eISSN 1308-4038

International Journal of Anatomical Variations (2010) 3: 15–18

Case Report

MDCT angiography of right-sided aortic arch with aberrant left subclavian artery and duplicated left vertebral artery

Published online February 23rd, 2010 © http://www.ijav.org

Berna OGUZ ✦
Adalet Elcin YIGIT
Kader KARLI OGUZ
Mithat HALILOGLU

Department of Radiology, Hacettepe University Faculty of Medicine, Ankara, TURKEY.

✦ Berna Oguz, MD
Hacettepe University
Faculty of Medicine
Department of Radiology
Ankara, 06100, TURKEY.
☎ +90 312 3051188
✉ oguzberna@yahoo.com

Received September 19th, 2009; accepted February 5th, 2010

ABSTRACT

We present an unusual case of duplicated left vertebral artery associated with right-sided aortic arch and aberrant left subclavian artery, demonstrated by MDCT angiography. Left vertebral artery had 2 seperate origins from left common carotid artery and aberrant left subclavian arteries; two branches united at C6 vertebral level. © **IJAV. 2010; 3: 15–18.**

Key words [multidetector CT anjiography] [3D imaging] [aortic arch variations] [duplicated vertebral artery]

Introduction

Congenital variations of the aortic arch and its branches are commonly encountered in radiological practice [1-3]. A right-sided aortic arch (RAA) with an aberrant left subclavian artery (ALSA) is a rare variation that occurs in 0.05% of the population. The most common vertebral artery variation is the left vertebral artery (LVA) arising from the aortic arch with a reported prevelance of 2.4%-5.8% in the literature [1,4,5]. Duplicated vertebral artery (DVA) variations are very rare either depicted incidentally in autopsy series, or angiographic studies including non-invazive MR and CT angiographic studies which have been increasingly utilized in daily practice [4-8]. We present MDCT angiographic findings of a case of RAA and ALSA associated with duplicated left vertebral artery.

Case Report

A 7-year-old boy had symptoms of gastro-esophageal reflux with no dysphagia. The barium swallow revealed a posterior impression to esophagus on the lateral view and right indentation on the frontal view at the level of the aortic arch suggesting RAA with ALSA (Figure 1). Multidetector CT angiography was performed subsequently to provide the definitive diagnosis by using a 16-slice MDCT scanner (Sensation, Siemens Medical Solutions, Erlangen, Germany). The technical parameters were: detector collimation 16x0.75 mm, pitch 1.75, reconstruction interval 0.5 mm, slice thickness 1 mm, gantry rotation time 0.5 sec, 80 mAs and 100 kVp. Non-ionic iodinated contrast material (300 mg/ml) was injected at a rate of 2 mL/sec by a power injector. Contrast dose was calculated by multiplying scanning time by injection rate with volume not to exceed 2 mL/kg. Three-dimensional (3D) volume-rendered (VR) and maximum-intensity-projection images (MIP) were obtained from the axial images using a separate workstation (Leonardo, Siemens Medical Solutions, Erlangen, Germany).

MDCT angiography identified RAA with ALSA arise from a diverticulum of Kommerell located posterior to the esophagus at the level of the fourth thoracic vertebra (Figure 2). No airway compression was identified. MDCT angiography also demonstrated that LVA had 2 seperate origins, from left common carotid artery (LCCA) and ALSA respectively with the latter slightly larger in caliber (Figure 3). Both vessels coursed straight up and united at C6 vertebral level to continue as the LVA, and entered the foramen transversarium at the same level. The right vertebral artey (RVA) was normally originating from the right subclavian artery (RSA) (Figure 3). The “duplicated left vertebral artery” was hypoplasic compared with the RVA. There was no other cardiovascular anomaly.

In our patient there was no symptoms related to above described vascular variations; thus surgery was not planned.

** This case report was presented as a poster presentation at European Society of Pediatric Radiology Congress, May 31-June 4, 2009, Istanbul, TURKEY.*

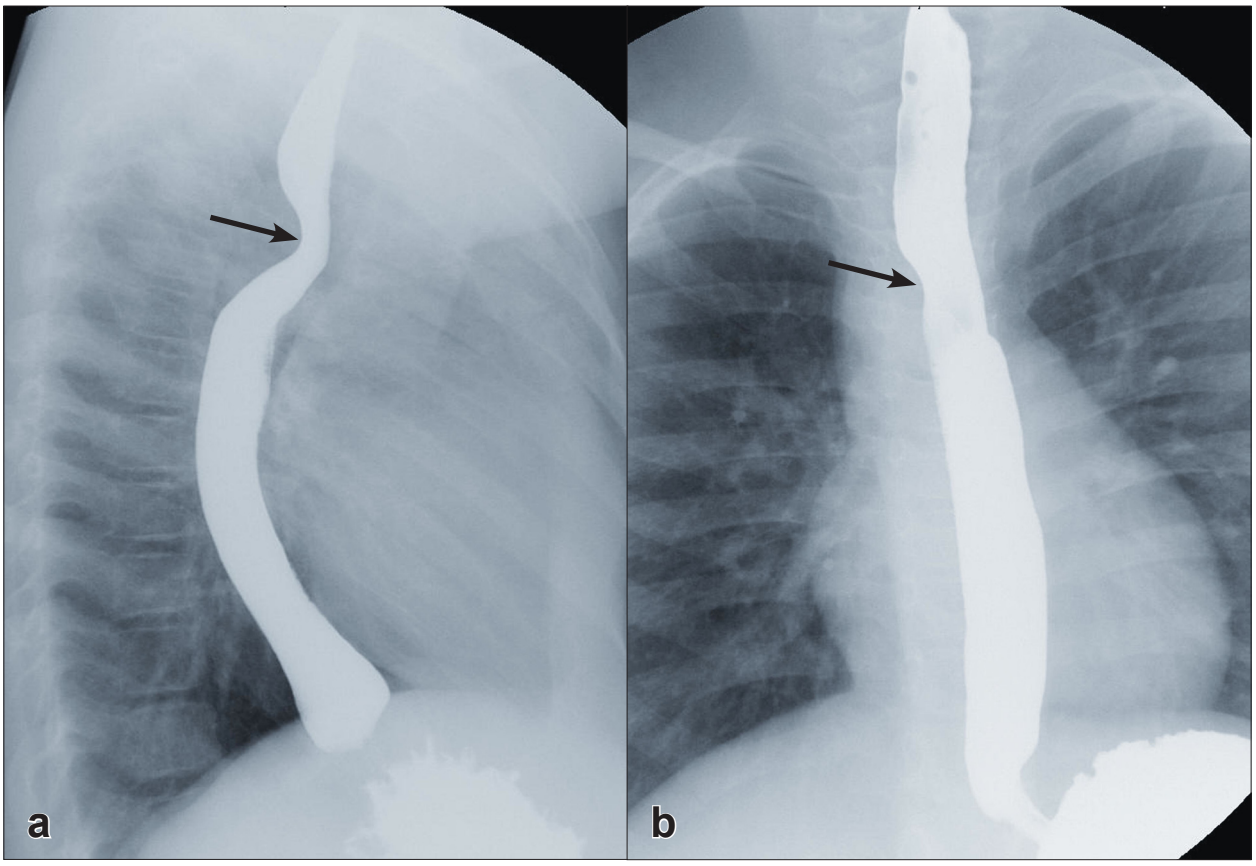

Figure 1. Barium esophagogram shows *posterior impression to esophagus* ***(arrow)*** on the lateral view **(a)** and *right indentation* ***(arrow)*** on the frontal view **(b)** at the level of the aortic arch (T4-5 level).

Discussion

The incidence of RAA in both radiologic and autopsy series is approximately 0.1% [1-3]. There are three major types of RAA: type 1, with mirror-image branching of the major arteries; type 2, with an ALSA as seen in our case that is the most common form; and type 3, with the isolation of left subclavian artery (where the subclavian artery is connected to the pulmonary artey through the ductus arteriosus).

Although the normal vertebral artery originates from the ipsilateral subclavian artery as the first branch, multiple variations in the origin of that vessel have been reported in the literature [1,4-8]. The vertebral artery can arise from the aortic arch, from the common carotid artery (CCA), or from subclavian branches, such as the thyrocervical trunk. Duplicated vertebral artery, a rare variation, refers to the artery with two seperate origins with variable course. In the literature, duplicated vertebral arteries originated from the aortic arch or from unusual levels of subclavian artery were reported [4-8]. Union of the duplicated segments has been noted mostly to be at the level of C4-C6 vertebrae as seen in our case [7,8]. To the best of our knowledge, DVA having separate origins, from CCA and the subclavian artery, and also the combination with RAA and ALSA is unusual as reported here.

In the human embryo, blood leaves the heart via the truncus arteriosus in the early developmental stage. This is divided by the aorticopulmonary septum into the ventral aortas, which later become the aortic sac and the pulmonary trunk. Aortic sac forms the proximal aorta from aortic valve to the origin of the left common carotid artery. Six symmetrical aortic arches connect the paired dorsal aortas with ventral aortas. Normally the 1st, 2nd and 5th pairs of arch arteries regress. The paired 3rd arches form the both common carotid and first part of the internal carotid arteries. The proximal part of the right 4th arch forms the brachiocefalic trunk and the proximal segment of right subclavian artery and distal part of it regresses. A great part of left 4th arch regresses and the remaining part forms a small segment of aortic arch between the origin of the left common carotid artery and left subclavian artery [6]. In the embryonic stage of development, the abnormal regression or persistence of the primitive arches give rise to anomalies of aortic arch and great vessels with their branches. Right-sided aortic arch with ALSA anomaly is caused by regression of embryonic left fourth arch between left common carotid artery and left subclavian artery, with concomitant persistence of the right fourth aortic arch [6,9]. A remnant of the left fourth aortic arch that forms the origin of the ALSA, may be dilated as a aortic diverticulum as in our case, called as Kommerell's diverticulum. In the literature, an atherosclerotic aneurysm and the rupture of Kommerell's diverticulum were reported in adults [9,10].

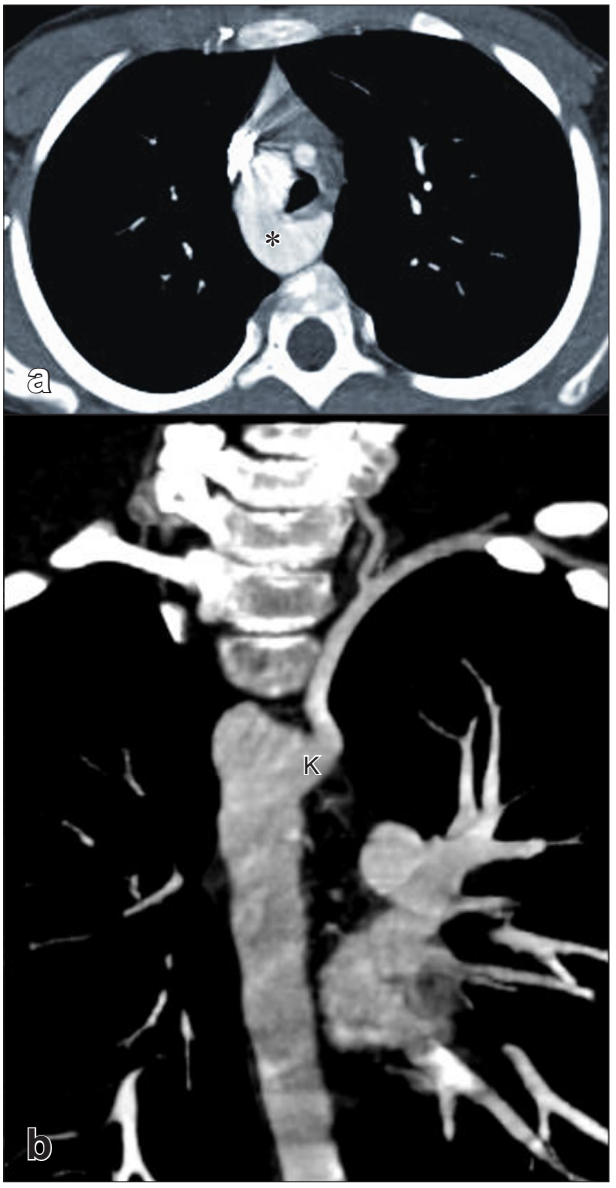

Figure 2. a) Axial CT image shows *right aortic arch* ***(asterisk)***. **b)** Coronal MIP image shows ALSA arising from a *diverticulum of Kommerell* ***(K)***.

Intersegmental branches of each dorsal aorta extend from the cervical to sacral region and vascularize the developing somites. In the cervical region, intersegmental arteries (C2-7) lose their connection with the aorta and anastomose with each other to form the left and right vertebral arteries. The seventh intersegmental arteries form the proximal portion of the subclavian artery, including the point of origin of the vertebral artery. If the cervical intersegmental arteries persist more cranial to the 7th, vertebral artery anomalies develop. The level at which the vertebral artery enters the foramen transversarium is related to specific cervical intersegmental vessel persisted to form the proximal vertebral artery. Duplication of the origin of the left vertebral artery would then be consistent with a persistence of more than one cervical intersegmental artery [3].

A chest X-ray, barium esophagography, bronchoscopy and echocardiography may give indirect clues on presence of RAA with ALSA. However, CT or MR angiography deliniates vascular anatomy leading diagnosis and takes advantages of being non-invasive and capable of demonstrating relationship with the trachea and esophagus using 3D applications and multiplanar reconstructions definitely.

Although mostly asymptomatic, importance of DVA arises from being prone to dissection [8]. On the other hand it can provide a protective mechanism for injury to or stenosis-occlusion of one of the duplicated limbs [7].

During the long life span of the children, vascular anomalies may become important in the planning of interventional and surgical procedures. Knowledge of the aortic arch and vertebral artery variations before the neurointerventional and neurosurgical procedures prevents complications. Radiologists should be familiar with various types of vascular variations since wider application of MDCT angiography, with excellent 3D images, increased the incidence of these variations in daily practice.

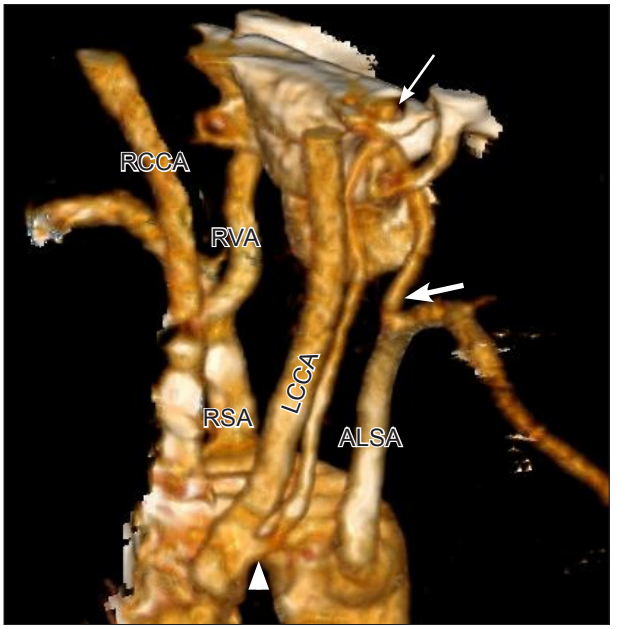

Figure 3. Three-dimensional VR CT angiogram in oblique coronal plane shows four supraaortic branches originating seperately from right-sided aortic arch: ***LCCA:*** *left common carotid artery;* ***RCCA:*** *right common carotid artery;* ***RSA:*** *right subclavian artery;* ***ALSA:*** *aberrant left subclavian artery.* Left vertebral artery had two seperate origins, *one segment originating from the left common carotid artery* ***(arrow head)*** and the *other segment from aberrant left subclavian artery* ***(thick arrow);*** both segments united at C6 vertebral level to continue as the *left vertebral artery* ***(thin arrow)***. *The right vertebral artery* ***(RVA)*** was originating from the right subclavian artery.

References

[1] **Natsis KI, Tsitouridis IA, Didagelos MV, Fillipidis AA, Vlasis KG, Tsikaras PD.** Anatomical variations in the branches of the human aortic arch in 633 angiographies: clinical significance and literature review. **Surg Radiol Anat. 2008; 31: 319–323.**

[2] **Jaffe RB.** Radiographic manifestations of congenital anomalies of the aortic arch. **Radiol Clin North Am. 1991; 29: 319–334.**

[3] **Kleinman PK, Spevak MR, Nimkin K.** Left-sided esophageal indentation in right aortic arch with aberrant left subclavian artery. **Radiology. 1994; 191: 565–567.**

[4] **Ka-Tak W, Lam WWM, Yu SCH.** MDCT of an aberrant right subclavian artery and of bilateral vertebral arteries with anomalous origins. **AJR Am J Roentgenol. 2007; 188: W274–275.**

[5] **Albayram S, Gailloud P, Wasserman BA.** Bilateral arch origin of the vertebral arteries. **AJNR Am J Neuroradiol. 2002; 23: 455–458.**

[6] **Satti SR, Cerniglia CA, Koenigsberg RA.** Cervical vertebral artery variations: an anatomic study. **AJNR Am J Neuroradiol. 2007; 28: 976–980.**

[7] **Ionete C, Omojola MF.** MR angiographic demonstration of bilateral duplication of the extracranial vertebral artery: unusual course and review of the literature. **AJNR Am J Neuroradiol. 2006; 27: 1304–1306.**

[8] **Koenigsberg RA, Pereira L, Nair B, McCormick D, Schwartzman R.** Unusual vertebral artery origins: examples and related patology. **Catheter Cardiovasc Interv. 2003; 59: 244–250.**

[9] **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 Vasc Surg. 2004; 39:131–139.**

[10] **Austin EH, Wolfe WG. Aneurysm of aberrant subclavian artery with a review of the literature. J Vasc Surg. 1985; 2: 571–577.**