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Case Report

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Spontaneous pneumothorax in two dogs undergoing combined laparoscopic ovariectomy and total laparoscopic gastropexy

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Conflict of Interest
The authors declare no conflicts of interest.

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ABSTRACT

Two dogs underwent a combined laparoscopic ovariectomy and total laparoscopic gastropexy. The intra-abdominal pressure and pulmonary compliance decreased, but the peak airway pressure increased at 20 min after the start of gastropexy with intracorporeal suturing. Right chest auscultation and percussion revealed reduced breath sounds and hyper-resonance. No abnormalities in the functioning of the instruments or diaphragmatic defects were detected. The tidal volume was reduced and a positive end-expiratory pressure of 5 cmH_2O was applied. The right chest of the two dogs was drained off: 950 mL (case 1) and 250 mL (case 2) of gas. After thoracentesis, the pulmonary compliance improved and surgery was completed successfully. The postoperative chest radiographs highlighted the residual right pneumothorax.

Keywords: Dogs; Gastropexy; Laparoscopy; Ovariectomy; Pneumothorax

A pneumothorax is an abnormal collection of gas in the pleural space that separates the lung from the chest wall and can affect the pulmonary function. A pneumothorax can occur spontaneously, even though it is commonly caused by either trauma to the chest or as a complication of medical practice (iatrogenic pneumothorax) [1]. An iatrogenic pneumothorax has been described widely in humans undergoing laparoscopic surgery [2]. The most common cause is the escape of intraperitoneal carbon dioxide (CO_2) into the pleural cavity through diaphragmatic defects [2-4]. In animals, an iatrogenic pneumothorax is common due to tracheal rupture, inadequate mechanical ventilation, and lung lesions caused by thoracentesis [5]. Organ laceration and hemorrhages are the most common intraoperative complications during laparoscopic surgery [5,6], whereas pneumothorax has not been described as a complication of laparoscopic procedures. The present report describes 2 cases of a pneumothorax that occurred in dogs undergoing a combined laparoscopic ovariectomy and total laparoscopic gastropexy.

Case 1 was a 14-month-old mixed breed dog, weighing 27 kg, and case 2 was a 9-month-old Weimaraner dog, weighing 26 kg. The patients had no significant prior medical history. They were healthy dogs that showed no abnormalities on a physical examination (cardiac and thoracic auscultation, heart rates [case 1 and case 2, 88 and 92 beats/min, respectively], respiratory rates

Table 1. Data of blood panel

Reference interval and cases	Haematocrit (%)	Haemoglobin (g/dL)	Erythrocytes (/µL)	Leukocytes (/µL)	Urea (mg/dL)	Creatinine (mg/dL)	Glucose (mg/dL)	Total bilirubin (mg/dL)	Gamma-glutamyl transferase (U/L)	Total proteins (g/dL)	Albumin (g/dL)
Reference interval	39–54	12–18	5,500,000–8,500,000	6,000–17,000	15–40	0.1–1.6	85–115	0.01–0.60	0.1–7.0	6.0–7.5	2.90–3.60
Case 1	48	16.7	7,530,000	7,140	38	0.68	93	0.06	2.8	6.68	3.30
Case 2	47	17.1	7,380,000	7,870	35	0.54	87	0.06	3.1	6.44	3.31

[14 and 16 breaths/min, respectively], rectal temperature [38.6°C and 38.3°C, respectively], and systolic blood pressure [144 and 138 mmHg, respectively], mucous membrane color) and they had a normal packed cell volume and biochemical parameters (urea, creatinine, glucose, total bilirubin, gamma-glutamyl transferase, total proteins, and albumin) (**Table 1**).

Both dogs were sedated using dexmedetomidine (Zoetis, Italy) 3 µg/kg and methadone (Dechra, Italy) 0.2 mg/kg combined and administered intramuscularly. Anesthesia was induced with 2 mg/kg of propofol (Merial, Italy) intravenously and endotracheal intubation was performed. Size selection of endotracheal tubes was based on direct digital palpation of the dog's tracheal diameter just above the thoracic inlet. Anesthesia was maintained with isoflurane (Esteve, Italy) delivered in 100% oxygen via a rebreathing circuit. Respiration was supported by intermittent positive pressure ventilation to maintain an end-tidal carbon dioxide tension ($EtCO_2$) in the range of 30–40 mmHg. The mechanical ventilator was set using the following parameters: tidal volume of 10–12 mL/kg, respiratory rates of 10–12 breaths/min, and ventilation pressure of 15–18 mmHg. The heart and respiratory rates, $EtCO_2$, arterial hemoglobin oxygen saturation, esophageal temperature and arterial blood pressure were measured using a multiparametric monitor (Dräger, Germany). Dexmedetomidine was reversed partially by atipamezole (Dechra) 20 µg/kg administered intramuscularly at the end of surgery.

The dogs were positioned in dorsal recumbency. The same surgeon performed the laparoscopic ovariectomy and gastropexy using a 3-port technique in both dogs (**Fig. 1**) [6]. A 10-mm cannula (T1) (MedLine, Italy) was inserted near the umbilicus on the midline to produce a pneumoperitoneum using CO_2. An automatic insufflator (Karl Storz Endoscopy, Italy) with a pressure of 12 mmHg and 30° and a diameter of 10 mm, and a telescope with a length of 31 cm (Karl Storz Endoscopy) were used. A 5-mm cannula (T2) (MedLine) was

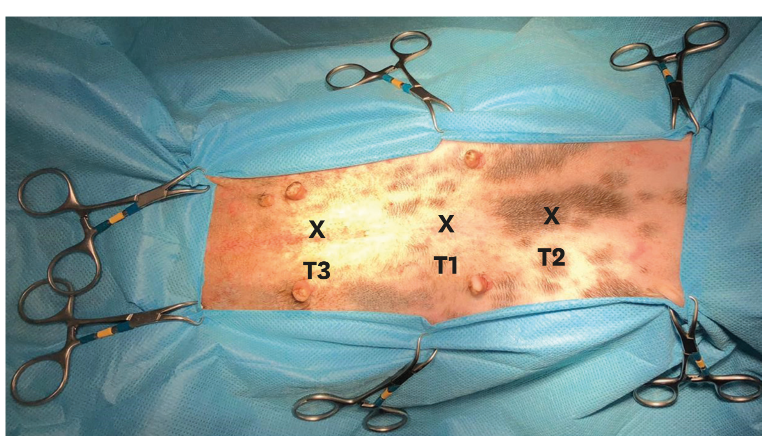

Fig. 1. Port location (T1, T2, and T3) indicated by the symbol "X". T1 is placed near the umbilicus on midline. T2 is positioned between the umbilicus and the xiphoid process of the sternum. T3 is placed between the umbilicus and the pubis.

inserted between the umbilicus and the xiphoid process of the sternum. A 10-mm cannula (T3) (MedLine) was inserted between the umbilicus and the pubis.

Each ovary was grasped at the level of the proper ligament using Wolf grasping forceps (Wolf Medical Instrument, Germany), and the ovarian pedicles were cauterized and cut using a bipolar vessel sealing device (B. Braun, Italy). Both ovaries were removed through T3.

Subsequently, an approximately 3-cm gastropexy was performed with total intracorporeal suturing [7]. A self-locking 0 polydioxanone monofilament-barbed suture with long-term absorption (Assut Europe, Italy) was inserted in the abdomen with a laparoscopic needle holder (Tontarra, Germany) through T3. A second needle holder was inserted in the abdomen through T2 to perform the suture. An approximatively 3 cm incision was made on the right peritoneal surface 3 cm caudally to the 13th rib using an electrosurgical monopolar hook scalpel (B. Braun) introduced through T3. The simple continuous suture was started between the greater and lesser curvatures of the stomach at 4–5 cm from the pyloric antrum.

A 20 min after the start of the simple continuous suture, the surgeon reported a progressive worsening in laparoscopic vision of the organs related to a decrease in intra-abdominal pressure. At the same time, the lung compliance decreased to 0.5 mL/kg and the peak airway pressure increased from 16 to 28 cmH_2O (case 1) and to 33 cmH_2O (case 2). No abnormalities were detected in the functioning of the laparoscopic instruments and the mechanic ventilator, and no diaphragmatic defects were detected. The insufflation of CO_2 into the abdomen was stopped; the tidal volume was reduced to 8 mL/kg and a positive end-expiratory pressure (PEEP) of 5 cmH_2O was applied to avoid an excessive pulmonary collapse. Chest auscultation revealed greatly reduced breath sounds on the right chest and chest percussion highlighted hyper-resonance of the right chest in both dogs. Needle right thoracentesis was performed at the eighth intercostal space using a 20-gauche needle attached to an extension set, three-way stopcock, and a 50 mL syringe. In approximately 5 min, 950 mL (case 1) and 250 mL (case 2) of gas were aspirated from the right thorax. After thoracentesis, the pulmonary compliance increased to 0.8 mL/kg (case 1) and 1 mL/kg (case 2), and the peak airway pressure decreased to below 25 cmH_2O. No barbed suture related injury was detected and the surgical procedure was completed successfully in 60 min (case 1) and 70 min (case 2). CO_2 was evacuated from the abdominal cavity by gently compressing the abdomen. The dogs recovered uneventfully. Postoperative chest radiographs highlighted a small amount of gas in the right and left pleural space and mild signs of right pulmonary atelectasis (**Figs. 2** and **3**). The dogs were monitored for 24 h and were discharged the day after surgery. The dogs' health status was monitored for evidence of complications through a daily telephone follow-up until suture removal.

The present study is the first report in veterinary medicine that describes a pneumothorax in dogs undergoing laparoscopic surgery. In humans, a pneumothorax is an intraoperative complication of gastric and gynecological laparoscopic procedures [2,3,8-10]. The surgeon's inexperience, $EtCO_2$ values more than 50 mmHg, and surgery time of more than 200 min have been identified as risk factors related to the development of a pneumothorax during laparoscopic procedure [11]. In the present report, the surgeon had long clinical practice with laparoscopic techniques and performed combined laparoscopic ovariectomy and total laparoscopic gastropexy in approximatively 60 min. Furthermore, intermittent positive pressure ventilation maintained $EtCO_2$ in the range of 30–40 mmHg.

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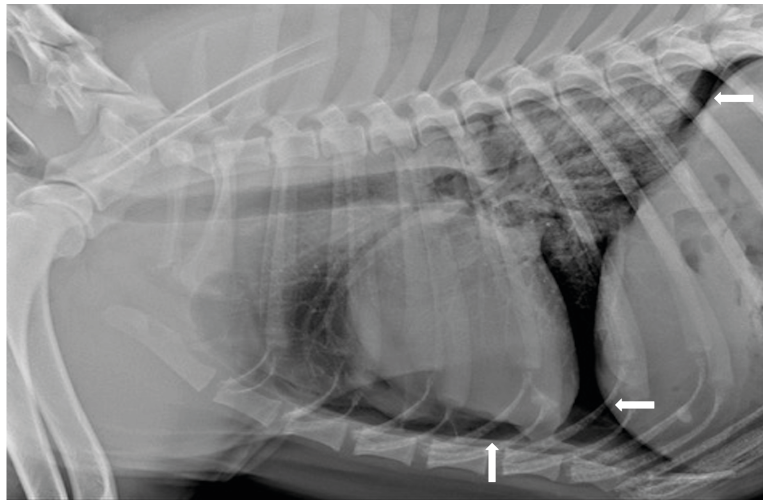

Fig. 2. Right lateral postoperative chest radiograph of case 1. The heart silhouette is slightly elevated from the sternum (arrow at the bottom left). A lung lobe retraction of the caudal lobes is visible (arrow in the upper right) and is associated with the residual pneumothorax (arrow at the bottom right).

The potential causes of an intraoperative pneumothorax are as follows: simple gas diffusion, congenital defects, and iatrogenic causes. Although highly unlikely, the possibility of simple CO_2 diffusion as the cause of the pneumothorax cannot be excluded. Congenital esophageal hiatus defects are the only widely described defects in young dogs [12,13]. These patients did not present any gastrointestinal symptoms related to congenital esophageal hiatus defects. Furthermore, no diaphragmatic defects were detected during surgery, even though the

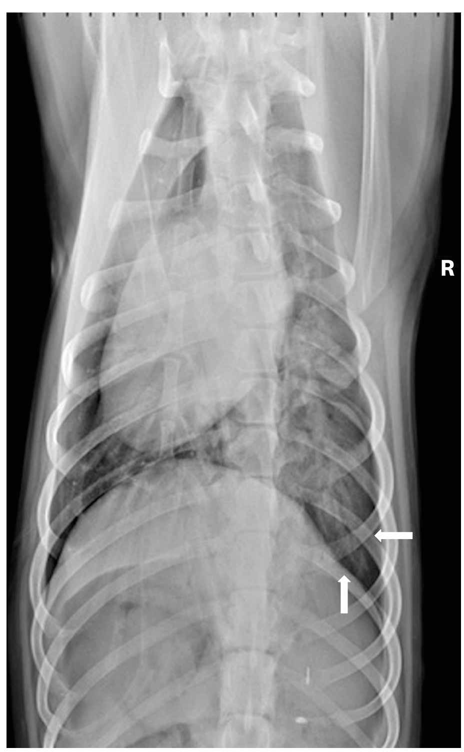

Fig. 3. Slightly rotated dorsoventral postoperative chest radiograph of case 1. Residual pneumothorax associated with moderate lung lobes retraction is visible (arrows).
R, right.

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presence of these defects in the diaphragm is not always demonstrable [3]. Iatrogenic causes include hiatal dissection, direct diaphragmatic trauma, and incorrect mechanical ventilation [1,14]. Hiatal dissection and direct lesions to the diaphragm were excluded because the surgeon verified the integrity of the anatomical structures. Mechanical ventilation was performed according to the veterinary medicine guidelines [15], and spirometry and capnography monitoring precluded iatrogenic volutrauma and barotrauma. Nevertheless, possible rupture of bullae or emphysematous bleb cannot be excluded because a preoperative chest radiograph was not performed [1]. The likely cause of the pneumothorax was traction of the stomach that caused esophageal motion, resulting in a small tear of the diaphragm [3,9]. Consequently, the flow of intraperitoneal CO_2 into the pleural space occurred under abdominal pressure [9].

The detection of an intraoperative pneumothorax may be difficult. An intraoperative pneumothorax was suspected based on the decrease in pulmonary compliance and the increase in the peak airway pressure [2,4]. As reported previously [9], the pneumothorax was only diagnosed by chest auscultation and percussion. No intraoperative radiograph was performed because the cardiorespiratory status of the dogs was sufficiently stable.

The prompt identification of an intraoperative pneumothorax allowed the problem to be treated using PEEP and thoracentesis. PEEP therapy decreased the pressure gradient between the abdominal and pleural cavities; consequently, CO_2 could leave the pleural space [9]. PEEP therapy may be sufficient to improve the pulmonary function because a pneumothorax is often a self-limiting complication because of the high solubility of CO_2 [4]. Nevertheless, simple aspiration is commonly recommended to improve the lung compliance [4]. Postoperative residual pneumothorax can occur, but it can be treated safely by conservative management.

The major limitation of the present study is that it was not confirmed whether the gas aspirated by thoracentesis was CO_2, even though a sudden decrease in intra-abdominal pressure associated with reduced breath sounds suggests that CO_2 under pressure may have flowed into the pleural cavity.

In conclusion, a pneumothorax can occur during laparoscopic surgery. Although the cause is uncertain, it is advisable to handle the stomach carefully to avoid excessive traction on the esophagus. Diagnosis is possible by chest auscultation and percussion, as well as by monitoring the lung compliance and peak airway pressure. The application of PEEP is an effective method to improve the pulmonary function and thoracentesis may be required to treat the pneumothorax.

REFERENCES

1. Pawloski DR, Broaddus KD. Pneumothorax: a review. J Am Anim Hosp Assoc 2010;46:385-397.
PUBMED | CROSSREF
2. Machairiotis N, Kougioumtzi I, Dryllis G, Katsikogiannis N, Katsikogianni F, Courcoutsakis N, Kioumis I, Pitsiou G, Zarogoulidis K, Zarogoulidis P. Laparoscopy induced pneumothorax. J Thorac Dis 2014;6:S404-S406.
PUBMED | CROSSREF
3. Azocar RJ, Rios JR, Hassan M. Spontaneous pneumothorax during laparoscopic adrenalectomy secondary to a congenital diaphragmatic defect. J Clin Anesth 2002;14:365-367.
PUBMED | CROSSREF

4. Park HJ, Kim DK, Yang MK, Seo JE, Kwon JH. Carbon dioxide pneumothorax occurring during laparoscopy-assisted gastrectomy due to a congenital diaphragmatic defect: a case report. Korean J Anesthesiol 2016;69:88-92.
PUBMED | CROSSREF

5. Boute NJ, McClaran JK. Laparoscopic contraindications, complications and conversions. In: Frassons BA, Mayhew PD (eds.). Small Animal Laparoscopy and Thoracoscopy. pp. 180-192, Wiley Blackwell, New Jersey, 2015.

6. Bendinelli C, Properzi R, Boschi P, Bresciani C, Rocca E, Sabbioni A, Leonardi F. Meloxicam vs robenacoxib for postoperative pain management in dogs undergoing combined laparoscopic ovariectomy and laparoscopic-assisted gastropexy. Vet Surg 2019;48:578-583.
PUBMED | CROSSREF

7. Takacs JD, Singh A, Case JB, Mayhew PD, Giuffrida MA, Caceres AV, Fox-Alvarez WA, Runge JJ. Total laparoscopic gastropexy using 1 simple continuous barbed suture line in 63 dogs. Vet Surg 2017;46:233-241.
PUBMED | CROSSREF

8. Cha SM, Jung YH, Kim DS, Kang H, Baek CW, Koo GH. Spontaneous pneumothorax during laparoscopy-assisted Billroth-I gastrectomy -A case report-. Korean J Anesthesiol 2010;58:405-408.
PUBMED | CROSSREF

9. Joris JL, Chiche JD, Lamy ML. Pneumothorax during laparoscopic fundoplication: diagnosis and treatment with positive end-expiratory pressure. Anesth Analg 1995;81:993-1000.
PUBMED

10. Mehran A, Brasesco O, De Velasco E, Szomstein S, Rosenthal R. Intra-operative pneumothorax complicating laparoscopic Roux-en-Y gastric bypass. Obes Surg 2004;14:124-128.
PUBMED | CROSSREF

11. Labow DM, Conlon KC. Pneumothorax after diagnostic laparoscopy. Surg Endosc 1999;13:935-936.
PUBMED | CROSSREF

12. Callan MB, Washabau RJ, Saunders HM, Kerr L, Prymak C, Holt D. Congenital esophageal hiatal hernia in the Chinese Shar-Pei dog. J Vet Intern Med 1993;7:210-215.
PUBMED | CROSSREF

13. Valentine BA, Cooper BJ, Dietze AE, Noden DM. Canine congenital diaphragmatic hernia. J Vet Intern Med 1988;2:109-112.
PUBMED | CROSSREF

14. Voyles CR, Madden B. The "floppy diaphragm" sign with laparoscopic-associated pneumothorax. JSLS 1998;2:71-73.
PUBMED

15. Bumbacher S, Schramel JP, Mosing M. Evaluation of three tidal volumes (10, 12 and 15 mL kg^{-1}) in dogs for controlled mechanical ventilation assessed by volumetric capnography: a randomized clinical trial. Vet Anaesth Analg 2017;44:775-784.
PUBMED | CROSSREF