A ventral diaphragmatic advancement technique to repair a large congenital peritoneopericardial diaphragmatic hernia in a dog

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OBJECTIVE
To report a ventral diaphragmatic advancement technique to repair a large congenital peritoneopericardial diaphragmatic hernia in a dog.

ANIMAL
A 5-month-old 15-kg entire male Labrador Retriever.

CLINICAL PRESENTATION, PROGRESSION, AND PROCEDURES
The dog presented with a history of diarrhea for a week and acute-onset lethargy and vomiting for 3 days. Clinical examination revealed borborygmi on auscultation of the chest, and subsequent imaging showed a congenital peritoneopericardial diaphragmatic hernia.

TREATMENT AND OUTCOME
The ventro-central diaphragmatic defect was repaired with a pericardial flap, which subsequently failed 7 months later. The revision surgery was performed with a novel surgical technique. The defect was closed by means of incising the ventral attachments of the diaphragm either side of the defect and sliding it medially to allow a tension-free closure. The ventral aspect of the incised diaphragm was reattached with circumcostal sutures and the central defect closed. The dog recovered rapidly and without complication. An excellent outcome was reported after surgery.

CLINICAL RELEVANCE
This novel technique was a simple method to repair a peritoneopericardial diaphragmatic hernia and had good clinical results in this case.

Keywords: diaphragmatic, defect, techniques, peritoneopericardial, hernia

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µg/kg, IV) and methadone (0.3 mg/kg, IV). Anesthesia was induced with propofol (1.3 mg/kg, IV) and maintained with isoflurane. An epidural injection of morphine (0.1 mg/kg) and a line block with 0.5% bupivacaine hydrochloride solution were performed. Cefuroxime sodium (20 mg/kg, IV) was administered every 90 minutes throughout anesthesia. Volume-controlled mechanical ventilation was initiated in the operating room. With the patient in dorsal recumbency, a ventral midline celiotomy was performed. The PPDH was identified in a ventral and central position. The content of the hernia was reduced (small intestines and gall bladder). The hernia was closed by use of a pericardial flap to aid apposition of the diaphragmatic edges. The repair was performed with simple interrupted and mattress sutures of 2-0 nylon (Monosof; Covidien). A 12-gauge thoracic drain was placed temporarily to allow drainage of the thorax. Closure of the abdominal incision was performed in 3 layers: the abdominal wall with 0 polydioxanone (PDS II; Ethicon Inc) and 3-0 poliglecaprone 25 (Monocryl; Ethicon Inc) for the subcutaneous and intradermal layers. During hospitalization, the patient received paracetamol (10 mg/kg, IV, q 8 h) and meloxicam (0.1 mg/kg, PO, q 24 h). Methadone (0.1 mg/kg, IV, q 4 h) was administered if the Glasgow composite pain scale (short form) score was > 5 (on a scale of 0 to 24), where higher values reflect greater signs of pain. The patient was discharged from the hospital the following day with meloxicam (0.1 mg/kg, PO, q 24 h) for 10 days and strict rest for 4 to 6 weeks. At the 2-week recheck, the wound had healed well and clinical signs had resolved.

The patient initially recovered completely and returned to normal activity. However, the dog was presented again 7 months later with similar clinical signs. Radiographs were performed, and recurrence of the PPDH was identified. General anesthesia was performed following the protocol previously used. Paracetamol (10 mg/kg, IV) and a continuous rate infusion of fentanyl (5 to 10 µg/kg/h) were administered for perioperative analgesia. With the patient in dorsal recumbency, a ventral midline celiotomy was

Figure 1—Left lateral thoracic radiograph of a 5-month-old entire male Labrador Retriever evaluated for an acute history of lethargy and vomiting. The enlarged cardiac silhouette and gas densities consistent with intestinal loops visible within the pericardial sac are highly suggestive of a peritoneopericardial diaphragmatic hernia.

Figure 2—Pictures of the revision surgery from the dog described in Figure 1, showing the surgical site upon opening of the abdominal cavity (A), once the hernia had been reduced (B), after the ventral attachment of the diaphragm was incised from the peritoneum laterally on both sides of the defect (C), when the left side had been advanced into the defect (D), and with the final repair (E).
The diaphragmatic defect was visualized ventrally in a similar position as before and measured around 3 cm in diameter. A complete dehiscence of the previous repair was observed. Adhesions between the liver, small intestine, and diaphragm were present and gently dissected free. The content of the hernia was reduced (small intestines and mesenteric fat). The diaphragm was incised ventrally along the costal arch approximately 5 cm from the defect on each side. Interrupted sutures of 3-0 polypropylene (Prolene; Ethicon Inc) and polydioxanone (PDS II; Ethicon Inc) were placed between the diaphragm and circumcostally. The diaphragm was progressively advanced into the central defect on each side. The remaining central defect was then closed with interrupted sutures of 3-0 polydioxanone (PDS II; Ethicon Inc) under no tension (Figure 2). The pericardial sac was drained. A 12-gauge thoracic drain (Guidewire chest tube 12 GA X 20 cm; MILA) was placed temporarily to allow drainage of the thorax. Closure of the abdominal incision was performed in 3 layers: 0 polydioxanone (PDS II; Ethicon Inc) for the abdominal wall, 3-0 polyglactin 25 (Monocryl; Ethicon Inc) for the subcutaneous and intradermal layers, and 3-0 nylon (Ethilon; Ethicon Inc) in a Ford interlocking pattern for the skin. The patient recovered from surgery and anesthesia uneventfully. During hospitalization, the patient received paracetamol (10 mg/kg, IV, q 8 h), meloxicam (0.1 mg/kg, PO, q 24 h), omeprazole (1 mg/kg, IV, q 12 h), and maropitant (1 mg/kg, IV, q 24 h). Methadone (0.2 mg/kg, IV, q 4 h) was administered and topped up as before. Signs of aspiration pneumonia subsequently developed (increased respiratory efforts, cough, and crackles on auscultation). Cefuroxime (20 mg/kg, q 8 h) was started, and clinical signs improved. The patient was discharged from the hospital 48 hours postsurgery with omeprazole (1 mg/kg, PO, q 12 h) and paracetamol (10 mg/kg, PO, q 8 h) for 5 days, cephalaxin (20 mg/kg, PO, q 12 h) for 7 days, and strict rest for 4 weeks. At the 5- and 14-day postoperative rechecks, the patient was recovering well. An abdominal ultrasound performed 3 months postoperatively did not show any evidence of PPDH. Abdominal radiographs and ultrasound were taken 2 years and 8 months postoperatively to investigate gastrointestinal symptoms and did not reveal any evidence of PPDH.

**Comments**

Peritoneopericardial diaphragmatic hernia is a congenital anomaly in which the presence of a remaining connection between the pericardial and peritoneal cavity allows the displacement of abdominal viscera into the pericardium. Although it is most commonly an incidental finding, the defect can lead to indirect pulmonary compression and entrapment of viscera within the pericardium, which may cause respiratory, cardiac, and/or gastrointestinal signs. In our case, the patient showed gastrointestinal signs in both occurrences as well as typical abnormalities on chest auscultation. Clinically significant adhesions of organs within the pericardial sac are rare in dogs. The adhesions identified between the liver, small intestine, and diaphragm during the second surgery were suspected to be a result of the first repair attempt. Surgical repair is most commonly performed via a median celiotomy and a simple herniorrhaphy with continuous or interrupted sutures. For cases in which primary closure cannot be achieved due to excessive tension, several methods have been described in the literature such as the use of mesh and autologous flaps/grafts (fascia lata, latissimus dorsi muscle, serratus muscle, internal oblique muscle and transversus abdominis muscle, and pericardium). Although the pericardial flap is a published technique for PPDH repair, its success rate is unknown. The cause of failure of the repair 7 months postsurgery in this case was unclear but may potentially have been attributed to excessive tension or inherent abnormality in the strength of the pericardium itself. For the second repair, the use of a pericardial flap was therefore not considered. Instead, preparation for a reconstruction with a propylene mesh placement had been made. However, once the hernia was reduced, it was possible to use the inherent elasticity of the diaphragm to close the defect.

To the best of the authors’ knowledge, the diaphragmatic repair technique used for the dog of this report has not previously been described in the literature. This provided a straightforward approach to reconstruction with no requirement for additional techniques. This method has the advantage of avoiding the use of surgical mesh, which could increase the patient’s risk for complications (failure, visceral adhesions, fistula, and infection).

We believe the technique shows promise. However, there may be some limitations to the technique as the elasticity of the diaphragm may be variable depending on the localization of the defect. Future studies to measure and analyze diaphragmatic stretch depending on the localization of the defect. Future clinical studies would also be required to evaluate the technique’s reliability and potential complications. For the case we have reported, the outcome was excellent.

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**References**


