

SURGICAL TREATMENT OF A TRAUMATIC DIAPHRAGMATIC HERNIA IN A CAT USING STRATAFIX™ BARBED SUTURE: CASE REPORT

**Bogdan SICOE, Roxana DASCĂLU, Larisa SCHÜSZLER, Daniel BUMB,
Cristian ZAHA, Cornel IGNA**

Banat's University of Agricultural Sciences and Veterinary Medicine
"King Michael I of Romania" from Timisoara, Faculty of Veterinary Medicine,
119 Calea Aradului, Timișoara, România

Corresponding author email: ignacornel@gmail.com

Abstract

A diaphragmatic hernia occurs when organs from the abdominal cavity migrate into the thoracic cavity, through a discontinuity of the diaphragm. Traumatic diaphragmatic hernia occurs secondary to car accidents, falling from different heights, kicks or animal fights. There is no breed nor sex predisposition. Time-lapse of diaphragmatic hernia ranges from a few hours to years. Barbed sutures, used especially in human surgery, have certain advantages over traditional sutures: shorter suturing time, better tissue coaptation and better tension holding in the surgical wound due to evenly distributed barbs along the thread. This study describes the history, clinical signs, clinical and paraclinical investigations, surgical treatment, as well as post-operative care and follow-up of a feline patient with a traumatic diaphragmatic hernia. The suture material used in this case provided excellent tension in the surgical wound, leading to a full recovery of the patient within 10 days.

Key words: cat, diaphragmatic hernia, Stratafix™.

INTRODUCTION

In a traumatic diaphragmatic hernia, abdominal organs are displaced within the thoracic cavity through a disruption in the diaphragm (Fossum, 2013). The most common cause that leads to a traumatic diaphragmatic hernia is represented by car accidents (Fossum, 2013; Hunt & Johnson, 2003; Hunt & Johnson, 2012; Igna, 2017). A rapid increase in intra-abdominal pressure associated with a blunt trauma to the abdominal wall leads to lung deflation and increased pleuroperitoneal pressure gradient, which may result in diaphragmatic tears that usually result in its weakest points (the muscular portions) (Fossum, 2013). Duration from occurrence to clinical presentation may range from a few hours to years (Fossum, 2013; Hunt & Johnson, 2012). Clinical signs may include dyspnoea (Fossum, 2013; Garson et al., 1980; Hunt & Johnson, 2012; Igna, 2017; Minihan et al., 2004), shock-associated signs (tachypnea, tachycardia, cyanotic mucous membranes, arrhythmias) or may be system-dependent (gastrointestinal, respiratory, cardiovascular) (Fossum, 2013). Animals with

chronic hernias may even be asymptomatic, but clinical signs are either respiratory or gastrointestinal related, or may be non-specific (Fossum, 2013). The most commonly herniated organs are the liver (Besalti et al., 2011; Fossum, 2013; Garson et al., 1980; Hunt & Johnson, 2003; Hunt & Johnson, 2012; Hyun, 2004) stomach, small intestines, spleen and pancreas; colon, omentum (Besalti et al., 2011; Hunt & Johnson, 2012), and kidneys (Katic et al., 2007; Störk et al., 2003). The aspect of the disruption may be circumferential, radial or mixt (Garson et al., 1980). Diaphragmatic hernias may also be associated with hemothorax, hydrothorax, chylothorax, lung contusions and pneumonia (Baines, 2016). Standard radiography is the simplest way to confirm a diaphragmatic hernia (Hunt & Johnson, 2012). Complete or partial loss of diaphragmatic line, loss of cardiac silhouette, lung displacement and presence of abdominal organs inside the thoracic cavity are commonly seen (Dascălu, 2012; Fossum, 2013; Igna et al., 2006; Igna, 2017). Thoracocentesis may aid in diagnosis (Fossum, 2013). Oral administration of contrast mediums and positive contrast

celiography may also aid in diagnosis, but may also give false negative results (Dascălu, 2012; Fossum, 2013; Hunt & Johnson, 2012). Ultrasonography is another diagnostic method that may be useful, especially when radiographs are not diagnostic or pleural effusion is present. Laboratory findings are uncommon, unless herniation of liver is present (elevated serum alanine aminotransferase and serum alkaline phosphatase) (Fossum, 2013). Medical management consists in oxygen therapy, thoracocentesis and shock therapy. Surgical therapy should be applied as soon as the patient is stabilized and not be delayed unnecessarily. Certain cases, however, such as gastric herniation, should be treated as emergencies, due to the fact that gastric distension may lead to rapid, fatal respiratory failure (Fossum, 2013).

MATERIALS AND METHODS

A 4-year old European domestic short hair neutered female cat was presented in the Surgery Clinic of the Faculty of Veterinary Medicine from Timișoara regarding a non-healing wound on its caudo-ventral abdomen and a 4 day duration mild dyspnoea. The patient was an indoor-outdoor cat and was neutered in a private practice 10 days prior to presentation in our clinic; hence the non-healing wound was a ventral midline celiotomy. The patient received a combination of Ampiplus (ampicillin and sulbactam 20 mg/kg IV q8h) and Metronidazole (10 mg/kg IV q12h) for the last 3 days prior to presentation. Clinical examination was unremarkable, except for a mild dyspnoea and slightly obvious abdominal breathing, and a 4 cm long non-healing wound.

On auscultation, heart sounds were muffled on the right side and more intense on the left side; hyporesonance of the right thoracic wall was also noted. Blood work was unremarkable, and radiographic examination was pursued. Right lateral (Figure 1) and ventro-dorsal (Figure 2) radiographs of the thorax and abdomen were performed and the following were noted: on the lateral view, the diaphragmatic line is visible only in its most dorsal portion, the cardiac silhouette is difficult to visualise and appears elevated, the trachea is elevated, there is

generally increased soft tissue opacity within the central, ventral and caudal thorax, with only the cranial and caudal lung lobes being clearly visualised and a moderate interstitial to alveolar pattern located primarily perihilar.

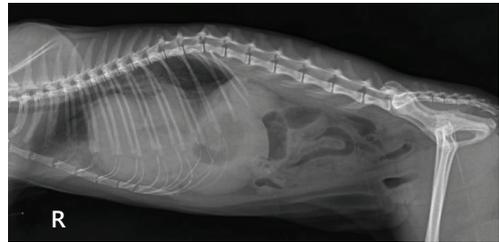


Figure 1. Right lateral view of the thorax and abdomen



Figure 2. Ventro-dorsal view of the thorax and abdomen

Within the abdomen, the gastric gas bubble is abnormal in shape and abnormally located, and in the caudal portion of the ventral abdominal wall, free air/gas and some granular radio-opaque material is present between the *rectus abdominis* muscle and subcutaneous tissue and skin; on the ventro-dorsal view: the diaphragmatic line is visible in a small portion on the left side, there is collapse of the right middle lung lobe and part of the right cranial lung lobe, there is increased soft tissue opacity in the right middle-caudal and center of the thorax, masking the cardiac silhouette. Within the abdomen, the distal extremity of the spleen appears to be enlarged and rounded, and on both radiographs, there is overall mild loss of serosal detail and the liver also appears enlarged and rounded. No musculoskeletal abnormalities were noted on either radiograph. A diagnosis of traumatic diaphragmatic hernia

was established. The prognosis in this case was guarded.

The surgical procedure was performed under general anaesthesia, which consisted of premedication with Xylazine (0.05 mg/kg IV) and Ketamine (8 mg/kg IV) followed by induction with Isoflurane 5% and maintained on Isoflurane 2% vaporized in oxygen using intermittent positive pressure ventilation throughout the surgery. Postoperative analgesia was provided with one dose of Butorphanol (0.4 mg/kg SQ) administered 15 minutes before recovery. Ampiplus (ampicillin and sulbactam 20 mg/kg IV q8h) was administered 30 minutes preoperative and immediate postoperative. Dexamethasone (0.1 mg/kg IV) was also given to prevent reperfusion injuries of herniated organs and of the collapsed lung lobes.

The surgical site was aseptically prepared. The patient was placed in dorsal recumbency. A ventral midline celiotomy was performed, extending from the xyphoid process to the non-healing wound and the edges of the non-healing were excised. Celiotomy revealed herniation of the liver, stomach, spleen, omentum and falciform ligament inside the thoracic cavity (Figure 3), through an approximately 2.5 cm long central linear disruption of the diaphragm, extending from its most ventral portion towards the tendinous center (Figure 4).

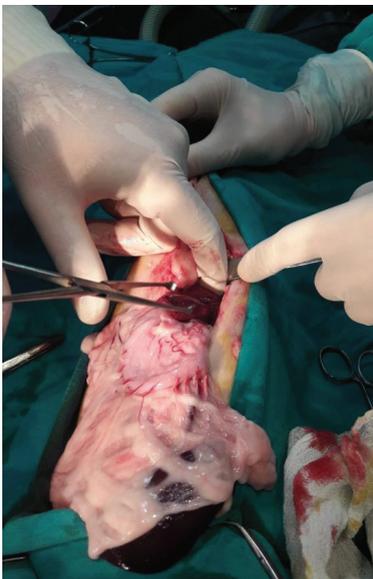


Figure 3. Removing the liver, stomach, spleen, omentum and falciform ligament from the thorax

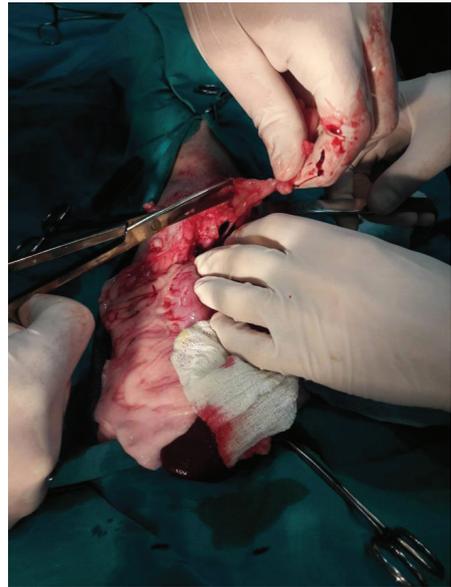


Figure 4. Intraoperative view of the diaphragmatic wound and beginning of the suture

Adherences were present between the two edges of the diaphragm and between the liver and diaphragm; these were severed using sharp dissection. Herniated organs were all viable and withdrawn from the thoracic cavity.

The liver and spleen were mildly enlarged, but viable. Lavage of the thoracic cavity was performed with warm sterile saline. Closure of the diaphragm was performed using unilateral Stratifix™ 2-0 Spiral PDS Plus (Ethicon™) (Figure 5).



Figure 5. Unilateral Stratifix™ 2-0 Spiral PDS Plus (Ethicon™) used for herniorrhaphy

The time required to close the rupture in the diaphragm was 1 min 52 sec, partly due to a quite large needle. The suture was started by passing the needle through the wound edges, in its most dorsal end, and then through the prefabricated loop on its other end, and was

continued in a simple continuous pattern. Suturing was interrupted to allow placing of a Foley catheter, and after reaching the ventral end of the wound, 2 more passes were made in the ventral abdominal wall. The Foley catheter was placed from the thoracic cavity into the abdominal cavity, and exteriorized through a stab incision performed cranio-dorsally in the right abdominal wall (Figure 6).

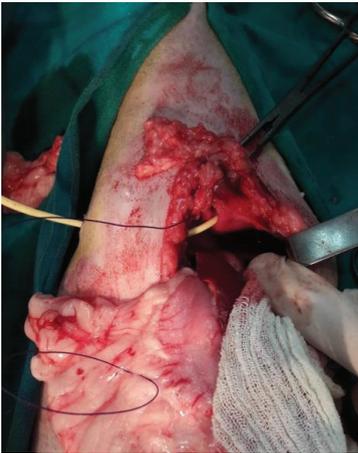


Figure 6. Placement of the Foley catheter

Lungs were not completely inflated as to prevent reexpansion edema and reperfusion injury; a small amount of warm sterile saline was left inside the thoracic cavity to aid in this purpose. Closure of the celiotomy incision was routine.

RESULTS AND DISCUSSIONS

Although some authors prefer to leave small amounts of air inside the chest in order to prevent reexpansion edema (Hunt & Johnson, 2012), we preferred to leave a small amount of warm sterile saline. During surgery, standard monitoring of the cardiovascular (blood pressure, heart rate, CRT) and respiratory (capnogram, respiratory rate after diaphragm closure, pulse oximetry) systems was performed and all parameters were within normal limits. Closure was airtight. In the immediate postoperative period, the patient did not require assisted ventilation. The cat was no longer dyspnoeic after recovery; hence, there was no need for oxygen supplementation. Nevertheless, the patient was managed in-house for the following 10 days, receiving

Ampiplus (ampicillin and sulbactam 20 mg/kg IV q8h) daily. An Elizabethan collar was also applied and maintained through-out hospitalization. On the first postoperative day, 4 ml of serohemorrhagic fluid was aspirated via the Foley catheter, clinical examination was unremarkable, dyspnoea resolved completely and the cat had eaten. On the second postoperative day, 1 ml of serous fluid was aspirated via the Foley catheter, clinical examination was unremarkable, and the catheter was removed. The remainder of the 8 days were uneventful; skin sutures were removed on the 10th day and the patient was discharged. Until publication of this case report, no complications were reported by the owner and follow-ups were unremarkable.

Tension in the suture was excellent, due to even distribution of the barbs along the thread. Edges of the wound were perfectly apposed; during suturing, there was no need for an assistant to maintain tension in portions that were already apposed, but only to hold the thread in such a manner that the surgeon had a proper view of the surgical field.

Postoperative survival rates differ according to several authors: 89.7% (Gibson et al., 2005), 50-90% (Igna, 2017), 88.4% (Igna et al., 2014) and 81.3%, respectively (Legallet et al., 2017). Complications after diaphragmatic herniorrhaphy include pneumothorax and reexpansion edema (Fossum, 2013; Igna et al., 2014), tachypnea and dyspnoea (Schmiedt et al., 2003), ascites, recurrence of the hernia, hiatal hernia, megaesophagus, gastric ulceration and esophagitis (Hunt & Johnson, 2012); none of these were observed during follow-ups nor were reported by the owner.

CONCLUSIONS

Stratafix™ unidirectional barbed suture provided an airtight closure of the diaphragmatic disruption, excellent apposition of wound edges and proper tension, with no signs of recurrence on a long-term follow-up.

ACKNOWLEDGEMENTS

This study was realised using the support and infrastructure project "Dezvoltarea infrastructurii de cercetare, educație și servicii în domeniile

REFERENCES

- Baines, S. J. (2016). Diaphragmatic Herniorrhaphy. In: Griffon, D., Hamaide, A., *Complications in small animal surgery*. (pp 375-382). Wiley Blackwell.
- Besalti, O., Pekcan, Z., Çalışkan, M., Aykut, Z. G. (2011). A retrospective study on traumatic diaphragmatic hernias in cats. *Veteriner Fakültesi dergisi.*, 58(3). 175-179.
- Dascălu, R. (2012). *Diagnosticul radiografic la animalele de companie*. Timișoara, RO: Editura BrumaR.
- Fossum, T. W. (2013). Surgery of the lower respiratory system. In: Fossum, T. W., *Small Animal Surgery*. 4th ed. (pp 1002-1007). St. Louis, USA: Mosby Elsevier.
- Garson, H. L., Dodman, N. H., Baker, G. J. (1980). Diaphragmatic hernia. Analysis of fifty-six cases in dogs and cats. *J. Small Anim. Pract.*, 21. 469-481.
- Gibson, T. W., Brisson, B. A., Sears, W. (2005). Perioperative survival rates after surgery for diaphragmatic hernia in dogs and cats: 92 cases (1990-2002). *J Am Vet Med Assoc*, 227(1). 105-109.
- Hunt, G.B., Johnson, K. A. (2003). Diaphragmatic, Pericardial, and Hiatal Hernia. In: Slatter, D., *Textbook of small animal surgery*. 3rd ed. (pp 471 – 480). Philadelphia, USA: Saunders.
- Hunt, G. B., Johnson, K. A. (2012). Diaphragmatic Hernias. In: Tobias, K. M., Johnston, S. A., *Veterinary surgery: small animal*. (pp 1380 – 1391). Missouri, USA: Elsevier.
- Hyun, C. (2004). Radiographic diagnosis of diaphragmatic hernia: review of 60 cases in dogs and cats. *J. Vet. Sci.*, 5(2). 157-162.
- Igna, C., Schüzler, L., Sala, A., Dascălu, R. (2006). Radiographic diagnosis of diaphragmatic hernia in dogs. *Lucr. Șt. USAMVB Timișoara, Med. Vet.*, XXXIX. 92-96.
- Igna, C., Schüzler, L., Sala, A., Bumb, D., Proteasa, A., Dascălu, R. (2014). Diaphragmatic hernia in dogs and cats: A report of 43 cases (2001-2013). *Lucrări Științifice Medicină Veterinară*, XLVII(4). 48-53.
- Igna, C. (2017). *Clinică chirurgicală și prelegeri clinice pe specii - curs universitar*. Timișoara, RO. Agroprint.
- Katic, N., Bartolomeaus, E., Böhler, A., Dupré, G. (2007). Traumatic diaphragmatic rupture in a cat with partial kidney displacement into the thorax. *J Small Anim Pract*, 48(12). 705-708.
- Legallet, C., Thiemann Mankin, K., Selmic, L. E. (2017). Prognostic indicators for perioperative survival after diaphragmatic herniorrhaphy in cats and dogs: 96 cases (2001-2013). *BMC Vet Res*, 13(1). 16.
- Minihan, A. C., Berg, J., Evans, K. L. (2004). Chronic diaphragmatic hernia in 34 dogs and 16 cats. *J Am Anim Hosp Assoc.*, 40(1). 51-63.
- Schmiedt, C. W., Tobias, K. M., Stevenson, M. A. (2003). Traumatic diaphragmatic hernia in cats: 34 cases (1991-2001). *J Am Vet Med Assoc*, 222(9). 1237-1240.
- Störk, C. K., Hamaide, A. J., Schwedes, C., Clercx, C. M., Snaps, F. R., Balligand, M. H. (2003). Hemiurothorax following diaphragmatic hernia and kidney prolapse in a cat. *J Feline Med Surg*, 5(2). 91-96.