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Case Report
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An unusual right vertebral artery variation accompanying to bovine arch: A case report

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ABSTRACT

In a 74-year old male patient, brachiocephalic trunk and left common carotid artery are sharing a common root (bovine arch) and right vertebral artery (VA) variation was detected incidentally during computed tomography angiography for occlusion of common carotid artery. Right VA branches from the aortic arch (aberrant VA) and forwards retroesophageally and retrotracheally during its course and then entered cervical 7th transverse foramen whereas left VA branches from the subclavian artery and entered cervical 6th transverse foramen. The patient has not any symptom such as dyspnea and dysphagia. The most common anatomic variation of aortic arch is the bovine aortic arch. Incidence of the bovine aortic arch varies between 0.9% - 27.4% in the literature. Like in the present case, branching of the right vertebral artery from aortic arch is very rare.

Key words: *Bovine arch, right vertebral artery variation, computed tomography angiography*

Introduction

The aortic arch normally provides three branches called the brachiocephalic trunk, left common carotid artery and left subclavian artery [1]. Anatomic variations of the aortic arch greatly differs depending on the branches, branching off sites and number of the branches [2]. These variations are generally asymptomatic and incidentally diagnosed. However, especially depending on the aberrant subclavian artery, clinical symptoms such as dyspnea and dysphagia may appear as a result of compression of the variations onto trachea and esophagus [3]. Vertebral arteries are generally branch off the subclavian artery; however, abnormalities of origin are common particularly on the left VA [4]. Identification of diversity and frequency of these variations is important for conventional angiography, endovascular procedures, to prevent possible complications during thoracic and cervical surgeries and to determine appropriate treatment procedures [2].

Case Report

In a 74-year old male patient, brachiocephalic trunk and left common carotid artery are sharing a common root (bovine arch) and right VA variation was detected incidentally during computed tomography angiography for occlusion of common carotid artery. Right VA branches from the aortic arch (aberrant VA) whereas

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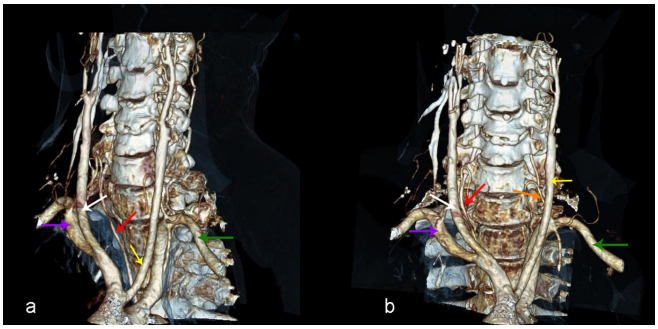

Figure 1. Computed tomography scan image (volume rendered). The right vertebral artery branches from the aortic arch after left subclavian artery. Brachiocephalic trunk and left common carotid artery are sharing a common root (bovine arch) (Red arrow, right vertebral artery; white arrow, right common carotid artery; yellow arrow, left common carotid artery; purple arrow, right subclavian artery; orange arrow, left vertebral artery; green arrow, left subclavian artery).

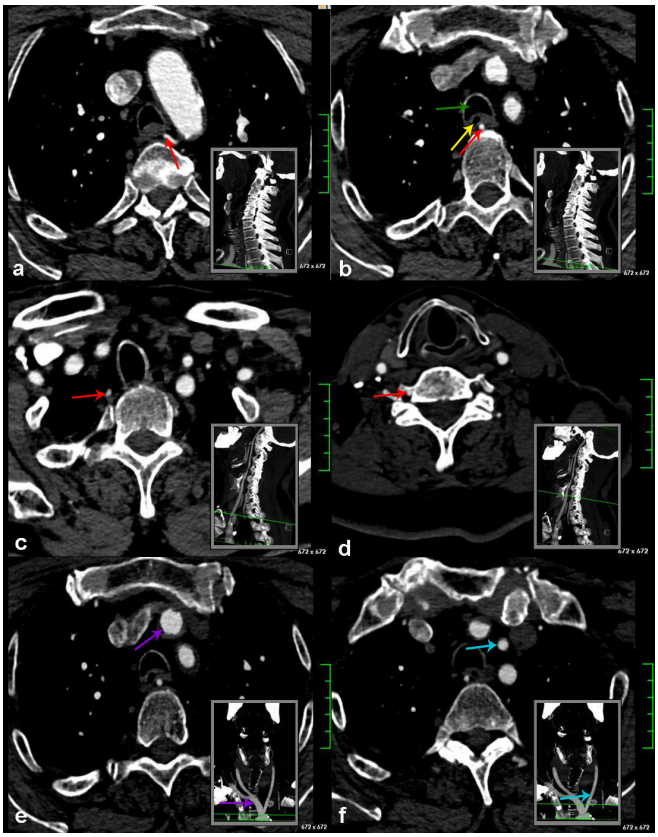

Figure 2. Computed tomography scan image. Axial view images correlated with coronal slices. a-d; images show the course of right vertebral artery. The right vertebral artery forwards retroesophageally and retrotracheally during its course (Red arrow, right vertebral artery; yellow arrow, oesophagus; green arrow, trachea). e, f; images show the course of left main carotid artery (Purple arrow, brachiocephalic trunk; blue arrow, left main carotid artery).

left VA branches from the subclavian artery and entered cervical 6th transverse foramen (Figure 1a,b). In the measurements on coronal slices, the diameter of the common trunk, which branches brachiocephalic trunk and left common carotid artery, was found 16.42 mm. The diameters of the brachiocephalic trunk, left common carotid artery, right VA and left VA were found 13.33 mm, 6.26 mm, 3.12 mm, and 1.56 mm, respectively. The right VA branches from the aortic arch after left subclavian artery and forwards retroesophageally and retrotracheally during its course (Figure 2) and then entered cervical 7th transverse foramen (Figure 1b). The patient has not any symptom such as dyspnea and dysphagia.

Table 1. Racial differences of frequency of aortic arch variations.

Nation	Frequency (%)	Authors
Afro-American	48.3	McDonald et al. [15]
White-American	33.1	McDonald et al.[15]
India	23	Nayak et al. [16]
Turkey	20.8	Karacan et al. [11]
Portugal	18	Grande et al. [17]
England	17.6	Thomson et al. [2]
Greece	17	Natsis et al. [1]
Japon	16.7	Adachi et al. [18]
Korea	16	Shin et al. [19]
Poland	2.6	Nizankowski et al. [20]

Table 2. Incidence of the bovine aortic arch.

Nation	Frequency (%)	Authors
USA	27.4	Berko et al. [4]
Turkey	21.1	Çelikyay et al. [12]
Turkey	14.1	Karacan et al. [11]
China	13.12	Tapia et al. [21]
South Africa	3.4	Satyapal et al. [22]
USA	3.2	Moskowitz and Topaz [23]
Poland	0.9	Nizankowski et al. [20]

Discussion

Embryological development of aortic arch occurs between weeks 4 and 8 of the fetal life. Primitive arterial arches branch off the arterial sac and create the final form of large arteries. The 4th arch consists the final form of aortic arch [5]. The right 3rd arch creates common carotid arteries bilaterally and the 4th arch composes the brachiocephalic trunk and right subclavian artery. The vertebral arteries originate from the 7th segmental artery branched off the subclavian artery [6]. Two growth factors, VEGF and TGFβ play an important role during angiogenesis. VEGF reduces cellular adhesion in newly developed vessels whereas TGFβ strengths the extracellular matrix [7]. Many different

anatomic variations appear during such process [8].

Studies conducted have encountered normal aortic arch pattern by 64.9-83%. Normal aortic arch pattern has been reported as 64.9% in the study of Liechty et al. [9] carried out on 1,000 cadavers, 74% in the computed tomography angiography study conducted by Jakanan and Adair [10], 83% in the angiography study on Greek population by Natsis et al. [1], 79.2% by Karacan et al. [11] in Turkish population and 50% by Berko et al. [4] in the black race. As is seen from the date, frequency of aortic arch variations show racial differences (Table 1).

The most common anatomic variation of aortic arch is the bovine aortic arch. Two branches originate from aortic arch in this variation; first branch is the root where right subclavian artery, right common carotid artery and left common carotid artery are branches off whereas the second branch is left subclavian artery [12]. Incidence of the bovine aortic arch varies between 0.9% and 27.4% in the literature [11] (Table 2).

Variations of the origin of the vertebral arteries have been reported rare on the right side and as 1.79% on the left side [13]. Uchino et al. [14] reported left VA variation as 6% whereas right VA variation as 3.8% in their computed tomography angiography study. In the same study, the most common left VA variation was direct branching from aortic arch directly between left common carotid artery and left subclavian artery by 4.1%. Branching was found from excessively proximal side of left subclavian artery by 1.3%, as a single root with left subclavian artery by 0.3%, direct branching from aortic arch from distal side of left subclavian artery by 0.2% and from aberrant left subclavian artery in one patient with right aortic arch whereas double origin VA was found 0.1%. Right VA was branched from excessively proximal side of left subclavian artery in 3.1% of the cases; 0.4% of the cases branched from the aberrant left subclavian artery; 3 cases (0.1%) branched from left common carotid artery and one case had double origin in the same study. In one case, the VA branched from aortic arch on the distal side of left subclavian artery and elevated retroesophageally. Karacan et al. [11] and Celikyay et al. [12] have reported that left VA branched from aortic arch in 4.1% and 3.7% of the cases, respectively and they have not detected the right VA branching from aortic arch.

Like in the present case, branching of the right vertebral artery from aortic arch is very rare. A similar case has been observed in 1 case in the study of Uchino et al. [14] conducted on 2357 cases. However, any cases which has both right VA branches from aortic arch and bovine aortic arch, as the present case, were not reached in the literature.

Since computed tomography angiography is a non-invasive technique and commonly used, detection of vascular variations and pathologies have become easier. Preoperative detection of these variations will provide a basis for the clinicians to plan treatment options better, to assess possible intraoperative complications during endovascular procedures and especially cervical and thoracic surgeries and prevent these complications.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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