagawa's classification for variations in the branching type of the aortic arch, and also to type II of Holzapfel's classification for anomalies of the right subclavian artery arising as the last branch of the aortic arch. The structures in the vicinity of the artery were as follows.

1) Aortic arch

Three arteries arose from the aortic arch which took a normal course. They

were in contact with one another in the following order (Fig. 4): a) the so-called bicarotid trunk, b) the left subclavian artery, and c) the right subclavian artery.

a) Bicarotid trunk (Figs. 1, 3, 4)

This trunk (ca. 20 and 12 mm in longer and shorter external diameter, respectively) arose from the superolateral wall of the aortic arch on the right side. The section of its origin was oval in shape, including its long axis in the frontal direction. The trunk ran slightly laterally and superiorly and divided into the right and left common carotid arteries about 7 mm superior to its origin.

The right common carotid (ca. 9.5 mm in external diameter at its origin) gave off a small branch (ca. 1.5 mm in external diameter) from its medial wall about 30 mm superior to its origin (Fig. 3). The branch appeared to be the a. thyroidea ima, and ran inferomedially

for about 10 mm. Further observations, however, could not be made since it had been destroyed by the time the case was discovered.

The left common carotid artery (ca. 11.0 mm in external diameter at its origin) showed no variation in course and ramifications.

b) The left subclavian artery (Figs. 1, 3, 4)

This artery (ca. 11.0 mm in external diameter at its origin) arose from the superior wall of the convexity, the highest portion of the arch, in contact with the bicarotid trunk on the left side and ran superolaterally to the left. It

curved laterally in a right angle at about 30 mm superior to its origin, and on the medial side of the anterior scalenus muscle gave off three branches from the same place: the left internal thoracic artery inferolaterally, the left vertebral artery superiorly, and the left thyrocervical trunk superolaterally. It then passed into a space between the scalenus anterior and medius down to beneath the clavicle.

The left vertebral artery ran superomedially to enter the transverse foramen of the 6th cervical vertebra.

c) The right subclavian artery (Figs. 1, 4, 5, 6)

Fig. 1. Schematic drawing of the right subclavian artery and its surrounding structures.

This artery (ca. 12 mm in external diameter at its origin) arose from the posterosuperior wall of the aortic arch in contact with the left subclavian posterolaterally at the level of the 3rd thoracic vertebra. No diverticulum was found near its origin. It ran upward about 10 mm and arched superomedially at the level of the 2nd thoracic vertebra, and passed obliquely behind the esophagus between the 1st and 2nd thoracic vertebrae on their anterior surface at an angle of about 50° against the median line. It made a depression on the posterior wall of the esophagus.

The right vertebral artery left the

superior wall of the right subclavian as the first branch on the right side of the 1st thoracic vertebra, and ran slightly medially and superiorly on the anterolateral side of the 1st thoracic and 7th cervical vertebrae to enter the transverse foramen of the 6th cervical vertebra. The right vertebral artery (ca. 3.5 mm in external diameter at its origin) was considerably thinner than its left counterpart (ca. 6.0 mm).

The right subclavian ran superolaterally to the right and gave off the internal thoracic artery from its inferior wall inferiorly and the thyrocervical trunk from its anterior wall superiorly,

Fig. 2. Schematic drawing of the azygos venous system.
Numbers: Posterior intercostal veins

medial to the anterior scalenus muscle and about 10 mm distal to the origin of the right vertebral. The right subclavian arched inferolaterally posterior to the muscle down to beneath the clavicle.

2) Thoracic duct (Figs. 1, 3, 5)

This duct ascended between the thoracic aorta and the azygos vein, anterior to the vertebral column on the right side, and obliquely behind the esophagus at the level of the 6th thoracic vertebra superomedially. It ran superiorly on the left side of the vertebral column and came behind the aortic arch. It bent superolaterally posterior to the origin of the left subclavian artery and passed anterior to the origin of the left vertebral artery to pour into the left venous angle.

3) Recurrent laryngeal nerve (Figs. 1, 6)

The right recurrent laryngeal nerve was not found. Instead, the inferior laryngeal nerve which left the right vagus nerve about 10 mm superomedial to the origin of the right thyrocervical trunk, was distributed to the larynx directly. Simultaneously, several esophageal branches left the nerve inferiorly.

The left recurrent laryngeal nerve hooked around the aortic arch.

4) Sympathetic nerve trunk

The stellate ganglion and the ansa subclavia on both sides were located in the lateral of the vertebral column and the superomedial of the origin of the vertebral arteries.

5) Azygos venous system (Fig. 2)

a) Azygos vein

This vein ascended on the right side of the thoracic vertebrae, receiving the right 2nd to 12th posterior intercostal veins. It poured into the posterior wall of the superior vena cava at the level

of the 4th thoracic vertebra. The right supreme intercostal vein receiving the right 1st and 2nd intercostal veins, ascended in the anterolateral of the 1st thoracic vertebra and passed behind the right subclavian artery up to medial to the origin of the right vertebral artery to pour into the right vertebral vein.

b) Hemiazygos vein

This vein, thinner than the azygos vein, ascended on the left side of the vertebral column receiving the left 6th to 12th posterior intercostal veins, and poured into the azygos with three branches which ran transversely in front of the 7th, 8th and 9th thoracic vertebrae. The left 6th intercostal vein communicated with the hemiazygos and the accessory hemiazygos veins.

c) Accessory hemiazygos vein

This vein, considerably thinner than the hemiazygos, receiving the left 2nd to 6th intercostal veins descended on the left side of the vertebral column and poured into the azygos vein passing anterior to the 6th thoracic vertebra.

The left supreme intercostal receiving the left 1st and 2nd intercostal veins ascended on the left side of the vertebral column to pour into the inferior wall of the left brachiocephalic vein, and communicated with the accessory hemiazygos via a vein at the level of the 4th intercostal vein.

Discussion

The case of the right subclavian artery as the last branch of the aortic arch, corresponding to type G of Adachi's classification (1928), which is called the pattern E on the classification of De Garis et al. (1933), has not been rare at the present time. Since Suzuki (1894) reported as the first case of type G mentioned above in the Japanese, 84 reports in adults, fetuses and neonates have been

encountered in the anatomical field; 53 adults including two cadavers whose ages are unknown, 31 fetuses and neonates. So, the present case may be ranked as the 85th case of type G in the Japanese as far as the present authors have known. Hanai et al. (1963) reported such a case in a 9 month old fetus and the present report was the second case at the same university.

The present authors have read extensive reports referring to the case of type G in the Japanese, including the type H and type CG of the Adachi-Williams-Nakagawa's classification. Such reports have increased in number since Fujimoto et al. and Nishimura et al. reported successively in 1963. As a result, there were great differences of opinion among the researchers about the interpretation both in the number and in the order of the cases so far reported.

Taniguchi (1934) once prepared a table, and his case was compared with 9 cases he had read. Likewise Nakagawa (1939), Adachi (1941), Omochi et al. (1942), Arakawa et al. (1958), Ueki et al. (1962), Fujimoto et al., Nishimura et al., Tsuji et al. (1965), Morita et al. (1967) and Okumura et al. (1974) have made similar tables one after another. The items in the tables occasionally differed to some extent from the descriptions in the reports. Some of the discrepancies have been partly corrected in later reports, but others have introduced new errors. Accordingly, the present authors attempted to reexamine the contents of the original reports or tables carefully, ranging from the 1st case to our own case, and finally prepared the table attached to this report after correcting items that appeared to be errors.

The present case of the type G of Adachi's classification was the first case in approximately 470 adult cadavers for student's dissection at this university

and showed 0.2 ± 0.2 per cent in frequency. The incidence of this anomalous case in the Japanese was 57 cases in ca. 12153 cadavers (0.47 ± 0.06 per cent). These 57 cases comprised 30 cases in 4050 fetuses and neonates (0.74 ± 0.13 per cent), and 27 cases in ca. 8103 adults (0.33 ± 0.06 per cent). The incidence of the former is about twice as much as the latter and the difference between the two was statistically significant at less than one per cent level.

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Addendum

Since the present paper was submitted for publication the following two reports have been published:

- Yamazaki, M.: A case of the retro-esophageal right subclavian artery as the last branch of the aortic arch (abstract). Acta Anat. Nippon., 54: 263, 1979. (in Japanese)
- Kato, S.: Branches of the aortic arch (abstract). Acta Anat. Nippon., 54: 265, 1979. (in Japanese)

Explanation of Figures

- Fig. 3. Anterior view. The so-called bicarotid trunk arises from the aortic arch. The a. thyreoidea ima (?) leaves the right common carotid artery. ca. $\times 0.8$
- Fig. 4. Plastic cast of the aortic arch and three arteries arising from it. ca. $\times 0.6$
- Fig. 5. Anterior view. The right subclavian artery passes obliquely between the esophagus and the vertebral column. ca. $\times 0.7$
- Fig. 6. The vicinity of the thyrocervical trunk of the right subclavian artery. The right vagus nerve supplies several branches to the larynx directly and several esophageal branches inferiorly. ca. $\times 1.1$

Key to Abbreviations

B: Esophageal branches	aa: Aortic arch
C: Cervical vertebrae	bt: Bicarotid trunk
D: Thoracic duct	im: A. thyreoidea ima (?)
E: Esophagus	it: Internal thoracic artery
G: Thyroid gland	lc: Left common carotid artery
L: Inferior laryngeal nerve	ls: Left subclavian artery
P: Phrenic nerve	lv: Left brachiocephalic vein
R: Recurrent laryngeal nerve	rc: Right common carotid artery
S: Anterior scalenus muscle	rs: Right subclavian artery
T: Trachea	sv: Superior vena cava
V: Vagus nerve	tt: Thyrocervical trunk