

Surgical correction of persistent right aortic arch in a cat and three dogs

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ABSTRACT: We here report the diagnosis and surgical outcomes of a cat and three dogs with persistent right aortic arch causing oesophageal enlargement. The chief complaint in all cases was regurgitation just after solid food intake. Barium oesophagographic examinations revealed enlarged oesophaguses cranial to the heart and strictures due to arteriosus ligament constriction of the oesophagus. Surgical correction was carried out using left fourth intercostal thoracotomy and severance of the ligamentum arteriosum. The cases frequently displayed residual clinical signs and still required modified diets after a mean follow-up period of 8.6 months, but owner satisfaction was acceptable.

Keywords: feline; canine; oesophagus; surgery; PRAA

The term vascular ring anomaly (VRA) defines the abnormal development of embryonic aortic arches inside the large vessels in dogs and cats (Berry et al. 1984; Kyles 2003; Yalcin et al. 2009). The most common type of VRA in dogs and cats is persistent right aortic arch (PRAA), which causes constriction of the oesophagus and finally leads to oesophageal dilatation (Kyles 2003; Buchanan 2004). The oesophagus is surrounded by the ligamentum arteriosum dorsally, pulmonary artery on the left, aorta on the right and base of the heart ventrally, and this ring formation constricts the oesophagus. Persistence of the right aortic arch causes constriction of the oesophagus at the level of the heart base, and as a result, cranial dilatation of the oesophagus occurs (Jeffrey et al. 1995; Kyles 2003). The most common clinical symptom of the VRA is regurgitation, which begins at weaning with introduction to solid foods. Affected puppies or kittens are mostly smaller than their littermates and their body condition score is low (Jeffrey et al. 1995; Hedlund 2007). Due to regurgitation, aspiration pneumonia may also develop (Kyles 2003; Buchanan 2004; Koc et al. 2004; Kim et al. 2006). Diagnosis is based on history, physical examination findings and contrast oesophagography, although barium oesophagography has also been suggested

for the diagnosis of vascular ring anomalies. Direct radiography was found acceptable for revealing oesophageal enlargement and tracheal deviation, which is a crucial finding of PRAA (Buchanan 2004). Oesophagograms are not diagnostic of vascular rings in some cases because of inadequate filling or minimal dysfunction or enlargement. In these kinds of cases, the diagnosis can be made by endoscopy of the oesophagus or surgical exploration (White et al. 2003; Buchanan 2004; Hedlund 2007). This report describes the perisurgical management of one cat and three dogs with PRAA, its surgical corrections and outcomes.

MATERIAL AND METHODS

Three dogs and one cat with persistent right aortic arch, admitted to the Department of Surgery, Faculty of Veterinary Medicine, Ankara University between 2011 and 2014 were included in this study. The medical records of the department were reviewed. Cases with a thorough history, preoperative clinical signs, and that were definitively diagnosed by direct and indirect oesophagography, treated surgically and followed up by clinical examination and/or telephone conversation were included.

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Routine cell blood count and serum biochemistry workup were checked for any abnormality. A presumptive diagnosis of PRAA was made for the four cases on the basis of the history, clinical signs and physical examination findings. Differential diagnoses were reached by direct chest x-ray and barium oesophagogram. Using surgical exploration, the diagnoses were confirmed as PRAA with left ligamentum arteriosum (LA). Anaesthesia was induced using propofol HCl (Fresenius Kabi, Spain) 6.6 mg/kg, *i.v.* and maintained with isoflurane. Supportive fluid therapy was maintained using Ringer's lactate solution (20 ml/kg/h *i.v.*) throughout the procedure, and cefazoline sodium (Iespor, I.E. Ulugay, Turkey) 20 mg/kg, *i.v.* was administered before the induction of anaesthesia.

Surgical procedures. Approach to the thoracic cavity was achieved through a left lateral thoracotomy incision at the level of the 4th left intercostal space. The left vagus nerve was identified and retracted. The heart was observed in its pleural covering and the vascular ring anomaly was identified to be abnormally formed. The oesophagus was found to be constricted by a complete ring formed with PRAA and persistent left LA. The PRAA compressed the oesophagus on its dorsal aspect during its course from the right to the left. The pleura was incised to expose the LA. Heavy silk (No. 1 or 0) sutures used for ligation, and two ligatures were passed around the ligament. Ligatures were tied separately and then transected (Figure 1). The lungs were repositioned and inflated to eliminate

atelectasis. The air inside the chest was removed with a three-way catheter attached to a syringe until the negative pressure was maintained, therefore a chest tube was not placed.

Intercostal and intrapleural bupivacaine hydrochloride (Marcaïn[®]/0.5, AstraZeneca, UK) was used to supplement analgesia (Thompson and Johnson 1991; Pascoe and Dyson 1993). For intercostal analgesia, the thoracotomy incision site and two or three sites cranial and caudal to the incision site were blocked with 2 mg/kg bupivacaine. Intrapleural analgesia was provided before the thoracotomy site was sutured with 0.5% bupivacaine hydrochloride diluted in 5–10 ml of saline. The incision site was closed in a routine manner with Ethicon[®] and tension sutures were placed at 1/2-inch intervals behind the 4th rib and in front of the 5th rib.

Postoperative pain was treated with systemic butorphanol chloride (Hydromorphone Hydrochloride[®], Maine Pharmaceutical Co. Ltd., USA) given at 0.1 mg/kg, *i.v.*, every six hours for one week. Cefazoline sodium, *i.v.*, was administered at a dose of 20 mg/kg every eight hours for seven days after the operations. Postoperatively, dogs and cat were maintained on intravenous fluids for four days, and no episodes of regurgitation were noticed during feeding. Feeding was resumed from the third postoperative day with commercially available feed (Hill's a/d) five to six times daily with the head in an elevated position for two weeks. After that, the owners were recommended to feed the dogs and cat

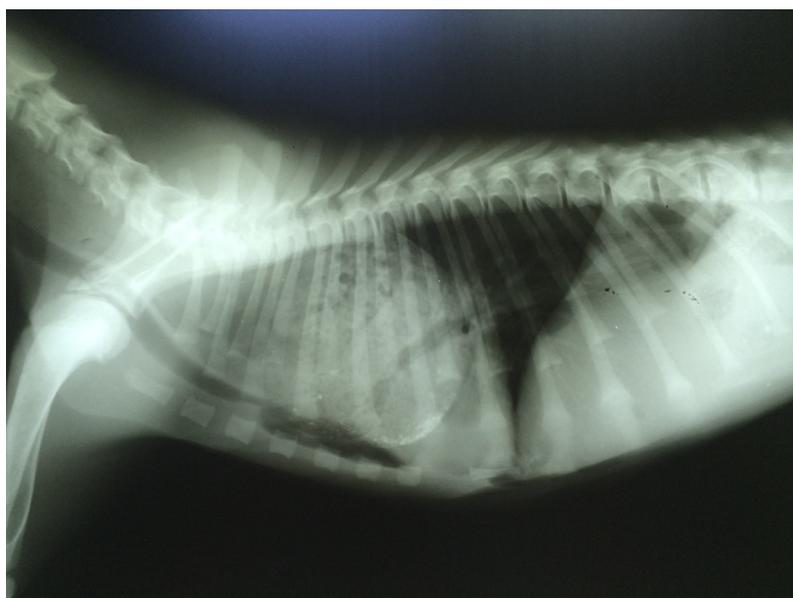


Figure 1. Transfixing sutures in place in the persistent left ligamentum arteriosum in case 3

with small amounts of soft food four to five times daily in a normal position.

Follow-up information was obtained by means of telephone conversations with the dogs' owners for up to ten months and two years after the surgical correction and for up to two years for the cat.

RESULTS

The first patient was a two-year-old, male, mixed breed cat. The second case was a 43-day-old male German shepherd dog and cervical oesophagus was noted as a palpable, enlarged cavity in this case. The third case was a five-month-old, mixed breed, female dog. The fourth case was a four-month-old male Rottweiler; the body condition of this dog was so poor that he died intraoperatively due to cardiac arrest. All of the cases had a history of regurgitation following food intake. Appetite was normal in all cases but the physical development of the animals was slower than that of their siblings. Direct radiography revealed tracheal deviation to the left at the level of heart base on ventrodorsal projection. However, the trachea was deviated ventrally in lateral radiograph. Dilatation of the oesophagus cranial to the heart base was observed in the barium oesophagogram (Figures 2 and 3). Cell blood count (CBC) and serum chemistry screening were unremarkable before surgery in all four cases.

Constriction of the oesophagus by ligamentum arteriosus and oesophageal dilatation was con-

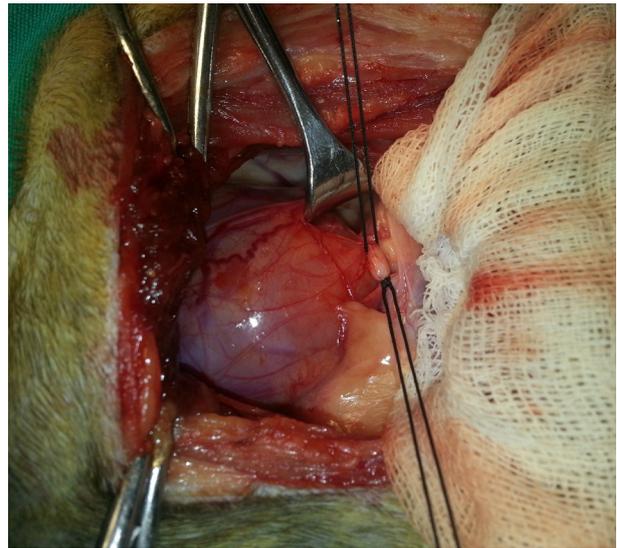


Figure 3. Contrast oesophagogram and dilatation of the oesophagus cranial to the heart in case 4

firmed during surgery in all cases. One dog died during the operation due to cardiac arrest. PRAA was a ligamentous structure in all cases except for the third case in which the PRAA was fibrotic but contained blood. Wound healing was completed normally in all surviving animals. In one of the surviving dogs, the oesophagus was normal except for mild dilatation, and at the fourth month the dog gained 3 kg in body weight (case 2). The other dog had regurgitation episodes for one week following surgery, but gradual improvement was observed. The cat experienced regurgitation and vomiting episodes for five days after the operation but im-



Figure 2. Direct oesophagography in case 4; dilatation of the oesophagus and ventral deviation of the trachea cranial to the heart are obvious on this radiograph

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proved gradually over one month. All survivors improved after the operation with the residual clinical signs deemed acceptable by the owners.

DISCUSSION

Persistent right aortic arc can be diagnosed tentatively by clinical signs, and definitive diagnosis can be reached by direct and barium oesophagogram. All cases presented here were confirmed during surgery. The most affected dog breeds are Irish setters and German shepherds (Gunby et al. 2004; Yalcin et al. 2009), whereas in cats there is no breed predisposition. The cases presented here concerned a German shepherd, a Rottweiler, a mixed breed dog and one domestic short-haired cat, which is consistent with the fact that as only a small number of cases have been reported in the literature no breed predisposition has yet been identified. Siamese and Persian cats appear to have been overlooked in the literature (Kyles 2003).

Persistent right aortic arch can be suspected based on clinical signs and history, but it should be confirmed by thoracic radiographs which demonstrate tracheal deviation to the left, cranial to the heart. Additionally, ventrally deviated trachea cranial to the heart on the right lateral thoracic radiograph was suggestive of a persistent retrooesophageal left subclavian artery (Christiansen et al. 2007). In the presented cases, the radiographic signs showed persistent retrooesophageal left subclavian arteries in addition to PRAA.

Tracheal deviation which is one of the reliable signs for diagnosing PRAA in direct radiography has been found to be sufficient for diagnosis by some authors (Buchanan 2004). According to the results of this study, determining the extent of oesophageal dilatation and also ruling out other oesophageal disorders like megaesophagus barium oesophagogram can be suggested in addition to the tracheal deviation. Vascular ring anomalies in dogs and cats may take multiple forms and include PRAA with left ligamentum arteriosum, persistent right ligamentum arteriosum with a left aortic arch, aberrant left or right subclavian artery, aberrant intercostals and double aortic arch (Kyles 2003; Christiansen et al. 2007; Menzel and Distl 2011; Bottorff and Sisson 2012). In the cases presented in this study, PRAA with left ligamentum arteriosum was the only abnormality. A presumptive diagnosis of PRAA was made

on the basis of the history, clinical signs, physical examination findings, oesophagography and oesophagoscopy. However, in our case, the dogs responded well to the surgical correction and regained nearly full function of the oesophagus. There were no further episodes of regurgitation and the dogs gradually gained weight. Vascular ring anomalies should be considered as a probable cause of postprandial regurgitation with oesophageal dilatation and stricture after weaning in any young dog.

Surgery remains the only treatment option for PRAA and the results of long-term medical therapy are poor because of the nature of the problem. If the VRA persists, the oesophageal dilatation worsens and leads to malnutrition-related death of the animal. Surgery with the patient in lateral recumbence is preferred and surgical correction performed through a left-side thoracotomy by ligation and transection of the ligamentum arteriosum (Lawther 1970; Vogtli et al. 1994; Saunders et al. 2013). We also performed left-sided thoracotomies in our cases and ligation of the ligamentum arteriosum was carried out without any complication or damage to the surrounding tissues. In the second case, the ligamentous structure was still active and contained blood. However, double ligation is a standard technique and prevents the possibility of haemorrhage, an important point which should be considered.

Thoracotomy is a painful procedure in small animals, and it should be managed perioperatively. Intercostal and intrapleural analgesia is recommended for this kind of operation (Thompson and Johnson 1991; Pascoe and Dyson 1993). In our cases, the applied analgesia protocol was found to be sufficient, and the results of our study are in line with previous studies about intercostal and intrapleural anaesthesia.

Surgical intervention should be planned after the diagnosis of VRA to ensure that further dilatation of the oesophagus can be prevented and to stimulate peristalsis of the oesophagus (Kyles 2003). In our four cases, surgical treatment was carried out after the diagnosis. Three cases were within the age limits reported in previous reports, but the cat was two years old at the time of presentation and thus survived a long time with PRAA. Cats suffering from VRA have not been presented at this age to the authors' knowledge and this finding seems to be an exception in the literature. The previously reported cat with PRAA was under 12 weeks of age (Plesman et al. 2011). Our patient was underweight, and due to mal-

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nutrition and dilatation of the oesophagus, its food intake was abnormal. In this exceptional case, the oesophageal dilatation was expected to worsen and possibly end in the death of the animal. However, we have observed that after surgical correction of the ligamentum arteriosum the animal regained weight and episodes of regurgitation gradually resolved. The main pathology occurring in the oesophagus cannot be reversed completely after surgical intervention to resolve PRAA (Hedlund 2007). However, further dilatation of the oesophagus can be prevented and some improvement of its motility can be ensured so as to decrease the frequency of regurgitation and improve body condition.

The low number of cases is the main limitation of this study. Vascular ring anomalies can be seen together with other heart anomalies so cardiologic examinations like echocardiography and electrocardiography (ECG) are also advised for the follow-up. The outcomes of the surgery were followed up with telephone conversations with the owners in monthly intervals. All the three animals responded well to surgical treatment. There was regurgitation in the early post-operative period, but this gradually resolved after the surgery. The animals gradually gained weight in the post-operative period, and the owners expressed their satisfaction with the recovery of their animals.

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