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Karlapudi Satish Kumar
Department of Veterinary
Medicine, College of Veterinary
Science, Rajendranagar,
PV Narsimha Rao Telangana
Veterinary University,
Hyderabad, Telangana, India

VVV Amruth Kumar
Department of Veterinary
Medicine, College of Veterinary
Science, Korutla Jagityal,
Telangana State, India

Corresponding Author:
Karlapudi Satish Kumar
Department of Veterinary
Medicine, College of Veterinary
Science, Rajendranagar,
PV Narsimha Rao Telangana
Veterinary University,
Hyderabad, Telangana, India

Diagnosis and repair of peritoneopericardial diaphragmatic hernia (PPDH) in a Doberman dog: A first report from India

Karlapudi Satish Kumar and VVV Amruth Kumar

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Abstract

Peritoneopericardial diaphragmatic hernia is one of the unusual developmental anomalies of diaphragm in dogs and cats, which are presented without any specific signs. Presented dog was examined clinically, physically and later subjected for chest radiograph and echocardiography for confirmation. Surgical repair was carried out through a midline celiotomy and the diaphragm was closed by opposing the margins in two layer using simple continuous pattern with polydioxanone suture material. Affected dog was showing normal temperature, elevated pulse and heart rate. Muffled heart sounds and barborhythmia were detected on auscultation of chest. X-ray on left lateral exposure revealed loss of continuity of diaphragm along with gas filled radiolucent intestines within the pericardium and adjacent soft tissue structures of thorax. Presence of anechoic area with hyperechoic crystals within the pericardial space, diastolic collapse of right atrium and left ventricle were the echocardiographic features. Ultrasound guided thoracocentesis sample revealed alkaline pH (8.5). Surgical repair of the PPDH was performed through a midline celiotomy and the diaphragm was closed using simple continuous sutures with polydioxanone suture material.

Keywords: peritoneopericardial diaphragmatic hernia; diagnosis; surgical repair; dog

Introduction

Peritoneopericardial diaphragmatic hernia (PPDH) is a congenital anomaly in dogs with a communication between the pericardial sac and the peritoneal cavity that allows displacement of abdominal organs to the pericardial sac (Banz and Gottfried, 2010; Mcclaran, 2013) ^[1] and ^[9]. Abdominal organs that can be herniated into the pericardial sac include liver, gallbladder, omentum, intestines, spleen, and pancreas (Banz and Gottfried, 2010; Burns *et al.* 2013) ^[1] and ^[3]. In small animals, PPDH is the most common congenital anomaly involving the pericardium and the diaphragm (Burns *et al.* 2013; Reimer *et al.* 2004) ^[3, 13]. Trauma is also one of the causes for acquired diaphragmatic hernias in dogs particularly in very young age (Hoddinott, 2013) ^[4]. Adhesions between the herniated organs and pericardium or myocardium is the most common associated complications that may result fatal among these species (Banz and Gottfried, 2010) ^[1]. Malformations and teratogen-induced factors are the most probable causes for PPDH among various species (Rexing and Coolman, 2004) ^[14]. Most of the dogs remain asymptomatic and many times the PPDH is an incidental finding during routine check-up (Banz and Gottfried, 2010; Hunt and Johnson, 2012) ^[1, 6] or at necropsy (Reza *et al.* 2014) ^[15]. An embryonic development defect of the dorsolateral septum transversum that is associated in a structure termed as sterno-costal triangle may result in this developmental abnormality (Berry *et al.* 1990) ^[2]. Peritoneopericardial diaphragmatic hernia has been reported in dogs, cats, rabbits, donkey and calf (Margolis *et al.* 2018; Wright *et al.* 1987) ^[8, 17]. This paper presents an incidental case of PPDH and its surgical repair in an adult Doberman dog.

Observations and Results

An eight year old male Doberman dog was referred to the Cardiology ward of Veterinary Clinical Complex, CVSc, Rajendranagar, Hyderabad with the history of chronic recurrent vomiting, anorexia, weakness, tachypnoea and going down in condition for a couple of months.

Treatment by a local vet did not completely alleviate the signs and were recurring once the medication was discontinued. Clinical parameters, viz., pulse and heart rate were considerably elevated while the rectal temperature was within the normal range, with slightly pale conjunctival mucous membrane. The dog was partially recumbent and extremely weak. Auscultation of chest revealed low intensity heart beat with muffled sounds, exaggerated respiratory sounds and typical barborygmi sounds of intestines. Physical examination of abdomen didn't reveal any abnormality. Neutrophilic leukocytosis was the CBP abnormality but with normal serum chemistry values. X-ray on left lateral exposure of thorax revealed radiolucent areas within the pericardial space and adjacent soft tissue structures of thorax. Continuity of abdominal soft tissue structures into thorax along with gas filled intestinal loops, through the diaphragm was also noticed on radiograph (Fig. 1). B-mode echocardiographic examination revealed huge amounts of anechoic area with swirling hyperechoic crystals within the pericardial space. Occasionally collapse of left ventricle free wall and right atrial wall was also noticed (Fig. 2 to 4). Sample aspirated on ultrasound guided thoracocentesis revealed alkaline pH of 8.5 and thus confirming PPDH as herniation of abdominal viscera through diaphragm.

Surgical repair of the PPDH was performed using routine protocol, under inhalation anaesthesia and positive pressure ventilator. The hernia was approached through a midline celiotomy (Fig. 5 to 7) and the diaphragm was closed from dorsal to ventral direction, by opposing the margins in two layers using simple continuous pattern with polydioxanone suture material (Fig. 8). Despite every effort, the dog died on day 7 post-operative.



Fig 3: B-mode short axis 5 chamber view of PPDH dog. Note collapsed right atrial wall (arrow)



Fig 4: B-mode short axis view of PPDH dog showing collapsed left ventricle free wall (arrow)

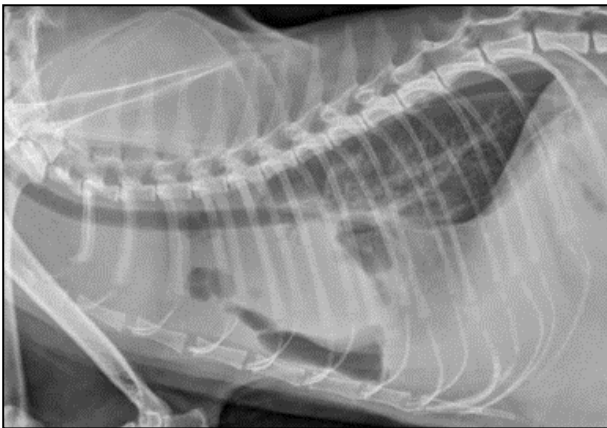


Fig 1: Lateral chest radiograph of Doberman with PPDH. Note the gas filled intestines within the pericardial sac.



Fig 2: B-mode echocardiogram. Note the Anechoic area (PE) in the pericardial space with hyperechoic crystals.

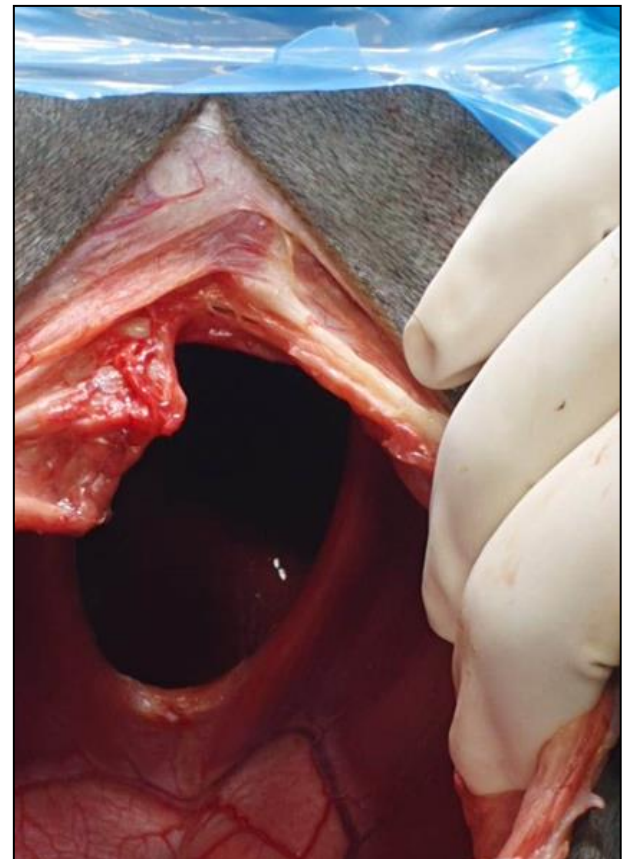


Fig 5: Intraoperative image of PPDH dog showing hernial ring of diaphragm.

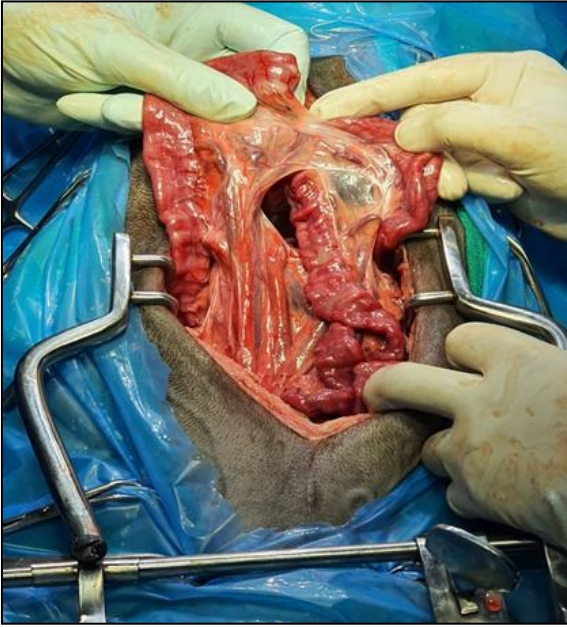


Fig 6: Herniated intestines being replaced during surgical repair.

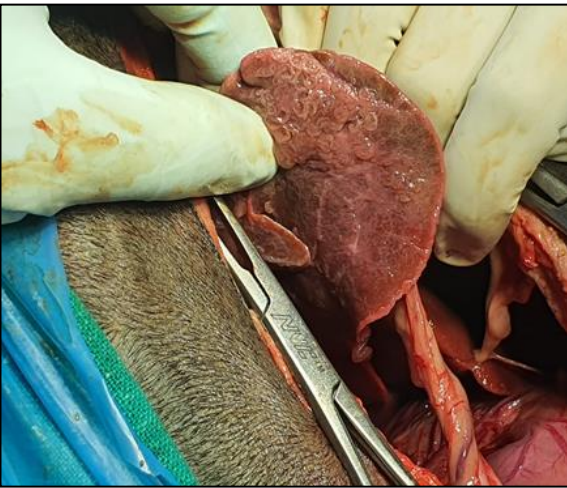


Fig 7: Abdomen viscera during surgical repair through a midline celiotomy

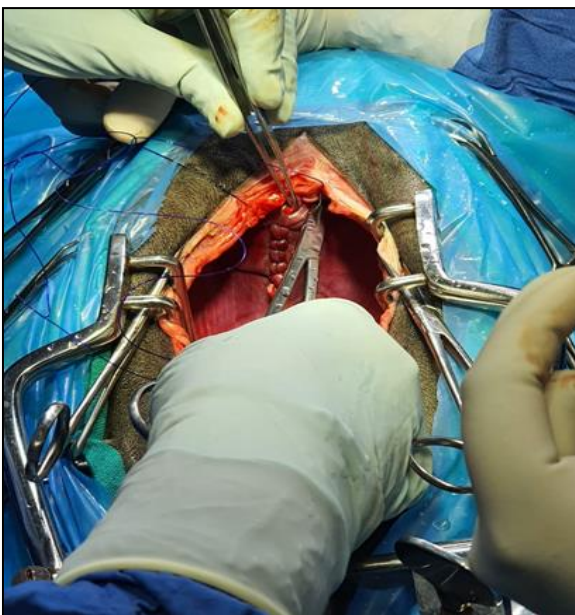


Fig 8: Closure of the diaphragm using simple continuous pattern with polydioxanone suture material.

Discussion

Many times dogs with PPDH are asymptomatic and / or are presented with non-specific signs that depend on the degree and nature of herniation (Burns *et al.* 2013 and Nikiphorou *et al.* 2016) [3, 11]. If the diaphragmatic hernia is large, the displaced abdominal organs into the pericardial sac may result in adhesion to the pericardium, organ entrapment or strangulation leading to gastrointestinal, respiratory or cardiac disorders. However, small defects that do not allow organ protrusion may remain asymptomatic (Mcclaran, 2013 and Litman, 2001) [9, 7]. The most common signs include intermittent vomiting, lack of appetite, weight loss and diarrhea that might be due to movement of the stomach or intestines into the pericardial sac. Some dogs are also presented with the signs of respiratory system *viz.*, dyspnea, cough, and wheeze, due to restricted movement of lungs associated with herniated organs (Banz and Gottfried, 2010 and Reed, 1988) [1, 12]. Unusual manifestations of PPDH include, abdominal distension, shock and collapse (Nikiphorou *et al.* 2016 and Reed, 1988) [11, 12]. Though the signs associated with PPDH are noticed at any stage of life, most commonly recorded later years rather than first few years and this is partly due to the fact that traumatic events, even late in patient's life, may cause abdominal contents to move into pericardial cavity giving rise to acute clinical signs (Evans and Biery, 1980) [4]. The most common findings on physical examination of PPDH dogs and cats include muffled heart sounds, heart murmurs, decreased lung sounds and barborogmy on auscultation or an empty abdomen on palpation (Burns *et al.* 2013; Reimer *et al.* 2004 and Neiger, 1996) [3, 13, 10].

The diagnosis of PPDH was an incidental finding in 46% of the dogs (Burns *et al.* 2013) [3]. PPDH is diagnosed by taking chest and abdominal x-rays (preferably contrast) and identifying stomach, intestines or liver in the pericardial sac. Thoracic radiograph may reveal an enlarged cardiac silhouette, presence of abdominal organs within the pericardial sac or loss of distinction between the heart and the diaphragm (Reimer *et al.* 2004 and Neiger, 1996) [13, 10]. The pathognomic radiographic findings include the evidence of gas filled herniated intestinal loops in pericardial sac (Rexing and Coolman, 2004) [14]. Echocardiography may also be done to assess the amount and nature of fluid in the pericardial sac and the effects of pericardial fluid and organs on the heart (Neiger, 1996; Reed, 1988 and Wallace *et al.* 1992) [10, 12, 16].

Surgical procedure followed in the present case is in accordance with (Banz and Gottfried, 2010 and Burns *et al.* 2013) [1, 3], who reported a ventral midline celiotomy approach for correcting PPDH among dogs and cats. The authors (Burns *et al.* 2013) [3] also opined that a caudal median sternotomy is required when adhesions are present between the herniated viscera and partial pericardectomy when adhesions of the herniated organs to the pericardium is present (Banz and Gottfried, 2010) [1]. Whereas, (Mcclaran, 2013) [9] suggested reconstruction of diaphragm with pericardial grafts in cases of large defects or in agenesis of the diaphragm. Prognosis following surgical repair of PPDH is usually good with 81-87.5% of the dogs recovering within 10-15 days postoperatively with a short-term postoperative mortality of 5-12.5% among dogs (Banz and Gottfried, 2010) [1]. Common postoperative complications include incisional dehiscence, regurgitation, pericardial steatitis or pneumothorax (Wallace *et al.* 1992) [16] and whereas, intraoperative complications such as, adhesions of the liver to the pericardium, hypotension, respiratory acidosis,

hypoventilation and hypoxia are most commonly observed in (Reimer *et al.* 2004) [13]. We conclude that, though the occurrence of the peritoneopericardial diaphragmatic hernia in dogs is rare, it should also be considered as one of the differentials when specific signs are present and should be corrected.

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