First case report of patent ductus arteriosus occlusion with titanium endoclip in a cat

During embryogenesis period, the ductus arteriosus originates from the sixth left aortic arch, acting as a vascular connection between the pulmonary artery and the descending aorta. After birth, the functional ductus arteriosus persistence characterizes the anomaly Persistent Ductus Arteriosus (PDA), which is an unusual condition in cats. At first, as a result of this anomaly, volume overload is observed in the left atrium and ventricle, which according to the chronicity of the disease and the duct diameter, can impair lung function and even reverse the feeling of blood flow through the shunt.

**Case summary:** A mongrel female feline was referred for the surgical sector of the Animal Experimentation Unit at UENF, presenting diagnosis of PDA. During the clinical examination the mucous membranes were normal colored, heart rate considered normal, but with the presence of systolic murmur III / VI, more audible in the left hemithorax region. The surgical procedure was performed by thoracotomy in the fourth intercostal space, identifying the PDA and performing the occlusion of the duct with vascular titanium clip.

**Relevance and novel information:** The present study describes the first case report of a vascular titanium clip occlusion in PDA, which is an uncommon anomaly in the specie. A left lateral thoracotomy approach was performed. The use of a vascular titanium clip is a technique that requires little dissection during the surgery, reducing complication risks in the postoperative. The procedure was successfully performed without complications and minimal bleeding.

**Key-words:** congenital heart disease, shunt, surgery, feline, thorax.
Introduction

The incidence of congenital heart disease in cats seen in clinical practice is one case per 1,000 patients (1). Anomalies of the endocardial cushion defects are considered the most prevalent in cats, such as ventricular septal defect, partial or complete atroventricular septal defect, atroventricular valve dysplasia (2) where the left atroventricular valve is more affected than the right. Aortic stenosis and pulmonary stenosis are relatively rare, and the persistent ductus arteriosus (PDA) (3).

In cats, the PDA may occur alone or coexist with other malformations, especially with ventricular septal defect (4) (5). The ductus arteriosus is a variable channel length and diameter similar to the descending aorta and is a structure present in mammalian fetuses. Although the thickness of its wall is similar to the wall thickness of the aorta and pulmonary artery, its middle layer is basically composed of smooth muscle, different from the layer of elastic fibers found in aorta and pulmonary arteries (6). During embryogenesis, the ductus arteriosus originates from the sixth left aortic arch, acting as a vascular connection between the pulmonary artery and the descending aorta. This connection allows the flow of blood from the nonfunctional fetal lungs to the aorta, allowing fetal perfusion (7). After birth, onset of respiration and increased blood oxygen tension contribute to the closing of the duct, separating the systemic circulation of the pulmonary circulation (8).

The blood flow deviation through the shunt in the left-right direction results in increased pulmonary circulation, compromising its complacency and generating extender work of breathing. As a result, an overloaded volume is observed in the left atrium and ventricle and pulmonary edema may occur (6).

In 2001, Buchanan (9) reported that this overloaded volume in the left atrium and ventricle generates an eccentric hypertrophy, leading to cardiac remodeling and predisposing patients to develop left heart failure. Over time, the chronic increased volume in the pulmonary circulation leads to a series of morphological and vasculature pulmonary changes, such as arteriolar hypertrophy, occlusion of arterioles and lung capillaries, leading to increased vascular resistance and pulmonary blood pressure (6). In cats, the literature on pulmonary arterial hypertension secondary to the presence of PDA is scarce (10). When the pulmonary vascular resistance
exceeds systemic vascular resistance, the shunt becomes reverse and the dynamics of the blood flow changes to right-left (6). It is generally observed early reversal of the shunt in patients with a high diameter of the duct (11) (10). Echocardiography is the most appropriate test to confirm the diagnosis of PDA, evaluate the impact caused by the shunt and possible associated lesions (6).

Definitive treatment of PDA is based on surgical correction, the account of the first successful surgery of this anomaly in feline dates from 1975 (12). The surgery consists in closing the duct using ligation with suture or via a vascular clip. It is further described intravascular catheterization technique occlusion (13). The closing of duct through ligation with suture leads to some risks that could compromise the procedure. The tissue around the duct is thin and friable, and should be carefully dissected along with the location and removal of the vagus nerve and the recurrent laryngeal nerve. The passage of the suture and the subsequent ligation of the voltage can damage and tear the duct, leading to bleeding and may compromise the patient's life.

The use of titanium vascular clip technique requires little dissection greatly reducing complications and risks during the procedure and the postoperative (14). The technic is developed by thoracoscopy, a less invasive method with reduced surgical trauma and postoperative pain and a shorter surgical recovery by the animal, when compared to traditional technique by thoracotomy.

One factor that may prevent the use of vascular clip is the diameter of the duct, which cannot exceed 12 mm in diameter, as this is the largest vascular clip size found. Other problems related to use of the clip include risk of shunt and recanalization interference clip with imaging tests such as CT scans, X-rays and magnetic resonance imaging (15).

The prognosis for feline PDA carrier untreated is unfavorable, and 50% or more of patients die after
diagnosis. Cats with chronic PDA are likely to develop left congestive heart failure and pulmonary edema. Patients underwent surgical treatment have an excellent prognosis (1).

In the present work was carried out occlusion of PDA in a feline, with the use of vascular titanium clip (SLS-clip®, Vitalitec) through thoracotomy, aiming more security and reduced risk of trans-operative complications compared with ligation technique with suture.

Anamnesis

A 12-months-old female, mongrel feline, with diagnosis of PDA and left-right deviation was referred to the surgery sector of the Animal Experimentation Unit. The complete blood count and biochemical test were within normal limits, and the Doppler echocardiographic examination revealed a left ventricle dilatation, thickening of pulmonary valve leaflets and presence of turbulent flow coming from the right ventricular outflow tract with continuous and turbulent flow in pulmonary artery due the presence of left to right 0.42 cm diameter shunt. Also, the evaluation revealed a 14.1 mmhg pulmonary pressure
gradient with 187.7 cm/s speeding, suggesting pulmonary arterial overload. The left ventricular systolic function remained normal.

During preoperative physical examination by the surgical team were found normal colored mucosa membranes, heart rate normal value, but with the presence of systolic murmur III / VI, more audible in the left hemithorax region. As there was the presence of cardiac murmur, which was audible in the left hemithorax ruled out the possibility of shunt reversal. Auscultation of lung fields was normal, not observable increase in respiratory effort was observed.

Patient preparation for surgery was performed by venipuncture and fluid to Ringer's lactate based, followed by the pre-anesthetic medication administration associating acepromazine (0.1 mg / kg, IM) and midazolam (0.2 mg / kg , IM). After conducting extensive trichotomy of the left hemithorax, the patient was induced with propofol (4 mg / kg, IV) and the Anesthesia was maintained with isoflurane (1.5 to 2.0 V%).

For analgesia fentanyl infusion was administered (0.8 mg / kg / minute) and antisepsis of the surgical region was performed with povidone iodine.
The surgical approach was performed through a thoracotomy in the fourth intercostal space, followed by separation of the lung lobes with the aid of sterile gauze moistened with saline. The vagus nerve and the recurrent laryngeal nerve were identified and kept away from the surgical field, delicately, then the PDA was identified visually and with digital touch that provided perception of blood flow through the aorta to the pulmonary artery this technique orders the minimum dissection reducing the risk of rupture of the duct.

A Bakey clamp was placed to occlude the duct, the occlusion was maintained for 5 minutes to assess the possible right pulmonary artery accidental occlusion that represents hemodynamic changes, which would be indicated in the parameters of capnography, oximetry, ECG, heart rate and blood pressure observed in the multiparameter monitor.

There was an artery engorgement descending aorta due to shunt closure, bypassing the volume and thereby increasing the blood flow to the aorta. After removal of the Bakey clamp was positioned and fixed the endoclip 2 titanium vascular clips (SLS-clip®, Vitalitec) for permanent occlusion of the duct.
In sequence was carried out to thoracotomy with interrupted sutures of the ribs using polyglycolic acid 0 (Ethicon, Dexon), positioning them immediately cranial and caudal. Finally, there was thoracentesis restoring negative intrathoracic pressure. The animal returned from anesthesia and was taken to hospital where he remained for a period of 24 h without complications. During the postoperative Doppler echocardiography was observed an effective ductal occlusion and the pulmonary gradient pressure reduced to 1,82 mmhg.

Discussion

We opted for the realization of left thoracotomy, instead of thoracoscopy or catheterization technique for this surgical procedure, due to the deep knowledge of the surgical technique. The choice of using the vascular titanium clip was based on the report of Mandhan et al (14) that compared the complications caused by the use of ligation with suture and occlusion with the titanium clip, which observed that in the first case there is an increased risk of duct injury, leading to rupture and hemorrhage, during dissection and resection of the duct during surgery. In addition Panagopoulos et al (16) indicate a rate of 3 - 5% of the duct recanalization after ligation with suture.

The use of titanium vascular clip requires minimal dissection of the duct giving greater simplicity and rapidity to the procedure, however acquiring non-absorbable and monofilament sutures is less expensive when compared to endoclip and titanium vascular clip. In situations where the diameter of the duct is greater than 12 mm, the surgical procedure for the PDA correction of reference is through ligature, suture or with use of a duct occlusion device for catheterization, due to the biggest clip occlusion device has a 12 mm diameter.
Despite being provided complications PDA surgery in dogs as: hemorrhage, pulmonary trauma, heart failure, arrhythmias (17) (18) with a mortality rate ranging from 1.6 - 11% (19), during the current study were not observed changes that would compromise the procedure.

Conclusion

It is concluded that the use of the vascular occlusion clip PDA was an effective technique, since at the examination of postsurgical Doppler ecocardiography there was no remaining flux, also being a safe procedure, since the risk of complications during surgery were minimal.

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Conflicts of interest

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References


