The retroesophageal right subclavian artery
– A case report and review –

By

Akira IIMURA, Takeshi OGUCHI, Masahiro TOU, Masato MATSUO

Division of Dental Anatomy, Department of Oral Science, Kanagawa Dental University

– Received for Publication, June 26, 2017 –

Key Words: arterial anomaly, aortic arch, retroesophageal right subclavian artery, thoracic duct

Summary: In a student course of gross anatomy dissection at Kanagawa Dental University in 2011, we encountered an anomalous case of the right subclavian artery arising from the aortic arch as the last branch in an 84-year-old Japanese male cadaver. The anomalous artery ran obliquely upward, passed behind the esophagus and trachea, and ultimately ran toward the right scalene gap. The area of distribution of the anomalous artery was normal. We report a case of retroesophageal right subclavian artery, and discuss its development, or relation with the thoracic duct, and its clinical importance. Despite this type of variation being relatively rare, reports on such a case have been accumulating. Owing to the recent development of CT and MRI, the number of clinical reports on this anomaly has been increasing.

Introduction

Some reports are discussing that the incidence of retroesophageal right subclavian artery varies from 0.2 to 1.6% in Japanese people (Adachi, 19281, 0.2%; Nakagawa, 19392, 1.1%; Fujimoto, 19633, 0.3%; Horiguchi, 19824, 1.6%; Umetani, 19835, 0.2%). There have been many reports discussing a retroesophageal right subclavian artery, although such a case is relatively rare. In recent years the development of CT and MRI has resulted in increasing the number of reports on this anomaly among the clinical reports. Previous reports have discussed the anomaly in connection with embryology and with correlation with recurrent nerve, vertebral arteries, and thoracic duct.

However, there is a limit to the number of the reports which have discussed this anomaly in connection with variation of the thoracic duct. Accordingly, in an attempt to consider this anomaly, we reviewed details of the relevant anatomical and clinical references in the literature. Based on our observations of this anomaly, we discuss the anatomical aspects and clinical importance of this anomaly. The present study was performed on a cadaver donated to our institution for student dissection and research. The present study conforms to the Declaration of Helsinki in 1995.

Findings

A retroesophageal right subclavian artery arising from the aortic arch as its last branch was found in an 84-year-old Japanese male cadaver during dissection practice at Kanagawa Dental University in 2011. The cause of death was pneumonia. Gross dissection was performed according to the standard procedure, and bifurcation of the retroesophageal right subclavian artery was observed (Fig. 1, 2).

The right subclavian artery arose from the posterolateral wall of the aortic arch as its 4th branch. No diverticulum was found in the vicinity of its origin. It coursed superiorly rightward behind the esophagus and trachea, reaching the level of the 1st thoracic vertebra, and ultimately ran toward the right scalene gap (Fig. 3).

Another branch of the aortic arch, the right common carotid artery, arose from the superolateral wall on the right side of the aortic arch. It ascended vertically along the trachea from the left inferior site to the right superior site, and gave off the internal and external carotid arteries. The branch from the external carotid artery formed a short common trunk, a trunk common to the superior thyroid artery and the lingual artery. The left common carotid and left subclavian arteries followed their normal courses. The vertebral arteries arose from the corresponding subclavian
arteries respectively, and entered the transverse foramen of the 6th cervical vertebra. The right and left internal thoracic arteries arose from the inferior wall of the subclavian arteries, respectively (Fig. 6, 7).

**The recurrent nerve**

The left recurrent laryngeal nerve passed in front of the aortic arch, and then wound around the underneath and rear. After branching, the nerve ascended along a groove where the trachea is close to the esophagus. However, the right recurrent nerve was not found. Instead, the right inferior laryngeal nerve was directly distributed in the larynx. This nerve had branched from the vagus at the level of the lower margin of the thyroid cartilage, then it was distributed in the normal distribution area of the inferior laryngeal nerve (Fig. 4, 5).
The retroesophageal right subclavian artery

The retroesophageal right subclavian artery was raised, thereby enabling observation of the right vagus nerve. Normally, the right recurrent nerve becomes recurrent through the inferior margin of the right subclavian artery. In this case, however, the right recurrent nerve did not exist. The right vagus nerve gave off a branch at the level of the right lobe center of the thyroid gland. This branch was distributed in the region in which the right inferior laryngeal nerve has been distributed. The right subclavian artery appeared in the cervical region through the dorsal side of esophagus and then gave off the internal mammary artery and vertebral artery behind the anterior scalene muscle.

Fig. 5. Photograph of the cervico-thoracic transition region.

Fig. 7. Right common carotid artery and its branches.

The right common carotid artery was raised, thereby enabling observation of the right vagus nerve. Normally, the right recurrent nerve becomes recurrent through the inferior margin of the right subclavian artery. In this case, however, the right recurrent nerve did not exist. The right vagus nerve gave off a branch at the level of the right lobe center of the thyroid gland. This branch was distributed in the region in which the right inferior laryngeal nerve has been distributed. The right subclavian artery appeared in the cervical region through the dorsal side of esophagus and then gave off the internal mammary artery and vertebral artery behind the anterior scalene muscle.

Fig. 6. Left vertebral artery.

The left subclavian artery gave off the left vertebral artery, left thyrocervical artery, and left transverse cervical artery. The left vertebral artery ascended to the transverse foramen along the rear of the left common carotid artery. In addition, the left vagus nerve and left internal jugular vein were observed.

Fig. 8. A schema for development of the retroesophageal right subclavian artery.

A: Normally, the caudal portion of the right dorsal aorta disappears. Accordingly, the right subclavian artery is formed by the right 7th intersegmental artery, a part of the right dorsal aorta, and the right 4th aortic arch.

B–D: In this case, the right 4th aortic arch and the cranial part of the right dorsal aorta have disappeared, and then the right 7th intersegmental artery and the caudal part of the right dorsal aorta have remained.

The right 7th intersegmental artery moved cranially with the left 7th intersegmental artery. Ultimately, the retroesophageal right subclavian artery arose from the superior wall of the aortic arch adjacent to the left subclavian artery, and passed behind the trachea and esophagus.
Azygos vein and Thoracic duct

The development of both the hemiazygos vein and accessory hemiazygos vein was poor. The right intercostal vein had directly been drained to the azygos vein. Ultimately, the azygos vein had normally been drained to the superior vena cava.

The thoracic duct had ascended between the esophagus and the thoracic aorta, having passed behind the aortic arch, and then it had run superiorly on the left side of the vertebral column and drained to the left venous angle.

Discussion

The present case of the right subclavian artery arising as the last branch of the aortic arch consistent with Type G of Adachi’s classification (1928)11. Since Suzuki (1984)6 reported a case as the first Japanese case of Type G, there have been more than 100 reports on the same type of variation as Type G. The number of clinical reports on this anomaly has been increasing owing to the development of the medical imaging system.

In the normal embryologic development, the right and left subclavian arteries originate from the 7th intersegmental arteries. The distal segment of the right dorsal aorta degenerates, and the right 7th intersegmental artery becomes confluent with the right 3rd and 4th arches, thereby forming the brachiocephalic artery. In the anomaly of the right subclavian artery, the abnormal development resulted from degeneration of the entire right 4th arterial arch. The right 7th intersegmental artery was persistently attached to the descending aorta distal from the bifurcation of the left subclavian artery (Fig. 8).

In this case, the origin of the right subclavian artery was close to the origin of the left subclavian artery. This case was similar to the cases reported by Yanai (1981)7 and Takemura (1990)8. In the cases reported by Takemura (1990)8 and Raman (1993)10, however, the origin of the right subclavian artery was very distant from the origin of the left subclavian artery. The difference in positions of the origins will account for the difference in factors of the movement of the right 7th intersegmental artery.

The highest and lowest incidences of this anomaly have been reported to be 0.9% (Nakagawa, 1939)2 and 0.15% (Yoshitomi, 1977)11, respectively. A recent report has shown that the incidence of this anomaly is from 0.2% to 2.5%, the average being 1%. Furthermore, the incidence of this anomaly has generally been considered to be high in Negrose.

Recurrent laryngeal nerve and Vertebral artery

The right recurrent laryngeal nerve was not found. One possible reason is considered to be that the 6th and 4th brachial arch arteries disappeared. In this case, the right and left vertebral arteries arose from their respective subclavian arteries. In Type CG, the left vertebral artery arose directly from the aortic arch. There have been some reports discussing various types of retroesophageal subclavian artery, which have anomaly of the vertebral artery.

Thoracic duct

Some reports have shown the thoracic duct in the case of retroesophageal subclavian artery (Fujimoto, 1963)3; Okumura, 197412; Takemura, 19798; Emura, 198814; Takemura, 19909; Rahman, 199310; Kawashima, 200115; Kawai, 201116; Okamoto, 201317).

These reports have indicated the following three types of distribution of the thoracic duct:

Type 1, the thoracic duct running a normal course, and being connected with the left venous angle (Adachi Type VI);
Type 2, the thoracic duct running alongside of the retroesophageal right subclavian artery and terminating at the right venous angle (Adachi Type V);
Type 3, the thoracic duct giving off two branches which terminated at the right and left venous angles, respectively (Adachi Type IV).

Takemura (1979)8, Kitamura (1980)13, Emura (1988)14, Takemura (1990)9, Rahman (1993)10, and Kawashima (2001)15 have reported 1 case of Type 1 respectively. Fujimoto (1963)3, Okumura (1974)12, and Okamoto (2013)7 have reported 1 case of Type 2 respectively. Kawai (2011)16 has reported 2 Type 1 cases, 2 Type 3 cases, and 1 Type 2 case.

As for the normal arterial system case, Kutsuna (1968)18 has described that the incidences of Type 1 and Type 3 are 85.6% and 2.9%, respectively, while Type 2 was not found. Miyatani (1979)19 has reported that the incidences of Type 1 and Type 3 are 80.0% and 10.0%, respectively. This result showed a tendency similar to Adachi’s classification. Since the number of cases was only a few, it was difficult to discuss the incidence of the different types of thoracic duct.

In the case of retroesophageal right subclavian artery, it has been reported that the incidence of Type 3, which exhibits connection of the thoracic ducts with the right and left venous angles, showed a tendency to be higher than that in the normal arterial system.

Formation of the thoracic ducts has embryologically been described as follows. Moor (1988)20 has described that the lymphatic system begins to develop at the end of the 5th week of the development. The development is
2 weeks later than that of the cardiovascular system. In the initial stage, there were thoracic ducts on both sides of the thoracic aorta. In the 9th week the right and left thoracic ducts were connected with the right and left venous angles, respectively. In the cranial part of the thoracic duct, the right and left thoracic ducts had been anastomosed. At the end of the development, the caudal side of the left thoracic duct, and the cranial side of the right thoracic duct disappeared. Ultimately, the adult type of thoracic duct was formed.

From the above-described observations, it is considered that the thoracic duct connected with right venous angle remained in Type 3. In the case of the retrooesophageal right subclavian artery, the ratio of the thoracic duct connected with the right venous angle remaining was higher than that in the normal arterial system. Accordingly, it is considered that formation of the retrooesophageal right subclavian artery with remaining of the right thoracic duct is correlated.

Clinical importance

It has been indicted that this anomaly includes some clinical problems. The origin of anomalous artery from the aorta tends to accompany arteriosus diverticulum. The diverticulum has been described by B. Kommerell (1936)\textsuperscript{21} and called Kommerell’s diverticulum.

Kieffer (1994)\textsuperscript{22} has reported that 17 of 33 cases of aberrant subclavian artery had accompanied Kommerell’s diverticulum. According to Kawashima’s (2001)\textsuperscript{15} report, the diverticulum was indistinct in his cases, while Mieno (2011)\textsuperscript{23} has reported 3 cases of Kommerell’s diverticulum associated with anomalous subclavian artery. Myers (2000)\textsuperscript{24} has described that the retrooesophageal subclavian artery is apt to form an aneurysm. According to Cina’s (2004)\textsuperscript{25} report, it is recommended that surgical treatment be applied to 3 cm or more diameter Kommerell’s diverticulum.

H. Rahman (1993)\textsuperscript{10} has indicated that esophageal compression by the anomalous artery causes dysphagia and dyspnea. Roofthooft (2008)\textsuperscript{26} has also indicated the presence of dysphagia and dyspnea in 20% of the patients with this anomaly.

In recent times, three-dimensional morphology of blood vessels has been come available owing to CT or MRI. Consequently, in the case of retrooesophageal subclavian artery, it is necessary to confirm the presence of diverticulum and dysphagia and the severity level. Furthermore care must be taken against surgical injury to the right recurrent nerve in thyroidectomy and tracheotomy.

**Reference**

1. Adachi B: Das Arteriensystem der Japaner. Bd. 1, Maruzen co., Kyoto. 1928; 29–41.
2. Nakagawa M: Über die Type der Verzweigung des Aortenbogens. J Juzen Med Soc 1939; 44:243–259 (in Japanese).
3. Fujimoto T, Kato N: A case of the right subclavian artery passing behind the esophagus. Acta Anat Nippon 1963; 38:311–320 (in Japanese).
4. Horiguchi M, Yamada T, Uchiyama Y: A case of retrooesophageal right subclavian artery with special reference to the morphology of cardiac nerves. Acta Anat Nippon 1982; 57:1–8 (in Japanese).
5. Umetani T, Ishimoto Y, Yamadori T: A case of the right subclavian artery as the last branch of the aortic arch. Acta Anat Nippon 1983; 58:626–629.
6. Suzuki B: Ein Fall von Missbildung der Arteria subclavia ex trae. Tokyo J Med 1894; 8:1031–1035 (in Japanese).
7. Ykanai K, Abe T, Oh M: A case of the right subclavian artery as the last branch of the aortic arch in a Japanese female cadaver. Acta Anat Nippon 1981; 56:28–33 (in Japanese).
8. Takemura A, Matsumoto M, Mori T: A case of the right subclavian artery as the last branch of the aortic arch. Okajimas Folia Anat Jpn 1979; 56:317–328.
9. Takemura A, Okuda H, Oda K, Yi Ru Fang, Hsien M, Ohta Y: A case of the right subclavian artery as the last branch of the aortic arch in the human fetus and a new classification on these variation. Acta Anat Nippon 1990; 65:374–380 (in Japanese).
10. Rahman H, Sakurai A, Dong K, Setsu T, Umetani T, Yamadori T: The retrooesophageal subclavian artery – A case report and review. Acta Anat Nippon 1993; 68:281–287.
11. Yoshitomi M, Kanamaru E, Ohtome K: An anomalous case on four branches of the aortic arch. J Kurume Med Ass 1977; 40:853–855 (in Japanese).
12. Okumura K, Fujimoto T: A case of anomalous right subclavian artery passing behind the esophagus with a rare variation of the thoracic duct. Acta Anat Nippon 1974; 49:179–183 (in Japanese).
13. Kitamura K, Kuwana T, Fujimoto T: Two arterial variations: Ateria hepatica accessoria dextra and retrooesophageal right subclavian artery. Acta Anat Nippon 1980; 55:1–7 (in Japanese).
14. Emura S, Shoumura S, Ishizaki N, Iwasaki Y, Yamahira T, Ito M: An anomalous case of the right subclavian artery as the last branch of the aortic arch. Acta Anat Nippon 1988; 63:53–57 (in Japanese).
15. Kawashima T, Sato K, Sato F, Sasaki H: Topographical relationships of a retrooesophageal right subclavian artery and it's surrounding structures: With special reference to the autonomic nerve distribution to the heart. Japanese Research Society of clinical anatomy 2001; 2:161–17 (in Japanese).
16. Kawai K, Homma S, Kuma S, Kobayashi K, Koizumi M: A schematic diagram showing the various components of the embryonic aortic arch complex in the retrooesophageal right subclavian artery. Anat Sci Int 2011; 95:135–145.
17. Okamoto K, Wakebe T, Saiki K, Tsumurato T: A case of retrooesophageal right subclavian artery, with special reference to the second intercostal artery, retrooesophageal right vertebral artery, and thoracic duct. Anat Sci Int 2013; 98:234–238.
18. Kutsuna M: Ductus thoracicus. Anatomie des Lymphsystem der Japaner 1968; 219–252 (in Japanese).
19. Miyatani H: The radiologic study of thoracic duct in the human on lymphogram. Journal of the Juzen Medical Society 1979; 88:13–37 (in Japanese).
20. Keith L Moor: The lymphatic system. The developing human (Fourth Edition) 1988; 325–331.
21. Kommerell B: Verlagerung des Ösophagus durch eine abnorm verlaufende Arteria subclavia dextra. Fortschr Geb Rontgenstr 1936; 54:590–595.
22. Kieffer E, Bahnini A, Koskas F: Aberrant subclavian artery: sur-
gical treatment in thirty-three adult patient. J Vasc Surg 1994; 19: 100–109.

23) Mieno S, Ozawa H, Daimon M, Sasaki T, Woo E, Katsumata T: Surgical treatment for Kommerell diverticulum. Jpn J Cardiovasc Surg 2011; 40: 144–149 (in Japanese).

24) Myers JL, Gomes MN: Management of aberrant subclavian artery aneurysms. J Cardiovasc Surg (Torino) 2000; 41: 607–612.

25) Cina CS, Althani H, Pasenau J, Abouzahr L: Kommerell’s diverticulum and right-sided aortic arch: A cohort study and review of the literature. J Vascular Surgery 2004; 131–139.

26) Roofthooft MTR, van Meer H, Rietman WG, Ebels T, Berger RMF: Down syndrome and aberrant right subclavian artery. Eur J Pediatr 2008; 167: 1033–1036.

Abbreviations for figures

AzV: azygos vein
ECA: external carotid artery
ICA: internal carotid artery
IMA: internal mammary artery
LCCA: left common carotid artery
Ling. A: lingual artery
LIJV: left internal jugular vein
LRN: left recurrent nerve
LSA: left subclavian artery
LVA: left vertebral artery
LVN: left vagus nerve
RBCV: right brachiocephalic vein
RCCA: right common carotid artery
RILN: right inferior laryngeal nerve
RSA: right subclavian artery
RVA: right vertebral artery
RVN: right recurrent nerve
SVC: superior vena cava
STA: superior thyroid artery