

Case Report Surgery



Vascular ring anomaly with a right patent ductus arteriosus and a left aortic arch in a juvenile cat

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ABSTRACT

This paper reports the clinical findings and surgical treatment of feline right patent ductus arteriosus (RPDA) with a left aortic arch. A two-month-old female Maine Coon was referred for an investigation of regurgitation after weaning. RPDA with a left aortic arch was diagnosed based on the echocardiographic and computed tomography (CT) findings. A right-fourth intercostal thoracotomy was found to be an appropriate approach to the duct. Preoperative diagnosis is crucial and diagnostic imaging, including radiography, echocardiography, and cardiac CT examination, is essential for determining if the aortic arch is right or left.

Keywords: Vascular malformations; esophageal stricture; aspiration pneumonia

INTRODUCTION

Vascular ring anomalies are congenital malformations of the great vessels that result in esophageal and tracheal constrictions [1-3]. The common clinical signs are regurgitation after weaning and associated aspiration pneumonia [1,2]. The medical treatments for esophageal constriction include feeding in an upright position, feeding a liquid diet, and gastrostomy tube placement in cases of poor nutritional status [2]. On the other hand, surgical treatment is often required and should be performed as early as possible to prevent irreversible damage to the esophagus [1]. A persistent right aortic arch (PRAA) with left ligamentum arteriosum accounts for 95% of vascular ring anomalies in dogs [3-5] and 85% in cats [2]. A right persistent ligamentum arteriosum or a right patent ductus arteriosus (RPDA) with a normal (left) aortic arch has been reported to be a rare type of vascular ring anomaly [6-9]. To the best of the authors' knowledge, RPDA has not been described in cats. The type of vascular ring anomaly is a significant factor determining the direction of the surgical approach; therefore, accurate diagnosis is essential. The present case report describes the clinical findings and surgical treatment of RPDA with a left aortic arch in a cat.

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Conflict of Interest

The authors declare no conflicts of interest.

CASE PRESENTATION

A two-month-old, intact female Maine Coon, weighing 0.75 kg, was presented to the referring veterinarian for the primary complaint of regurgitation after weaning. Thoracic radiographs, including a positive contrast esophagram, revealed esophageal dilatation cranial to the heart base. The cat was then referred to the authors' facility for further investigation and surgical treatment.

Thoracic radiographs obtained at the authors' facility revealed a dilated esophagus containing a radiopaque object cranial to the heart base, but the location of the trachea was unclear on the radiographs. Echocardiography revealed abnormal blood flow in the pulmonary artery at the right parasternal short-axis view (at the level of the heart base), even though the abnormal blood flow showed a different flow pattern from the typical left patent ductus arteriosus or pulmonary regurgitation [10,11]. Echocardiography did not reveal any left-sided cardiac enlargement.

Cardiac computed tomography (CT) was performed under general anesthesia. General anesthesia was induced with propofol (Propofol intravenous [IV] injection 1%; Fresenius Kabi, Japan) and maintained with isoflurane (Isoflurane for animal use; MSD Animal Health, USA) with mechanical ventilation. CT showed leftward displacement of the trachea, which is one of the characteristics of PRAA [3]. In the present case, the esophagus was severely dilated and displaced to the right side, resulting in the left-side displacement of the trachea (**Fig. 1A**). The cat had a left aortic arch, as the aorta was located on the left side of the trachea and the esophagus (**Fig. 1B**). The form of the vascular ring was unclear on CT, but the tentative diagnosis of RPDA with a left aortic arch was made based on the echocardiography and CT findings. CT also indicated mild aspiration pneumonia in multiple regions, including the middle lobe of the right lung, but the cat did not show any clinical signs of dyspnea.

The cat recovered uneventfully from anesthesia and was extubated after a CT examination. Soon after extubation, gurgling from the upper airway of the cat was observed, even though the cat was held in the standing position. Overflowing liquid from the esophagus was observed upon reintubation. After reintubation, general anesthesia was maintained with

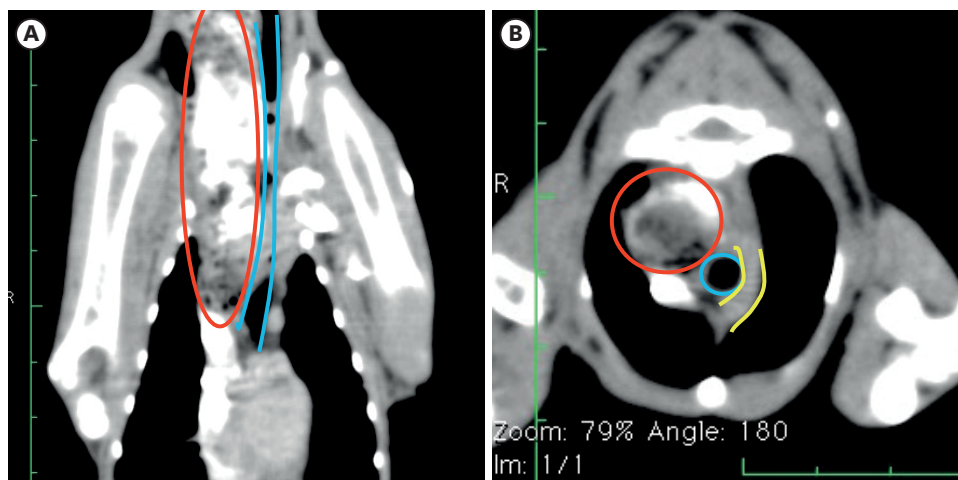


Fig. 1. Cardiac computed tomography. Dilated esophagus (red line) displaced the trachea (blue line) to the left side (A) and left aortic arch (yellow line) situated on the left side of the trachea (blue line) and the esophagus (red line) (B).

isoflurane. Midazolam hydrochloride (Dormicum injection 10 mg; Maruishi Pharmaceutical Co., Ltd., Japan, 0.2 mg/kg IV), butorphanol (Vetorphale; Meiji Animal Health Co., Ltd., Japan, 0.2 mg/kg IV), and Cefazolin Sodium (Cefazolin Sodium injection 1 mg; Nichi-Iko Pharmaceutical Co., Ltd., Japan, 20 mg/kg IV) were also administered intravenously.

Esophagoscopy was performed, and a large hairball containing liquid was identified within the esophagus. The hairball was removed using endoscopic forceps and pean forceps. The hairball was approximately 10 cm long and occupied from the esophagus orifice to the site of esophageal stricture.

A right-fourth intercostal thoracotomy was performed to approach the thoracic cavity. The azygos vein was observed caudal to the dilated esophagus (**Fig. 2A**). The dissection of the azygos vein revealed the aorta located beneath it. A black Braided Silk Suture, Size 0 was placed around the aorta to search for the duct. When traction was applied to the aorta, a small artery branching from the right side of the aorta became evident. The small artery ran ventrally and passed to the right side of the esophagus and caused an obvious constriction

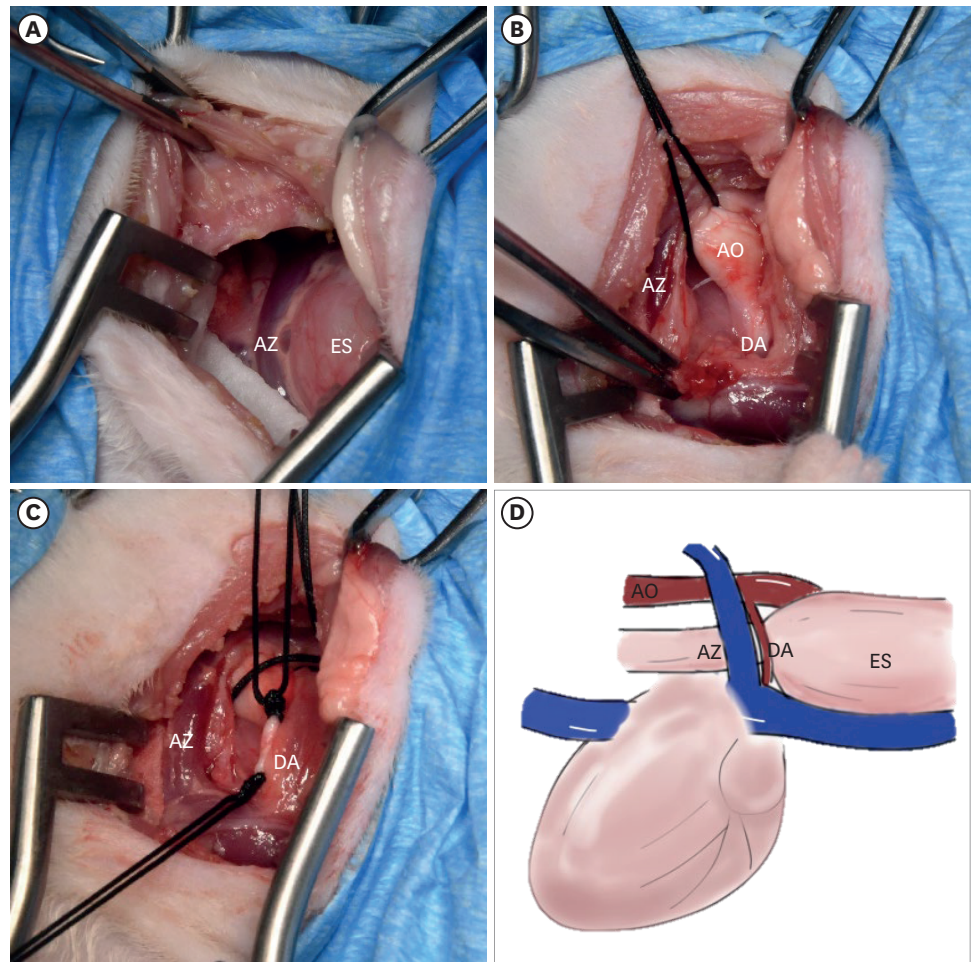


Fig. 2. Intraoperative findings. The azygos vein was observed caudal to the dilated esophagus (A). Traction of the aorta revealed the ductus arteriosus branching from the aorta (B). The duct was ligated at the dorsal and ventral parts with 0 silk before cutting the duct between the ligation (C). Diagrammatic representation of the ductus arteriosus and the other vessels shown from the right side (D). AZ, azygos vein; AO, aorta; DA, ductus arteriosus; ES, esophagus.

of the esophagus (**Fig. 2B**). The duct was dissected from the esophagus and ligated at the dorsal and ventral ends with 0 silk before cutting between them (**Fig. 2C**). After the duct was divided, there were no other tissues constricting the esophagus. Therefore, the duct was the cause of the esophageal constriction. Subsequent esophagoscopy showed that esophageal constriction was resolved. The thoracotomy incision was closed routinely after placing the thoracic drain. Postoperatively, the cat did not gurgle from the upper airway, and the breathing was stable. Nevertheless, the breathing became labored, and the cat died the next day, despite the treatments with antibiotics and oxygenation.

An autopsy of the oral, neck, and thoracoabdominal organs was conducted. The (left) aortic arch had the brachiocephalic trunk and left subclavian artery at the normal position. The small artery causing the esophageal constriction, which was observed intra-operatively, was identified as the right ductus arteriosus. The right ductus arteriosus ran ventral to the trachea and connected the pulmonary trunk at its left/right bifurcation (**Fig. 3**). The persistent left ligamentum arteriosum was grossly confirmed. A histopathological examination of the lung (right/left cranial/caudal lobes and right accessory lobe) revealed multifocal to the coalescing filling of the airways and alveoli by numerous neutrophils, proteinaceous fluid, colonies of cocci and coccobacilli, and few keratinous debris (squames). The histology lesions of the other organs included neutrophilic mediastinal lymphadenitis, focal ulcerative neutrophilic esophagitis, and mild neutrophilic tracheitis. The cause of death of the cat was determined to be aspiration pneumonia resulting in acute respiratory failure.

DISCUSSION

In the present case, cardiac CT showed the leftward displacement of the trachea, which is one of the characteristics of PRAA. A right-fourth intercostal thoracotomy was performed because the left aorta arch was located on the left side of the esophagus and trachea. Moreover, the echocardiographic findings were helpful in the tentative diagnosis of RPDA.

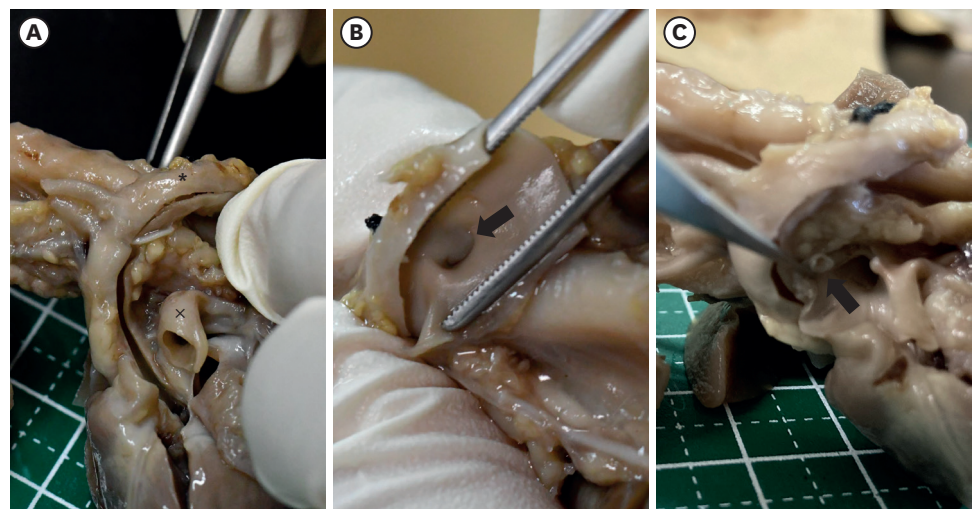


Fig. 3. Necropsy findings. The location of the openings of the ductus arteriosus in the aorta (*) and the pulmonary trunk (+) is shown (A). The openings of the duct in the aorta (B) and the pulmonary trunk (C) are revealed (arrow).

RPDA is challenging to identify compared to the left one because the connection to the pulmonary artery is not visible. In the present case, RPDA could not be found at first sight, but the silk ligature placed on the aorta was used as a good landmark. In previous reports of vascular ring anomalies with RPDA or a right ligamentum arteriosum, left lateral thoracotomies were performed based on the radiographic finding of tracheal displacement to the left [8]. Holt et al. [8] reported that dissection of the ductus arteriosus was possible and reasonable even with a left lateral thoracotomy. In the report, however, the patient was a German Shepherd Dog, a large breed, and it was likely that the dissection of the ductus arteriosus was only possible owing to the patient's size; the same procedure would be complicated in a small dog and a cat. Hurley et al. [9] reported that surgery with a left lateral thoracotomy of a small dog ended with a failure of the approach to the right ligamentum arteriosum.

A left lateral thoracotomy is commonly used to treat vascular ring anomalies because most are PRAA [1,2]. Some rare types are difficult to approach unless a right lateral thoracotomy is used [9]. Therefore, preoperative diagnosis using multiple imaging modalities containing radiography, echocardiography, and a cardiac CT examination is significant, particularly in identifying whether the aortic arch is right or left [12,13].

Although the cat was kept in the standing position, the cat aspirated liquid in the hairball when it recovered from the anesthesia after the CT examination. In a recent study on 20 cats with vascular ring anomalies, two cats had foreign material in the esophagus, including one cat with sponge/fibrous material. One adult cat had undergone an esophagotomy for esophageal foreign body removal before the diagnosis of vascular ring anomaly, and the treatment for a foreign body was not described for another cat. Cats with vascular ring anomalies may have foreign bodies in the dilated esophagus, and the foreign bodies may be a hairball. The risk of aspiration pneumonia is likely to be greater during recovery from anesthesia in patients with vascular ring anomalies. The risk could be even greater when the hairball contains a liquid. Extra care should be taken when a foreign body is present in the dilated esophagus and should be removed as soon as possible.

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