

## Left costocervical vein malformation with anomalous ramification of aortic arch in a dog

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**This report describes coexistence of anomalous branches of the aortic arch and the costocervical vein malformation in a German shepherd dog. The first branch of the aortic arch was a bicarotid trunk that divided into the left and right common carotid arteries. The next branch to leave the aortic arch was a common trunk for the right and left subclavian arteries, a bisubclavian trunk, which was immediately bifurcated. The right subclavian artery passed over the esophagus forming a deep groove, so-called incomplete vascular ring on the dorsal wall of the esophagus. Although the esophagus was constricted by the right subclavian artery dorsally and by the trachea ventrally, no clinical symptoms of esophageal obstruction and dysphagia were observed. The left costocervical vein coursed caudoventrally, passed over the aortic arch, and entered the left ventricle. This vessel was much smaller than the right costocervical vein and was partially occluded at its origin.**

**Key words:** anomaly, aortic arch, costocervical vein, german shepherd dog

### Introduction

Anomalous branching patterns of the aortic arch and termination of the left costocervical vein were encountered in a dog cadaver in the dissecting room at the College of Veterinary Medicine, Seoul National University.

Anomalies in the great vessels and of the heart are of interest from the surgical point of view, and many reports on anomalous aortic arches and their tributaries in animals and humans have been published [3,10,14,15,19,22]. During normal embryonic development, the formation of

the arterial system involves modifications of the ventral aorta, the dorsal aorta, and six paired aortic arches. The ventral aorta between the third and fourth arches form the left and right common carotid arteries, while the paired dorsal aorta fuse to form the descending aorta. The fourth aortic archs persist on both sides, but its fate is different on each side. The left fourth aortic arch forms the aortic arch between the left common carotid and the left subclavian arteries, while the right fourth aortic arch forms the proximal segment of the right subclavian artery [2,16,18]. In the dog, the anomalous origins of the common carotid and right subclavian arteries are known to be derived from the aortic arch. However, simultaneous formations of the anomalous arteries and costocervical vein have rarely been reported. In the present study, anomalous origins of the common carotid and the right subclavian arteries, and abnormal termination of the left costocervical vein, are described.

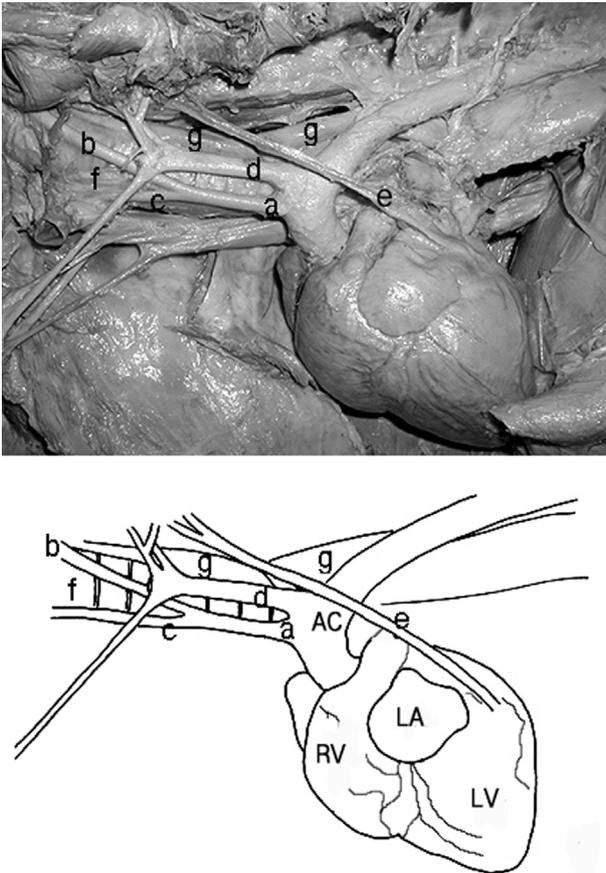
### Materials and Methods

A 7-years old female German shepherd dog in good health was presented for euthanasia. Following anesthesia with ketamine hydrochloride (Yuhan Co., Seoul, Korea), the dog was exsanguinated and perfused with embalming fluid (ethanol : phenol : glycerin : formalin : water = 50 : 5 : 10 : 5 : 30) via the left common carotid artery. The following day latex was injected into arterial system for the distinct observation. During routine dissection of the thorax, anomalous vessels branching off the aortic arch were encountered with deformity of costocervical vein. On further detailed dissection, the relevant structures were photographed, and the heart, lung and adjacent structures were thoroughly observed.

### Results

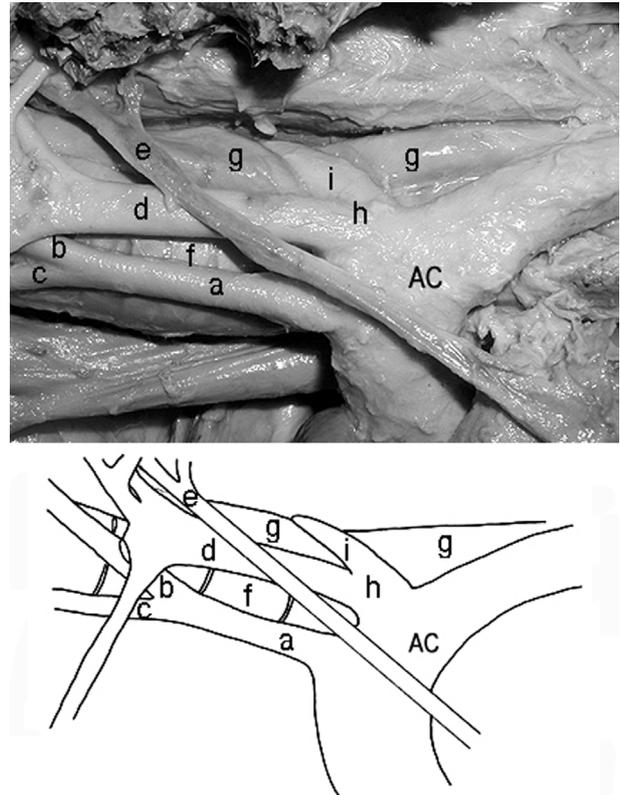
Two anomalous arteries were observed to arise directly from the aortic arch. The first branch to leave the aortic

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**Fig. 1.** Photograph and illustration of the left costocervical vein with anomalous ramification of aortic arch. The left costocervical vein passed over the aortic arch and enters directly to the left ventricle. Left view. a: bicarotid trunk, b: left common carotid artery, c: right common carotid artery, d: left subclavian artery, e: left costocervical vein, f: trachea, g: esophagus, AC: aortic arch, LA: left auricle, LV: left ventricle, RV: right ventricle.

arch was the bicarotid trunk. It coursed cranially along the ventral aspect of the trachea for about 5 cm, and divided into the left and right common carotid arteries. Both arteries were normal in size, position and branching pattern, and no occlusions were found. The second branch from the aortic arch was a common trunk for the left and right subclavian arteries (a bisubclavian trunk). This artery originated about 1 cm remote distance from the bicarotid trunk origin on the aortic arch. The bisubclavian trunk immediately divided into the left and right subclavian arteries. The left subclavian artery had normal distributions and no anomalies were observed. Instead of passing ventral to the trachea, the right subclavian artery coursed obliquely from left to right over the dorsal surface of the esophagus. In doing so, a deep groove, the so-called incomplete vascular ring was formed on the dorsal esophageal wall. The esophagus was, therefore, compressed by the right subclavian artery dorsally and the



**Fig. 2.** Photograph and illustration of the aortic arch and its tributaries. Left dorsal view. The esophagus is partially compressed by the right subclavian artery. a: bicarotid trunk, b: left common carotid artery, c: right common carotid artery, d: left subclavian artery, e: left costocervical vein, f: trachea, g: esophagus, h: bisubclavian trunk, i: right subclavian artery, AC: aortic arch.

trachea ventrally (Fig. 1 and 2). However, no esophageal obstruction was evident, and no regurgitation or dysphagia was noticed in the animal before embalming. The branches and termination of the right subclavian artery were similar to those of the left subclavian artery.

Abnormal termination of the left costocervical vein was also observed in this animal. The vein passed caudoventrally over the aortic arch and entered the left ventricle directly (Fig. 1). The left costocervical vein was much smaller in diameter than the right costocervical vein and partially occluded at its origin. The heart and lungs were normal in size, and no deformities were found except these vessels.

## Discussion

Many reports have been issued on the anomalous arterial developments in various species of dogs and cats [2,9,10, 13,17,22]. The vessels mainly involved are a persistent right fourth aortic arch and a persistent left ligamentum arteriosum. Persistent right ligamentum arteriosum or

double aortic arches with a normal left aortic arch, and aberrant left and right subclavian arteries have also been reported alone or in conjunction with other vascular anomalies [1,4,6,7,9,12,17,20].

In the present study, the left and right common carotid arteries, and the left and right subclavian arteries originated as a common trunk from the normal aortic arch; the bicarotid trunk and the bisubclavian trunk, respectively. In the normal dog, the aortic arch gives rise to the brachiocephalic trunk and the left subclavian artery. The brachiocephalic trunk, the first large artery from the aortic arch, in turn gives rise to the left common carotid artery and then terminates in the right common carotid and right subclavian arteries. Under normal embryonic development, the left fourth aortic arch forms part of the aortic arch. On the right, a portion of the trunk arteriosum elongates to form the brachiocephalic artery, and the right fourth aortic arch forms the proximal segment of the right subclavian artery. The distal part of the right subclavian artery is formed by a portion of the right dorsal aorta and the seventh intersegmental artery [18,22]. In the present study, therefore, the abnormal origin of the right subclavian artery may have been derived from the anomalous developing vessels on the right side. In the case of this abnormality, the right subclavian artery must cross the midline over the esophagus to reach the right forelimb. A complete or incomplete vascular ring is thus formed, which surrounds the esophagus and the trachea [18].

Vascular ring anomalies are known to be a common cause of regurgitation and megaesophagus especially in weaning dogs. Ninety-five percent of vascular ring anomalies in dogs are reported to be a result of the persistence of the right fourth aortic arch and the retention of the left ligamentum arteriosum. Aberrant left and right subclavian arteries have also been reported to cause incomplete vascular rings that compress the esophagus enough to cause clinical signs of abnormal swallowing [10,13]. In the present study, an incomplete vascular ring was found on the dorsal esophageal wall. However, regurgitation and other symptoms related to the esophageal constriction were not noticed until the animal was presented for euthanasia.

Almost all vascular ring anomalies in dogs are developed as a result of persistence of the fourth right aortic arch. The most commonly affected are German shepherds dog and Irish setters [17].

Different anomalous origins of the right subclavian artery have been reported in dogs. Bezuidenhout [2] and Ellison [7] described that the anomalous right subclavian artery generally arose from the aorta just caudal to the origin of the left subclavian artery, while Vitums [21] found that it arose from a bisubclavian trunk. In the dog of the present study, the anomalous right subclavian artery arose from a short bisubclavian trunk.

Bezuidenhout [2] reported occlusion of a common carotid artery with a concomitant enlargement of the vertebral artery in the dog. In this case, the first vessel branched from the aortic arch was a short bicarotid trunk, which divided into the left and right common carotid arteries. The right common carotid artery was partially occluded at its origin. In this case, the function and the area of supply were taken over by the right vertebral artery. In the present study, the first artery arising from the aortic arch was also a bicarotid trunk. However, no typical variations for the branches and termination of the common carotid arteries were found in this dog.

Several anomalous arteries in combination with venous malformation have been reported [5,11]. However, malformation of the costocervical vein with anomalous arteries has not been previously described. It is known that the left costocervical vein runs laterally to the left subclavian artery and terminates in the dorsolateral surface of the cranial part of the cranial vena cava or of the brachiocephalic vein [8]. In the present study, it was found that the left costocervical vein entered directly into the left ventricle. This vein was partially occluded at its origin. Nevertheless, it carried a little blood from the upper intercostals and cervical regions. Although the left costocervical vein returned a little venous blood to the left ventricle, no significant cardiovascular symptoms were noticed.

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