CASE REPORT

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Persistent right aortic arch and aberrant left subclavian artery in a dog

Persistência de arco aórtico direito e artéria subclávia esquerda aberrante em um cão

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ABSTRACT

A 1.5-year-old male German Shepherd dog was referred to a Teaching Veterinary Hospital with a chronic history of regurgitation and a previous presumptive diagnosis of megaesophagus. An esophagogram showed partial esophageal dilation, suggesting one vascular ring anomaly. Computed tomography identified a persistent right aortic arch (PRAA) and an aberrant left subclavian artery (ALSA). The patient underwent thoracotomy, ligamentum arteriosum ligation, and debridement of the periesophageal region. The ligation of the ALSA was not carried out because the esophagus was observed to be released entirely during the surgical intervention. Therefore, intervention on the subclavian artery was not necessary. Clinical follow-up occurred on seven, 14, and 30 postoperative days. The dog improved, showing only sporadic regurgitations. Clinical history and complementary exams were essential to establish a diagnosis. The liberation of the esophageal transit during surgery contributed to the decision not to perform the ALSA ligation.

Keywords: Canine. Computed tomography. Esophageal dilation. Regurgitation. Thoracotomy.

RESUMO

Um cão pastor alemão, macho, de 1,5 anos de idade, foi atendido em um Hospital Veterinário Universitário com história crônica de regurgitação e diagnóstico presuntivo prévio de megaesôfago. Um esofagograma mostrou dilatação parcial do esôfago sugerindo uma anomalia de anel vascular. A tomografia computadorizada identificou persistência do arco aórtico direito (PAAD) e artéria subclávia esquerda aberrante (ALSA). O paciente foi submetido à toracotomia, ligadura do ligamento arterioso e desbridamento da região periesofágica. A ligadura da ALSA não foi realizada, pois, durante a intervenção cirúrgica, observou-se que o esôfago estava completamente liberado, não sendo necessária intervenção na artéria subclávia. O acompanhamento clínico ocorreu aos sete, 14 e 30 dias de pós-operatório. O cão evidenciou boa recuperação, apresentando apenas regurgitações esporádicas. A história clínica associada aos exames complementares foi essencial para o diagnóstico. A liberação do trânsito esofágico durante a cirurgia contribuiu para a decisão de não realizar a ligadura da ALSA.

Palavras-chave: Canino. Tomografia computadorizada. Dilatação esofágica. Regurgitação. Toracotomia.

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Persistence of the right aortic arch (PRAA) corresponds to the most frequent vascular ring anomaly in dogs related to a congenital abnormality of the aortic vasculature, leading to external esophageal compression (Scansen et al., 2014; Maryann & Fossum, 2018). The dog breeds most frequently affected by this anomaly are purebred dogs, mainly German Shepherd and Labrador (Regier et al., 2021; Marvel et al., 2022).

The embryonic heart's left side usually hosts the aortic arch, comprising a duo of branches (brachiocephalic trunk, left subclavian artery) in canines. Suppose there is an aberration in the usual regression process of segments within the aortic arch system. In that case, it leads to the development of anomalies in the aortic arch, which can be linked to congenital heart irregularities. A right aortic arch arises when the persistence of the right dorsal aorta continues intact, while the left dorsal aorta experiences atypical regression (Stojanovska et al., 2012). Other dog anomalies include a double aortic arch and an aberrant right subclavian artery (Morgan & Bray, 2019; Regier et al., 2021). The right subclavian artery originates on the right side as a terminal branch of the brachiocephalic trunk, arising medial to the first intercostal space straight and is about 2 inches long. The aberrant subclavian artery can originate in two ways. The first involves the fusion of the distal portion of the right dorsal aortic arch, typically a reduced structure, with the sixth intersegmental artery on the right cervical side. The second scenario arises when only the distal segment of the right subclavian artery remains persistent, represented by the right cervical intersegmental artery (Vitums, 1962),

Computed tomography is the most suitable exam to define the type of vascular anomaly and contributes to surgical planning (Kyles, 2012; Nucci et al., 2018; Regier et al., 2021). However, echocardiography is essential in diagnosing dogs' cardiac anomalies (Duguay et al., 2023).

This report aims to describe cardiac anomalies in a dog diagnosed by clinical history and imaging studies.

A male German Shepherd dog, 1.5 years old, was referred to a Teaching Veterinary Hospital (TVH) with a history of frequent regurgitation when eating solid food since its acquisition. The owner reported that the animal was attended to in the first months of life by two other veterinary services, which concluded that it was a megaesophagus based on the clinical diagnosis without laboratory imaging support. Gastric protector and food management were prescribed through fractionated pasty feeding several times daily. The animal obtained relative clinical improvement. However, when solid food was instituted, it presented clinical signs again. The owner reports that she offers the animal only beaten feed, and the regurgitation condition improves when she fractionates the food several times a day.

On clinical examination, the animal had a poor body score with a structure smaller than expected for the breed. The mucous membranes were pale, the abdomen tense on palpation. The other clinical parameters were normal. In the hematological evaluation and biochemical profile, no pathological changes were observed.

Given the anamnesis and clinical signs, a simple chest radiographic examination was requested in three views (ventro-dorsal, right lateral-lateral, and left lateral-lateral). The lateral radiograph showed a dilated esophagus in the cervical and thoracic regions, and the trachea was ventrally displaced (Figure 1A). Static barium esophagram confirmed esophageal segmental dilation and partial obstruction by a stricture at the heart base (Figure 1B).

In computed tomography (CT) after injection of intravenous iodinated contrast, the PRAA was identified, and the ligamentum arteriosum was seen connecting the descending right aortic arch to the main pulmonary artery and compressing the esophagus externally, over the heart base (Figure 2A).

Additionally, an aberrant left subclavian artery (ALSA) was found. In sagittal reconstruction, it is observed the ligamentum arteriosum between the right aortic arch and pulmonary artery, saccular dilation of the esophagus cranial to the ligament, and standard shape/diameter of the esophagus caudal to the ligament (Figure 2B). At three-dimensional Multi Planar Reconstruction (using the maximum intensity projection - MIP editing tool), in the left dorsolateral view, it is possible to observe the aberrant left subclavian artery branching from the more dorsal part of the aortic

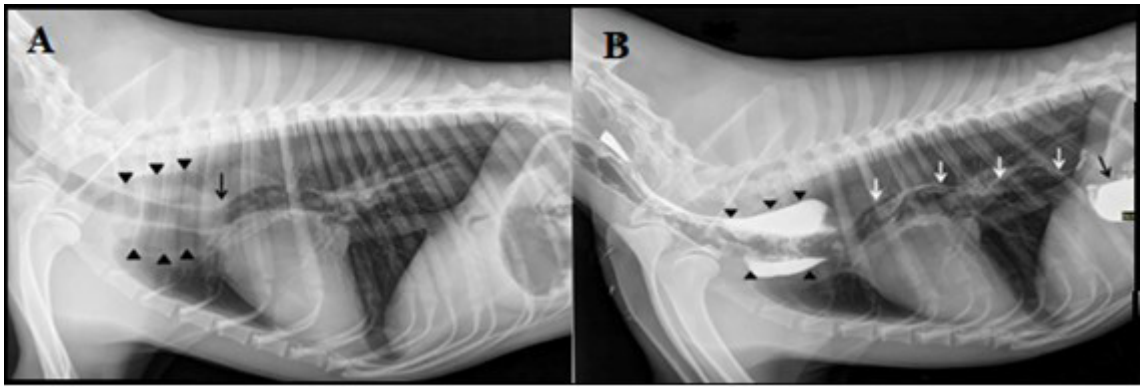

Figure 1 – Thoracic radiographic images, in right lateral view, of a German Shepherd dog with vascular ring anomaly. (A) Esophageal dilation cranial to the cardiac base (arrowheads) and ventral displacement of the trachea (arrow); (B) Esophagram showing retention of the contrast medium in the esophageal sacculation (arrowheads) and evolution of the contrast column (white arrows) from the heart base to the stomach (black arrow), with no signs of dilation.

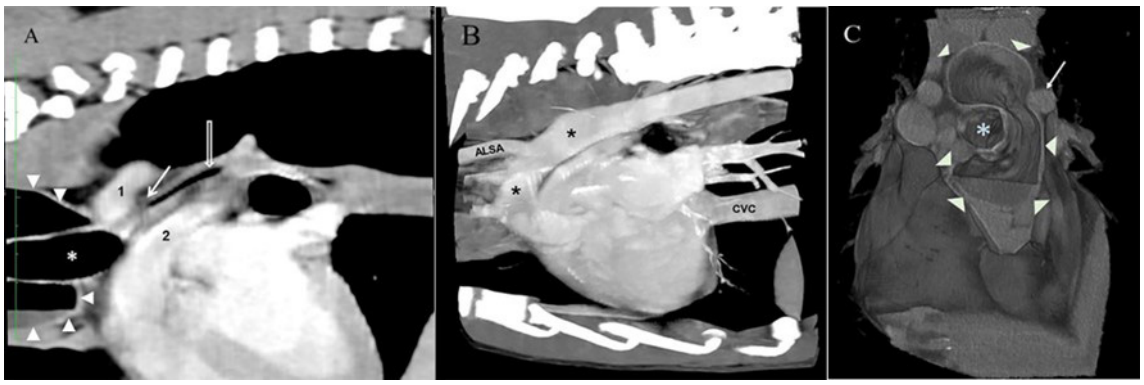

Figure 2 – Post-contrast computed tomography images of the reported dog with persistent right aortic arch and aberrant left subclavian artery. (A) Sagittal reconstruction showing the ligamentum arteriosum (solid white arrow) between the right aortic arch (1) and pulmonary artery (2), saccular dilation of the esophagus cranial to the ligament (arrowheads), and standard shape/diameter of the esophagus caudal to the ligament (hollow white arrow). The asterisk corresponds to the lumen of the trachea; (B) Three-dimensional Multi Planar Reconstruction (using the maximum intensity projection - MIP editing tool), in left dorsolateral view, showing the aberrant left subclavian artery (ALSA) branching from the more dorsal part of the aortic arch (*). CVC, Caudal Vena Cava; (C) Three-dimensional reconstruction, in frontal view; note the luminal stenosis of the esophageal sacculation (between arrowheads) between the trachea (asterisk) and the aberrant left subclavian artery (white arrow).

arch (Figure 1B). On three-dimensional reconstruction, the frontal view allows viewing of the luminal stenosis of the esophageal sacculation between the trachea and the aberrant left subclavian artery (Figure 2C).

A thoracotomy was performed, and the thoracic cavity was accessed through the fourth left intercostal space. The aberrant left subclavian artery, esophagus, aortic arch, and ligamentum arteriosum were identified. The ligamentum arteriosum was isolated, ligated using 2-0 absorbable multifilament thread (polyglactin 910), and sectioned (Figure 3). A rigid tube, about 3 cm in diameter, was carefully passed through the esophageal lumen before and after sectioning the ligamentum, allowing the liberation of the esophageal transit to be verified. Therefore, it was decided not to perform any surgical intervention on the ALSA. Finally, periesophageal fibrotic tissue around the constriction was debrided.

During the initial recovery period, it was requested that decent quality food be offered in fractional portions (four to six meals). Owners were instructed to feed the animal on an elevated platform and keep it in that position for 15 min after eating or drinking. On the seventh postoperative day, the dog showed signs of significant improvement, with no episodes of regurgitation. On day 14, the skin sutures were removed, and the animal gained weight. Minimal episodes of regurgitation were observed during the week. Regarding weight, the patient weighed 20kg at the time of diagnosis. Seven days after surgery, he had already gained half a kilo; 15 days after surgery, he weighed 21.4 kg; and 30 days after surgery, he weighed 23.7 kg. The dog was discharged 30

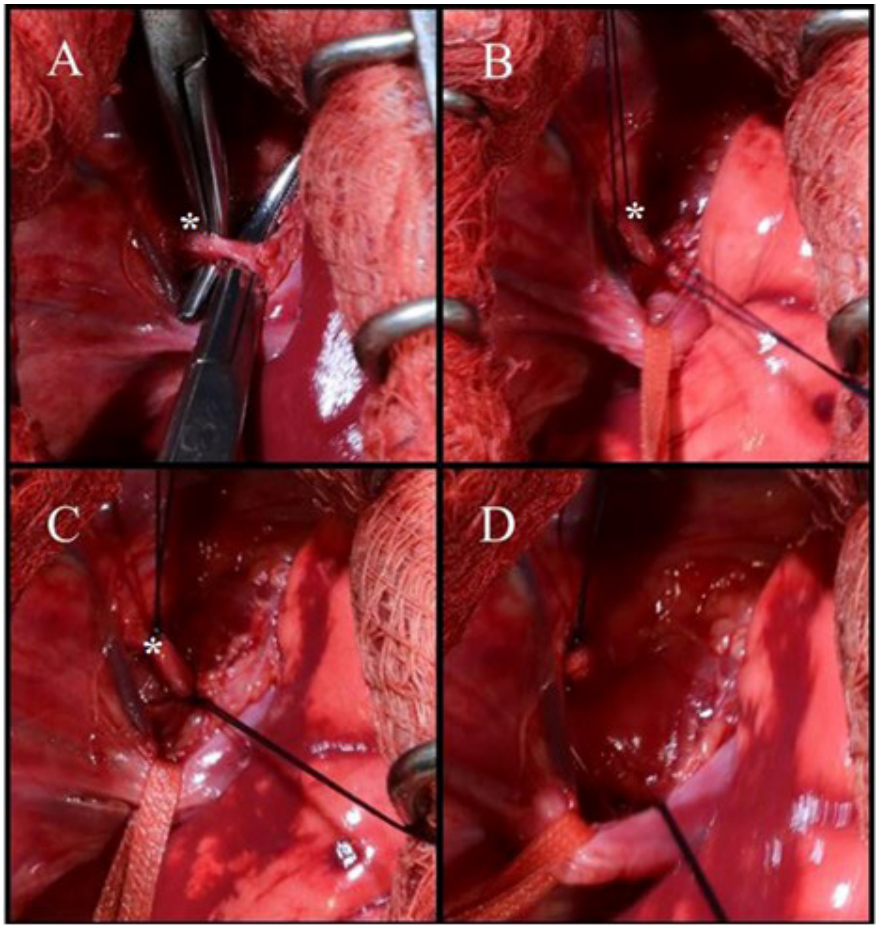

Figure 3 – Photographic images of the reported dog's surgical procedure with a persistent right aortic arch and aberrant left subclavian artery. (A and B) Isolated ligamentum arteriosum (*) above the forceps in A and supported by black suture threads in B; (C) Ligatures at both ends of the ligamentum arteriosum still anchored by the black suture threads; (D) The stump of the ligamentum arteriosum after being sectioned.

days after surgery when it was in good general condition, feeding well, and without new episodes of regurgitation.

According to the literature, the anamnesis and the clinical signs presented by the patient when he was admitted to the TVH were highly suggestive of a vascular anomaly (Saunders et al., 2013; Hakyoung et al., 2018; Antunes et al., 2022). In addition, the animal's breed (German Shepherd) is considered predisposed to present vascular anomalies, mainly the persistence of the fourth right aortic arch (PRAA) (Regier et al., 2021; Marvel et al., 2022). Thus, the possibility of persistence of the fourth right aortic arch, the most common vascular anomaly in dogs, was investigated. The animal in the case reported here presented clinical signs from an early age. PRAA is a condition frequently observed in young animals, in which early diagnosis is an essential factor for prognosis. The delay in diagnostic confirmation hinders the complete resolution due to the chronicity of esophageal dilation and motility disorders, so a late surgical procedure is not recommended (Kyles, 2012). In the presented case, the delay in confirming the diagnosis did not lead to an unfavorable prognosis, even with a late surgical treatment. There is no consensus in the literature about the time of diagnosis that allows successful surgical intervention. However, it is inferred that if the animal does not present serious sequelae such as aspiration pneumonia and body cachexia at the time of diagnosis, there is an excellent possibility of success in the surgical procedure. The patient in question did not present such sequelae. The dietary management likely adopted in the animal in this report when clinical signs began contributed to the absence of permanent damage to the esophagus. However, despite the significant improvement, sporadic episodes of regurgitation were observed during surgical recuperation. According to the literature, most cases have a favorable prognosis after correction of the anomaly. However, not all animals recover completely (Regier et al., 2021; Marvel et al., 2022). In this patient's case, there was a complete regression of clinical signs 30 days after surgery, demonstrating the effectiveness of the surgical procedure in correcting the disease.

The lack of definition of the case was initially due to the correlation of the symptoms of PRAA with megaesophagus. With different etiology, megaesophagus, or esophageal hypomotility, corresponds to a syndrome characterized

by segmental or complete esophageal dilation caused by loss of normal esophageal peristalsis through injury to intramural nerve plexuses (Winston 3rd et al., 2023). The diagnosis is based on radiographic history, which makes it possible to delimit the esophageal dilation and correlate it with secondary causes (Mace et al., 2013).

Surveys and contrasted radiographs associated with the history of chronic regurgitation were fundamental to diagnosing the vascular ring anomaly. However, characterization of the type of anomaly and identification of the ALSA was only possible by CT, which allowed for obtaining more details (Regier et al., 2021; Marvel et al., 2022), including the visualization of the ligamentum arteriosum, in this case. As an auxiliary exam in surgical planning, the lack of CT increases the surgical time and the chances of failure (Hakyoung et al., 2018). In another case of aberrant subclavian arteries described in the literature, CT was considered significant (Antunes et al., 2022). The absence of such an examination makes it impossible to correctly diagnose this vascular anomaly, as occurred in one report. Even in this report, the patient was euthanized due to clinical worsening even with treatment, and the diagnosis was only made at necropsy (Tavares et al., 2020).

Even without being performed on this animal, it is essential to emphasize that echocardiography can successfully diagnose cardiac anomalies in dogs (Duguay et al., 2023). In some cases, echocardiography may be more helpful in diagnosing heart disease than CT (Mei et al., 2019).

Although there are few publications in the scientific literature, ALSA occurs in about 33% of dogs with PRAA (Maryann & Fossum, 2018) and is already reported in Dalmatian (Tavares et al., 2020), Bull Terriers (Antunes et al., 2022), Belgian Shepherds (Saunders et al., 2013), Beagles (Vedrine & Durieux, 2017), Border Collies, Golden Retrievers, and Labradors (Scansen et al., 2014).

The aberrant left subclavian artery was not subjected to surgical intervention due to the absence of compression of surrounding structures. This decision was based on medical literature, which indicates that ligation of this artery can trigger subclavian steal syndrome in humans, resulting in ischemic complications in the forelimbs, pain, and neurological deficits (Nasser et al., 2023). However, a comprehensive clinical assessment of the patient and specific circumstances is essential when making this decision. When the artery does not cause compression of surrounding structures (e.g., esophagus) or other significant clinical problems, surgical intervention is avoided to prevent unnecessary complications (Regier et al., 2021). Therefore, the choice not to intervene on the aberrant left subclavian artery was based on the lack of clinical indication due to the absence of compression of adjacent structures. It is essential to highlight that, in many cases, an aberrant left subclavian artery is asymptomatic (Tavares et al., 2020; Nasser et al., 2023). Regurgitation presented by the patient at the time of care was associated with the esophageal external compression by the ligamentum arteriosum since such regurgitation completely regressed after surgery.

In the present case, the surgical technique employed to dissect, ligate, and section the structure responsible for esophageal compression proved easy. The combination of clinical history and complementary exams was essential to establish the final diagnosis, and verifying the liberation of the esophageal transit during surgery contributed to the decision not to perform the ALSA ligation despite the specific degree of compression caused by esophageal sacculation.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethics Statement

It was not necessary to submit it to the ethics committee as it was a case seen in the routine of a veterinary service.

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