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Case Report

Standing Thoracoscopic Diaphragmatic Hernia Repair Using a Dual-Facing Mesh in a Horse

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ABSTRACT

The purpose of the report, is to describe the surgical procedure adopted in a horse, to repair a diaphragmatic hernia by using a dual facing meshA 6-year-old Warmblood gelding was referred for colic surgery. Exploratory laparotomy revealed a small intestine strangulation in a 8–10 cm left dorsal diaphragmatic tear. A jejuno-jejunal anastomosis following resection of the strangulated intestine was accomplished. The horse recovered uneventfully and five days after surgery, a left sided thoracoscopy in standing position was performed. The diaphragmatic defect was repaired by using a dual facing mesh anchored with synthetic absorbable screws and permanent titanium helicoidal tacks.At follow-up thoracoscopy, 30 days later, the mesh was in the correct position, pleural tissue was covering 90% of the mesh surface, and signs of shrinking were absent. The surgical procedure performed by the authors is minimally invasive and presents some advantages compared to conventional thoracotomy as it gives an excellent visualization of the thoracic cavity combined with decreased perioperative morbidity and pain.Standing thoracoscopic application of a mesh should be considered as a reasonable option while planning the closure of a dorsal diaphragmatic tear in horses.

1. Introduction

Although diaphragmatic hernia is uncommon in the horse, it accounts for 0.67% to 7.77% of all equine surgical cases [1]. Clinical signs depend upon type and amount of abdominal viscera passed through the diaphragmatic defect, and mostly include abdominal pain but may also include respiratory compromise [2]. The degree of abdominal pain is often severe, and securing an accurate preoperative diagnosis is difficult; consequently, the correct diagnosis is often made intraoperatively or at necropsy [2]. Diagnosis may be even more challenging in horses presenting with mild respiratory compromise or other vague clinical signs [3]. Diaphragmatic tears can occur postmortem due to intestinal distension and usually are seen in the ventral diaphragm typically located at the ventral midline just dorsal to the xiphoid process [4]. Smooth-edged defects in the left dorsal diaphragm are believed to be congenital in origin, while acquired defects, occurring more frequently in the middle portion of the diaphragm [5], are usually larger and are commonly located at the transition of the muscular to the tendinous part of the diaphragm [6].

Successful surgical repair of diaphragmatic hernias has been reported in foals and young horses [7,8]. However, the prognosis in adult horses is guarded because of the operative access is challenging, there is a limited view of the surgical field, and significantly higher risk associated with general anesthesia [9]. Postoperative survival rate is reported to be 23% [10].

Current conventional surgical techniques involve surgical access through a retrosternal median laparotomy or transcostal access in lateral recumbency after resection of the ribs [8–10]. Some authors have recently reported a new technique for closure of diaphragmatic defects in adult horses using a minimally invasive approach that includes an intrathoracic suture [11].

The aim of this report is to describe the thoracoscopically assisted repair of a diaphragmatic hernia in a standing horse by using a dual-facing mesh, made of polyester and absorbable hydrophilic film, fixed with absorbable screws and titanium coils.

Animal welfare/ethical statement: Animals included in the study were referred to Veterinary Teaching Hospital. They had a high standard of veterinary care, and their owners were involved in informed consensus consent. The study follows international, national, and institutional guidelines for humane animal treatment and complies with relevant legislation in the country.

Conflict of interest statement: The authors declare no conflicts of interest.

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2. Clinical Report

2.1. History and Clinical Findings

A 6-year-old Warmblood gelding was referred for signs of acute abdominal pain. The owner reported no previous episodes of abdominal pain.

At physical examination, the horse was unable to stand despite the repetitive use of sedative and analgesic drugs. Heart rate 60 beats/min, respiratory rate 36 breaths/min, absent intestinal sounds, moderate abdominal distension, congested mucous membranes, capillary refill time of 3 seconds, and rectal temperature 38.3°C were the main clinical parameters. Multiple distended small intestine loops were detected at rectal exploration. Abdominal ultrasound confirmed the presence of several distended immotile loops of small intestine and revealed an increase of both peritoneal and pleural fluid (left hemithorax).

Emergency laboratory parameters included packed cell volume of 48%, total serum protein of 7.8 g/dL, and blood lactate of 6.3 mmol/L.

Clinical findings were suggestive of small intestine strangulation consequently the horse laparotomy. Surgical exploration of the abdomen revealed a tear (8–10 cm) in the left dorsal tendinous part of the diaphragm, dorsal to the spleen. Within the defect, a portion of small intestine was incarcerated. The herniated viscera were not reducible by manual traction until the defect of the diaphragm had been enlarged of few cms using the laparoscopic scissors. Six meters of necrotic jejunum was resected, and a side-to-side jejunojejunal anastomosis was performed. Since the defect was located in the dorsal part of the diaphragm, next to the abdominal vault, herniorrhaphy in dorsal recumbency would have been technically difficult to perform, so the abdomen was closed and a plan for a less invasive approach was programmed. Considering the size of the diaphragmatic defect and in order to prevent a relapse, a left-sided thoracoscopy in standing position was scheduled to be performed as soon as the horse's clinical condition would have been adequate for having the surgical procedure accomplished safely.

2.2. Materials and Methods

2.2.1. Surgical Procedure

Five days after laparotomy, food was withheld 12 hours prior to surgery, while free access to water was allowed.

Procaine penicillin (Depomicina; MSD Animal Health S.r.l., Segrate, Milano, Italy) (22,000 UI/kg bodyweight [bwt], intramuscular [IM]), streptomycin (Depomicina) (11 mg/kg bwt, IM), and flunixin meglumine (Flunifen; Ceva Salute Animale S.p.A., Agrate Brianza, Monza, Italy) (1.1 mg/kg bwt, intravenously [IV]) were administered within 30 minutes prior to surgery. The horse was restrained in stocks, and the left thoracic wall was clipped and aseptically prepared. Sedation was achieved with detomidine hydrochloride (Domidine; FATRO S.p.A, Italy) (8.4 μg/kg bwt, IV) and butorphanol tartrate (Dolorex; MSD Animal Health S.r.l.) (20 μg/kg bwt, IV) and maintained via continuous rate infusion of detomidine hydrochloride as previously described [12]. Oxygen 100% was administered at 6.5 L/min by nasal insufflation.

After draping, local anesthesia was obtained by infiltration of 2% mepivacaine (Carbosen 20 mg/mL, Industria Farmaceutica Galenica Senese S.r.l) (20 mL per portal site) through skin, intercostal musculature, and parietal pleura.

A 1-cm stab incision was made through the skin and the *serratus ventralis thoracis* muscle in the 10th intercostal space, just ventral to the epaxial muscles at the level of the ventral border of the tuber coxae. The optical portal was created through the introduction of the trocar (5–11 mm fixation cannula and 11-mm gun-like optical obturator [Visiport Plus RPF 5–11 mm Optical Trocar with Versaport Plus RPF Single Use Radiolucent Converterless Trocar Sleeve; Covidien Italia Spa, Segrate, Milano, Italy]). Pneumothorax was induced by opening the trocar valve until complete collapse of the ipsilateral lung [13].

Following the examination of the diaphragmatic defect through a 30° telescope (Fig. 1), two instrumental portals (one 5 mm–12 mm Versaport [Versaport Plus V2 5–12 mm; Covidien Italia Spa] and one 10 mm–15 mm Versaport [Versaport Plus RPF 10 mm–15 mm Bladed Trocar, Smooth Cannula; Covidien Italia Spa]) were created in the 13th intercostal space, 3 cm dorsal, and 3 cm ventral to the optical portal.

A dual-facing mesh (Parietex Optimized Composite Mesh; 20 cm × 15 cm; Covidien, Italia Spa) was used to repair the diaphragmatic tear. The mesh is made of both absorbable and nonabsorbable materials (Fig. 2). The parietal side consists of nonabsorbable three-dimensional polyester mesh, which is designed to provide long-term reinforcement of the soft tissue repaired. The visceral side is covered by an absorbable hydrophilic film (porcine collagen), which prevents adhesions in case of direct contact with viscera. The mesh was cut with surgical scissors in order to have 4 cm minimum overlap between the diaphragmatic defect and the mesh. It was rolled into a cylinder and inserted through the 10-mm trocar. In order to manipulate the mesh for accurate placement, two laparoscopic babcock forceps were used with the help of the second surgeon and three further instrumental portals (5 mm–12 mm Versaport [Versaport Plus V2 5–12 mm]) were created in the 14th intercostal space, 2 cm dorsal, 2 cm ventral, and 6 cm ventral to the optical portal. The polyester side was placed in contact with the diaphragm and fixed with helical titanium coils (Pro-tack [ProTack 5 mm Fixation Device, titanium helical tack, Medtronic, Covidien, Italia Spa]) and absorbable poly (D, L)-lactide screws (Sorbafix [SorbaFix Absorbable Fixation system; BARD Srl, Via Cina, 444, 00144 Roma]) (Fig. 3). High differential pressure was noticed between thoracic and abdominal cavity at each respiratory movement, hence several coils (10 titanium coils and 20 absorbable screws) were used to establish a successful fixation of the mesh.

After the tear was completely sealed, pneumothorax was reduced using a suction system connected to the trocar valve until expansion of the lung was achieved. Pneumoperitoneum was not reduced since the amount of air passing from the thorax into the abdomen was considered of minor importance (pneumothorax was

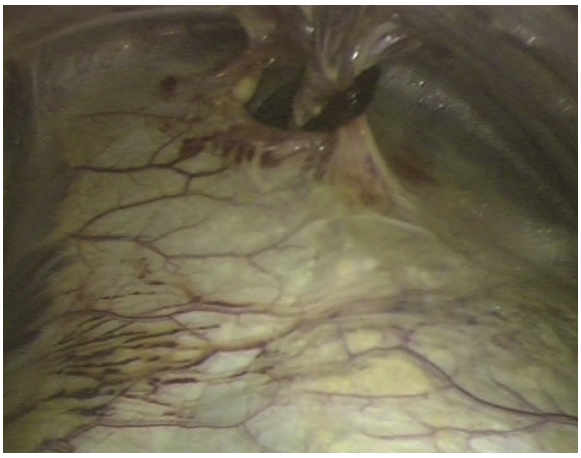

Fig. 1. Visualization of the 10-cm sized defect in the left dorsal part of the diaphragm. The adhesion was severed with an electrothermal bipolar tissue sealing system (Ligasure) before the application of the mesh.