

**PERITONIAL-PERICARDIAL DIAPHRAGMATIC HERNIA IN AN OLD FEMALE DOG**

***HÉRNIA DIAFRAGMÁTICA PERITÔNIO-PERICÁRDICA EM CADELA IDOSA DA RAÇA BASSET HOUND***

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**Resumo:** Uma cadela da raça Basset Hound, de 10 anos de idade, foi levada a uma clínica veterinária para correção de alteração oftálmica recidivante (*Cherry eye*) e de hérnia umbilical e castração eletiva. Durante a cirurgia, ela apresentou sopro cardíaco grau II/III, porém sem alterações no eletrocardiograma. Algumas horas após a cirurgia, o animal começou a apresentar vômito e diarreia sanguinolentos e hipoglicemia. A cadela foi internada, porém veio à óbito por parada cardiorrespiratória, sendo encaminhada para realização de necropsia no Setor de Patologia do Hospital Veterinário da Universidade Federal de Minas Gerais. À necropsia observou-se que o diafragma e o saco pericárdico apresentavam área de perda de continuidade circular de aproximadamente 4 cm de diâmetro, permitindo a comunicação entre as cavidades peritoneal e pericárdica. O lobo quadrado do fígado e parte do omento se insinuavam para o interior do saco pericárdico, através da abertura. O lobo hepático herniado apresentou-se reduzido de volume por fibrose. Além disso, foram observados gastrite hemorrágica intensa, enterite hemorrágica com depleção linfóide intensa, linfadenomegalia e esplenomegalia moderadas. Apesar da hérnia diafragmática peritônio-pericárdica, o animal resistiu ao procedimento cirúrgico, tendo sido a hérnia considerada um achado incidental de necropsia. O quadro de gastroenterite hemorrágica não teve relação direta com a hérnia.

**Palavras-chave:** defeito congênito, diafragma, pericárdio

**Abstract:** A 10-year-old female Basset Hound was taken to a veterinarian hospital so that surgery for the correction of a recurrent ophthalmic condition (*Cherry eye*) and an umbilical hernia, and the dog's castration could be performed. During surgery, the dog presented a systolic cardiac murmur grade II/III although no abnormalities were seen on the electrocardiogram. A few hours after surgery, the animal started to vomit and presented liquid feces with blood and hypoglycemia. The dog was hospitalized, but a few hours later suffered cardiopulmonary arrest and died, after which the dog was submitted to a necropsy. Necropsy revealed the presence of a round area with a diameter of 4 cm located in both the diaphragm and pericardial sac. This area created a communication between the peritoneal and pericardial cavities. Inside the pericardial sac, liver's quadrato lobe and part of the omentum were found. Fibrosis had caused a reduction in the herniated hepatic lobe volume. Furthermore, severe hemorrhagic gastritis, hemorrhagic enteritis with severe lymphoid depletion, moderately

enlarged lymph nodes and spleen were also observed. Despite the presence of the peritoneal-pericardial diaphragmatic hernia, the animal survived the surgery, which indicated that the hernia was an incidental finding during the necropsy. The hemorrhagic gastroenteritis had not a direct relationship to the hernia.

**Keywords:** Congenital anomaly, diaphragm, pericardium.

## INTRODUCTION

Peritoneum-pericardial diaphragmatic hernia (PPD) is a congenital communication between the pericardial sac and the abdominal cavity, which allows the displacement of abdominal organs into the pericardial sac (Evans and Biery, 1980; Smolec et al., 2018). Among the most frequently herniated organs are the liver, small intestine, gallbladder, omentum, spleen, colon, pancreas and the sickle cell ligament (Burns et al., 2013).

It is believed that the genesis of this type of hernia is related to the failure in embryonic development of the transverse dorsolateral septum, which forms the ventral portion of the diaphragm, in the structure called the sternocostal triangle (Burns et al., 2013; Nikiphorou et al., 2017; Smolec et al., 2018). Failure to close the transverse septum or to fuse this structure with pleuroperitoneal folds are the mechanisms proposed for the development of peritoneo-pericardial diaphragmatic hernia (Nikiphorou et al., 2017). Genetic defects, prenatal injuries and teratogenic agents are among the causes of this hernia (Burns et al., 2013; Nikiphorou et al., 2017). The possibility of genetic inheritance has not yet been proven, although peritoneum-pericardial diaphragmatic hernia has already been reported in puppies with the same type of hernia (Statz et al., 2007).

DPP hernia is uncommon in dogs and cats, accounting for only 0.025 % of small animal care at two veterinary hospitals in Ohio, United States, from June 1999 to June 2008 (Burns et al., 2013). Studies have shown that it occurs more often in cats than in dogs. Among the most affected breeds is Weimaraner in dogs and Persian and domestic long-haired in cats (Evans and Biery, 1980, Reimer et al., 2004, Banz and Gottfried, 2010, Burns et al., 2013). The average age at diagnosis is 14.4 months for dogs and 30 months for cats (Nikiphorou et al., 2017). However, in some cases, the diagnosis can occur much later, at 7 years of age or older (Evans and Biery, 1980; Rosenstein et al., 2001; Debiak et al., 2009; Burns et al., 2013).

The presence and severity of clinical signs depend on the degree of herniation and the herniated organ (Burns et al., 2013; Smolec et al., 2018), and the animal may be asymptomatic. But, when present, symptoms vary from mild to severe, and may even lead to death, as a consequence of impaired cardiac, respiratory (Debiak et al., 2009; Khorandish et al., 2014) or gastrointestinal (Smolec et al., 2018). The passage of the liver, spleen, stomach or intestines into the pericardial sac can result in cardiac tamponade, impaired respiratory function, gastrointestinal obstruction, gallbladder torsion and spleen or liver compression (Reimer et al., 2004; Burns et al., 2013).

As it is rare, the objective was to report the case of a 10-year-old Basset Hound dog who was diagnosed with peritoneum-pericardial diaphragmatic hernia.

## CASE REPORT

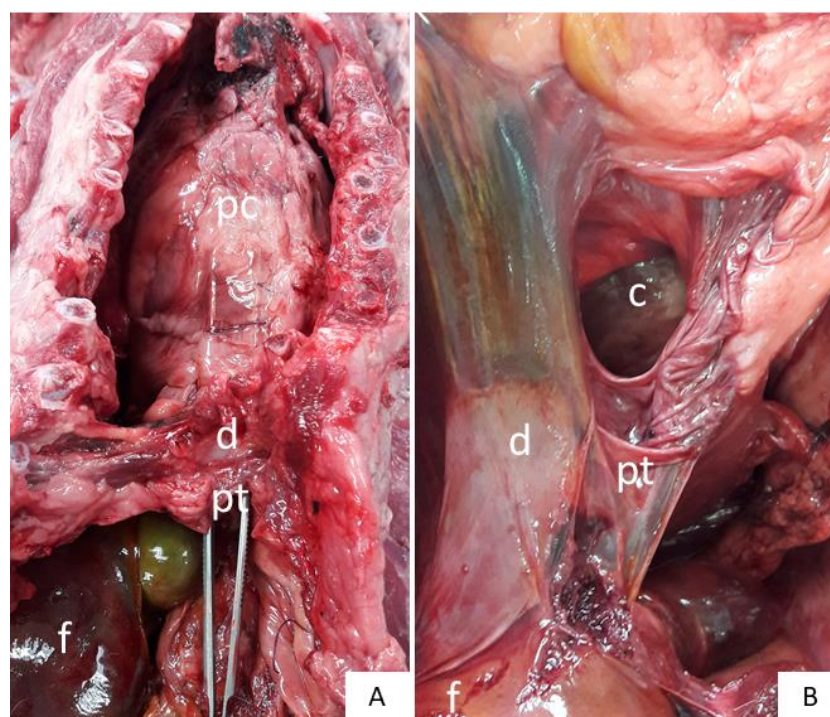
A 10-year-old Basset Hound dog was taken to a veterinary clinic for surgical correction of recurrent third eyelid prolapse (Cherry eye), umbilical hernia and for elective castration. According to the tutor, the animal ate normally, the feces were normal and the vaccines and worms were delayed. Upon pre-surgical physical examination, no changes were observed.

Complete blood count and biochemical profile were performed, which demonstrated normal parameters.

The animal was then referred for surgery and during the anesthetic monitoring, the presence of a heart murmur on the left side, grade II, without electrocardiographic abnormality was observed. However, the animal remained stable throughout the surgery without major complications.

Two hours after surgery, the animal began to experience frequent vomiting and bloody diarrhea. On clinical examination, the animal was hypoglycemic, and abdominal ultrasound showed only a thickening of the stomach wall. The dog was admitted and started to receive gastric protector, analgesic and glucose solution. But, a few hours later, the dog had cardiopulmonary arrest and died, being referred to the Pathology Sector of the Veterinary Hospital of UFMG, for the necropsy.

At necropsy, the oral and ocular mucous membranes were intensely hyperemic. In the diaphragm, there was a circular ventral area of loss of continuity of approximately 4 cm in diameter, which allowed communication between the abdominal and pericardial cavities. Through this opening, the square lobe of the liver and part of the omentum were insinuated into the pericardial sac. No hemorrhage or fibrosis was observed at the edges of the diaphragmatic opening. The square lobe was part of the herniated content and was moderately reduced in size, pale, with a slightly roughened surface and firmer than normal, as characteristics of fibrosis. The other hepatic lobes were slightly hyperemic. There was also hemorrhagic gastritis associated with the presence of two sharp and flat foreign bodies measuring 2x2.6 cm and 1.5x0.9 cm, and hemorrhagic enteritis with depletion of the lymphoid tissue associated with the mucosa. The mesenteric lymph nodes and the spleen were moderately enlarged and hyperemic. Samples of abdominal and thoracic organs were taken for histopathological examination which confirmed the macroscopic findings, with no other significant changes (**Figure 1**).



**Figure 1.** Necropsy image of a 10-year-old Basset Hound dog. A) Observe the communication between the abdominal and pericardial cavity demonstrated by the forceps. B) Diaphragm

with circular ventral area of loss of continuity of approximately 4 cm in diameter. Pericardium (pc), heart (c), diaphragm (d), peritoneum (pt) and liver (f).

## DISCUSSION

In the present case, although the DPP hernia was an incidental finding of necropsy diagnosed in an elderly dog, all indications are that this alteration is congenital. In dogs and cats, this hernia is the result of congenital anomalies, unlike humans, in which it can be of traumatic origin (Kheirandish et al., 2014). This is because in these animals, the peritoneal and pericardial cavities are not directly connected (Evans and Biery, 1980; Banz and Gottfried, 2010; Kheirandish et al., 2014). In humans, there is usually a fusion between the diaphragm and part of the fibrous pericardium, which allows the occurrence of traumatic peritoneum-pericardial hernia of traumatic origin (Evans and Biery, 1980).

Most patients with DPP hernia are diagnosed in their first years of life (48 %) and about 6 % are diagnosed after 8 years of age (Evans and Biery, 1980; Kheirandish et al., 2014; Smolec et al., 2018). The late diagnosis is due to the fact that, in some cases, traumatic events or that increase intra-abdominal pressure, even if they occur late in the patient's life, can cause more abdominal viscera to move into the pericardial cavity, thus causing the appearance of acute clinical signs in elderly animals (Kheirandish et al., 2014). In other cases, an elderly animal has the hernia diagnosed incidentally, when submitted to chest X-rays or surgeries performed for other purposes, or during necropsy, as occurred with the dog in the present case. The dog in question also had umbilical hernia, which is the congenital alteration most frequently seen in concomitance with the peritoneum-pericardial diaphragmatic hernia (Kheirandish et al., 2014). The diagnosis of umbilical hernia is made through history and clinical examination, without the need for ultrasound (Harrisson et al., 1994; Conze et al. 2001). However, knowing that these anomalies can occur concurrently it is important that imaging exams are carried out for a better investigation.

No changes were observed on the clinical examination before surgery. Even with several organs or a large portion of a certain abdominal organ in the pericardial cavity, some animals do not show clinical signs (Debiak et al., 2009). An example of this was reported by Debiak et al. (2009), in which the dog with peritoneum-pericardial diaphragmatic hernia presented a large number of intestinal loops inside the pericardial cavity without showing any symptoms. However, two hours after surgery, the dog began to show gastrointestinal signs. In general, gastrointestinal signs resulting from this type of hernia, such as vomiting and diarrhea, are more commonly observed when the herniated organs are the intestines and/or the stomach (Banz and Gottfried, 2010). On the other hand, animals that had other herniated organs, such as the liver and gallbladder, may also show clinical gastrointestinal signs (Rosestein et al., 2001; Statz et al., 2007). Nevertheless, in the present case, the presence of hemorrhagic enteritis with depletion of lymphoid tissue, hemorrhagic gastritis with foreign bodies and enlargement of the mesenteric and spleen lymphs, allows suspecting that the gastrointestinal changes are of infectious origin, as is the case of parvovirus, and aggravated by the presence of foreign bodies. Therefore, it is suggested that the DPP hernia did not lead to the appearance of the gastrointestinal clinical signs observed in the dog and that the hernia diagnosis was an incidental necropsy finding.

Burns et al (2013) determined that in 46 % of dogs and 50 % of affected cats, herniated DPP was an incidental finding detected through imaging tests. Although DPP hernia can be diagnosed by ultrasound, it is common that no changes are observed, especially when the herniated content is the omentum or a small part of the liver (Babicsak, 2011). The diaphragm defect observed in the present case was only 4 cm in diameter. But, when the defect is larger, the displacement of abdominal organs to the pericardial sac occurs more freely, which may result in the formation of adhesions of these to the pericardium, and entrapment or strangulation of organs,

leading to gastrointestinal, respiratory and/or cardiac changes (Burns et al., 2013; Smolec et al., 2018). On the contrary, small defects in the diaphragm may be occluded by the omentum or sickle-cell fat, so that animals may not show clinical signs (Reimer et al., 2004).

The most reported clinical finding in herniated PPD has been the presence of muffled sounds on cardiac auscultation, both in dogs and cats. In many cases, cardiac sounds are shifted more to the left or cranially, and precordial shock is more difficult to feel (Banz and Gottfried, 2010; Kheirandish et al., 2014). Heart murmurs, similarly to what was observed in the present case, have already been detected in animals with peritoneum-pericardial diaphragmatic hernia without any concomitant heart disease (Evans and Biery, 1980). It is suggested that the compression of the heart by the herniated abdominal organs can alter the blood flow in the heart, making it turbulent, thus causing the appearance of the murmur (Evans and Biery, 1980; Banz and Gottfried, 2010). On the other hand, it is known that DPP hernia can occur associated with acquired or congenital heart diseases (Banz and Gottfried, 2010; Burns et al., 2013), since embryologically, the formation of the cardiac septum and the ventral portion of the diaphragms occur simultaneously (Evans and Biery, 1980). In the present case, no changes were detected in the electrocardiogram of the surgical risk and in the macro and microscopic examination of the heart.

In this patient, only the square lobe of the liver and part of the omentum were in the pericardial cavity. In dogs and cats, the liver and gallbladder are the most frequently herniated organs (Statz et al., 2007; Banz and Gottfried, 2010), although all abdominal organs, with the exception of the adrenal glands and the urinary tract, are susceptible to herniation (Banz and Gottfried, 2010). When the liver is trapped in the pericardial sac, its circulation may be compromised, causing ischemia and hepatocellular hypoxia (Evans and Biery, 1980; Statz et al., 2007), which justifies the occurrence of herniated square lobe fibrosis in the present case. However, when larger portions of the liver are herniated, there may be a serum increase of enzymes activity such as ALT and AST, as well as cholestasis (Statz et al., 2007), which was not observed in the present case. Herniation of the liver and gallbladder can also contribute to the formation of choleliths and, consequently, lead to the onset of cholecystitis, hepatitis (Rosenstein et al., 2001) and hepatic encephalopathy (Evans and Biery, 1980).

## CONCLUSION

Based on the macroscopic findings, a diagnosis of peritoneo-pericardial hernia was achieved. Although rare, the early use of imaging tests can result in an early diagnosis of this alteration, favoring the prognosis.

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