Anomalous Origin of the Right Vertebral Artery: Incidence and Significance

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OBJECTIVE: **Detailed knowledge about anatomic variations of the aortic arch and its multiple branches is extremely important to endovascular and diagnostic radiologists. It is often hypothesized that anomalous origin and distribution of large aortic vessels may alter the cerebral hemodynamics and potentially lead to a vascular pathology.**

METHODS: **In this article, we describe a case of anomalous origin of the right vertebral artery, which was detected during an intervention. We further reviewed the available literature of anomalous origin of the right vertebral artery. The probable embryologic development and clinical significance are discussed.**

RESULTS: **The incidence of anomalous origin of a vertebral artery seems to be underestimated in recent literature. A careful review of the literature shows more than 100 such cases. The right vertebral artery can arise from the aortic arch or one of its branches. Dual origin of the vertebral artery is not uncommon. The embryologic developmental hypotheses are contradictory and complex.**

CONCLUSIONS: **Anomalous origin of the right vertebral artery may not be the sole reason behind a disease process. However, it can certainly lead to a misdiagnosis during diagnostic vascular studies. Detailed information is essential for any surgery or endovascular intervention in this location.**

INTRODUCTION

The vertebral artery (VA) is classically described as the first branch of the ipsilateral subclavian artery (SCA). In angiographic or anatomic postmortem studies, the anomalous origin of the VA, either right or left or both, is mostly incidental. But the anatomy of the VA and its various anomalies may become relevant during endovascular intervention or neck surgery. Anomalous origin of the right vertebral artery (RVA) is less common than its counterpart. The present report describes a case of anomalous origin of the RVA and discusses the various anomalous origins of RVA described in the literature with their possible embryologic development processes.

METHODS

An exhaustive literature search was conducted using electronic databases (MEDLINE, EMBASE, CAB Abstracts, Current Contents, and Google Scholar) for relevant published articles. The search terms used were "anomalous origin of RVA" and "dual origin of RVA." The resulting citations were exported, and the articles were screened independently by 2 authors (T.M. and H.C.) by reviewing the titles, abstracts and full texts. Bibliographies of identified publications and articles citing them were also examined. Both cadaver and clinical studies were included in the analysis. Data from identifiable papers are summarized in **Table 1**. Illustration of normal variant and anomalous origin of RVA has been depicted in **Figure 1**. The associated anomalies and clinical presentation/significance are shown in **Table 1** where information was available.

Key words
- Anomalous origin
- Clinical significance
- Embryologic development
- Misdiagnosis
- Right vertebral artery

Abbreviations and Acronyms
CCA: Common carotid artery
CIA: Cervical intersegmental artery
LCCA: Left common carotid artery
LVA: Left vertebral artery
LSCA: Left subclavian artery
RCCA: Right common carotid artery
RSCA: Right subclavian artery
RVA: Right vertebral artery
SCA: Subclavian artery
VA: Vertebral artery

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Table 1. Anomalous Origin of the Right Vertebral Artery: A Systematic Review of 115 Cases Including the Present Case

Number	Study	Other Anomaly	Clinical Significance/ Presentation
I. Origin as a single vessel			
A. Originating from the aortic arch			
1. RVA originating from the ascending aorta, just above the left coronary sinus			
1	Akdeniz et al., 2007[1]	Aberrant retro-esophageal RSCA	Acute coronary syndrome; coronary angiography and MRA
2. RVA from aortic arch between the innominate artery and LCCA			
1–4	Poynter, 1916[2]	Proximal to distal: innominate artery, RVA, LCCA, LVA, and LSCA	NA
3. RVA from the aortic arch between the RSCA and RCCA in cases of missing brachiocephalic arteries			
1–3	Poynter, 1916[2]	Proximal to distal: RSCA, RVA, RCCA, LCCA, LVA, and LSCA	NA
4	Lippert and Pabst, 1985[3]	NA	NA
4. RVA from aortic arch between the LCCA and LSCA			
1	Wasserman et al., 1992[4]	None	CTA evaluation of RTA
2	Albayram et al., 2002[5]	LVA fourth branch and RVA fifth branch; distal right anterior cerebral artery aneurysm at the A2-A3 junction	Evaluation of SAH
5. RVA from the aortic arch distal to the origin of the LSCA			
1	Kemmentmüller, 1911[6]	Retro-esophageal course of the RVA	
2	Lie, 1968[7]	NA	NA
3	Obounou-Akong, 1969[4]	NA	NA
4	Newton and Mani, 1974[8]	NA	NA
5	Nakaba, 1976[9]	Retro-esophageal course of the RVA	NA
6	Argenson et al., 1980[10]	NA	NA
7	Sakamoto, 1980[11]	NA	NA
8	Schwarzacher and Krammer, 1989[12]	LVA arising from the aortic arch between the LCCA and LSCA	NA
9	Takagi and Yamashita, 1992[13]	Coronary sinus opening into the left atrium	Cadaver study
10	Stoesslein et al., 1982[14]	Coarctation	NA
11	Lemke et al., 1999[15]	None	None
12	Kodama, 2000[16]	None	None
13	Karcaaltincaba et al., 2003[17]	LVA arises between the origins of the LCCA and LSCA	None
14	Ligege and Scholtz, 2004[18]	None	Evaluation of CVA with CTA
15	Goray et al., 2005[19]	LVA from the aortic arch beyond the origin of the LSCA (fourth branch); RVA was the fifth branch	Evaluation of spondyloepiphyseal dysplasia with CTA
16	Satti et al., 2007[20]	None	MRA evaluation of left cerebellar infarct
17	Al-Okaili and Schwartz, 2007[21]	LVA arising from aortic arch between the LCCA and LSCA	Incidental; evaluation of trauma; identified with MRA
18	Higashi et al., 2008[22]	Retro-esophageal course of the RVA	Cadaver study
19	Hsu et al., 2010[23]	LVA distal to the LSCA (fourth branch); RVA was the fifth branch	Thoracic aortic trauma evaluation with CTA
20	Dabus and Walker, 2010[24]	None	Incidental; MRA
21	Uchino et al., 2013[25]	None	Incidental
22	Lale et al., 2014[26]	None	Incidental
23	Present case, 2015	None	Incidental
B. Origin other than the aortic arch			
1. RVA directly from the brachiocephalic artery			
1	Daseler and Anson, 1959[27]	NA	NA
2	Argenson et al., 1980[10]	NA	NA
3	Lippert and Pabst, 1985[3]	NA	NA
4	Yamaki et al., 2006[28]	None	Cadaver study
2. RVA from the RSCA, distal to the right thyrocervical trunk			
1	Koenigsberg et al., 2003[29]	none	CTA evaluation of CAD

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