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## Is pneumothorax secondary to pneumoperitoneum a real risk in dogs undergoing total laparoscopic gastropexy?

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### Abstract

**Background:** There were described in veterinary literature, the possibility of pneumothorax as a complication of laparoscopic surgery in dogs undergoing laparoscopic ovariectomy associated with total laparoscopic gastropexy.

**Aim:** To assess if spontaneous pneumothorax secondary to pneumoperitoneum is a real risk in dogs undergoing total laparoscopic gastropexy.

**Methods:** Dogs undergoing totally laparoscopic gastropexy received chest X-rays (CXR) in lateral (left and right) and ventro-dorsal projection before and after the surgery. Two veterinary radiologists reported the x-rays and indicated the presence or not of pneumothorax.

**Results:** Postoperative pneumothorax was not detected on postoperative CXR in the total of 76 dogs of the study.

**Conclusion:** The odds risk of pneumothorax after total laparoscopic gastropexy surgical procedure is low.

**Keywords:** Pneumothorax, Chest radiography, Laparoscopy, Total laparoscopic gastropexy.

### Introduction

Pneumothorax secondary to pneumoperitoneum was widely described in human medicine, it was described in many kinds of laparoscopic surgery: cholecystectomy, fundoplication, hepatectomy, retroperitoneal nephrectomy, hiatal hernia repair, and gynecological surgery (Murdock *et al.*, 2000; Qiongfanf and Hong, 2018; Chae *et al.*, 2020).

The risk factors that have been correlated with pneumothorax development during laparoscopic surgery are operative times more than 200 min, positive end-tidal CO<sub>2</sub> (EtCO<sub>2</sub>) >50 mmHg, and surgeon experiences (Labow and Conlon, 1999; Hawasli, 2002). In veterinary medicine, laparoscopy becomes increasingly popular over the years. Spontaneous pneumothorax secondary to pneumoperitoneum has been described in two dogs undergoing laparoscopic ovariectomy associated with total laparoscopic gastropexy (Bendinelli *et al.*, 2019).

The aim of this study was to assess spontaneous pneumothorax secondary to pneumoperitoneum is a real risk in dogs undergoing totally laparoscopic gastropexy.

There were described in veterinary literature the possibility of pneumothorax as a complication of laparoscopic surgery in dogs undergoing laparoscopic ovariectomy associated with total laparoscopic gastropexy. However, to the authors opinion, very few patients developed a pneumothorax postoperatively.

### Materials and Methods

Animals enrolled in the study were female or male large breed dogs.

The inclusion criteria were as follows: dogs undergoing total laparoscopic gastropexy associated or not with other surgeries, age ≥6 months, healthy dogs that demonstrated no abnormalities on physical examination and blood analysis without previous abdominal surgery, previous 60 days pregnancy, or lactation.

All patient received chest X-rays (CXR) in lateral (left and right) and ventro-dorsal projection before and after the surgery. Two veterinary radiologists reported the X-rays and indicated the presence or not of pneumothorax.

The occurrence of any intraoperative and postoperative complications was recorded. Complications were

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classified as minor, defined as complications that did not require additional surgical treatment to resolve, and major as complications or associated morbidity that required additional surgical treatment or conversion to resolve.

#### **Surgical procedure and anesthetic management**

All dogs received perioperative analgesia with methadone, fentanyl, and anti-inflammatory drugs. All patients received mechanical ventilation (Drager Cato, Drager Spa, Italy): the ventilation consisted in a volume-controlled ventilation with tidal volume and respiratory frequencies variables in order to maintain normocapnia (35–45 mmHg) and to prevent the airways pressure build up above 16 mmHg.

The patients were monitored with multiparametric monitor (Drager Infinity Gamma XL, Drager Spa, Italy): we monitored electrocardiography (ECG), oxygen saturation (SPO<sub>2</sub>), end-tidal carbon dioxide (EtCO<sub>2</sub>), non-invasive blood pressure (NIBP), or invasive blood pressure (IBP), esophageal temperature. Intraoperative analgesia was evaluated using the cumulative pain scale previously described by Costa *et al.* (2019). According to this pain score system, rescue analgesia was administered when total score was  $\geq 10$ . The surgical technique used to perform total laparoscopic gastropexy in all dogs was described by Deroy *et al.* (2019). In all gastropexy procedure a simple continuous barbed suture line was performed as described by Takacs *et al.* (2017).

#### **Ethical approval**

This study was performed in accordance with the animal welfare legislation and was approved by the Institutional Ethics Committee for animal welfare (PROT. N. 13/CESA/2022). All owners were informed in detail about the study design and signed the consent form.

### **Results**

In total 76 dogs met the eligibility criteria for the study. Eighteen dogs were male (17 intact, 1 neutered) and 56 females (54 intact, 2 neutered). Demographic data were reported in Table 1 (weight, age) and Table 2 (breeds). Concomitant surgical procedures were performed in 46/76 (2 male castration, 1 ovariohysterectomy, and 43 ovariectomies). All dogs received pre and postoperative CXR.

The analysis of surgical time, time of pneumoperitoneum (PP time), median EtCO<sub>2</sub>, and the median intra-abdominal pressure (IAP) were reported in Table 3.

A total of 76 gastropexy were performed with three portal access. The continuous barbed suture line was performed with a self-locking 0 polydioxanone monofilament-barbed suture (Filbloc, Assut Europe, Italy).

All patients did not report cardiorespiratory complications attributable to a pneumothorax like reduction of lung compliance ( $< 1$  ml/mbar/kg), increase

**Table 1.** Demographic data of the dogs enrolled.

	<b>Median</b>	<b>DS</b>
Weight (kg)	34.9	12.8
Age (months)	31.9	30.5

DS: deviation standard.

**Table 2.** Breeds of the dogs enrolled in our study.

<b>Breeds</b>	<b>Number</b>
Mixed breed	23
Corso dog	8
Golden Retriever	6
Saint Bernard	6
Labrador	5
German Shepherd	3
Rottweiler	2
English Setter	2
Great Dane	2
Central Asian Shepherd	2
Belgian Shepherd	2
Bobtail	2
Tibetan Mastiff	2
Giant Schnauzer	2
Siberian Husky	2
Newfoundland	2
Dobermann	2
Bernese Mountain Dog	2
Pastore Bergamasco	1

**Table 3.** Intraoperative data.

	<b>Median</b>	<b>DS</b>
Surgery time (minute)	34.7	12.4
PP time (minute)	23.6	11.1
IAP (mmHg)	10.6	1.5
EtCO <sub>2</sub> (mmHg)	39.4	3.1

DS: deviation standard; PP: pneumoperitoneum; IAP: intrabdominal pressure; EtCO<sub>2</sub>: end-tidal CO<sub>2</sub>.

of peak airway pressure ( $> 20$  cmH<sub>2</sub>O), or desaturation (SPO<sub>2</sub>  $< 97\%$ ).

Furthermore, the worsening in laparoscopic vision of the organs and decrease in IAP was not recorded in any patients.

Postoperative pneumothorax was not detected in the total of 76 dogs in the study.

Minor complications were detected in six patients, four postoperative mild subcutaneous emphysema, and two intraoperative accidental spleen's microlesions after the insertion of the first port access.

All surgeries were completed without the necessity to convert in open abdominal surgery.

### Discussion

Pneumothorax is a known complication of human laparoscopic abdominal surgery. It is most commonly a complication during laparoscopic mobilization of the esophagus like total laparoscopic gastropexy in dogs.

In human medicine, this complication is not frequent but widely described in the literature. Risk factors correlated with the formation of pneumothorax secondary to pneumoperitoneum were surgical time more than 200 minute, positive EtCO<sub>2</sub> > 50 mmHg, and operator inexperience (Labow and Conlon, 1999).

Additional potential causes of an intraoperative pneumothorax include: simple gas diffusion, congenital defects, and iatrogenic causes. Although highly unlikely, the possibility of simple CO<sub>2</sub> diffusion as the cause of the pneumothorax cannot be excluded. Congenital esophageal hiatus defects are the only widely described defects in young dogs (Callan et al., 1993).

The detection of an intraoperative pneumothorax may be difficult. An intraoperative pneumothorax can be suspected based on the decrease in pulmonary compliance and the increase in the peak airway pressure (Machairiotis et al., 2014).

Pneumothorax in the dog was recently described by Bendinelli et al. (2019) after laparoscopic ovariectomy and gastropexy procedures (Bendinelli et al., 2019).

In these two cases, during the execution of the gastropexy, the surgeon reported a progressive worsening in laparoscopic vision of the organs related to a decrease in IAP. No abnormalities were detected in the functioning of the laparoscopic instruments and the mechanic ventilator, and no diaphragmatic defects were detected. Iatrogenic trauma was also excluded by the surgeons. The two dogs developed a reduction of lung compliance (0.5 ml/mbar/kg) and an increase of peak airway pressure (26–28 cmH<sub>2</sub>O).

The insufflation of CO<sub>2</sub> into the abdomen was stopped; the tidal volume was reduced from 10 to 8 ml/kg and a positive end-expiratory pressure of 5 cmH<sub>2</sub>O was applied to avoid an excessive pulmonary collapse. The dogs received a thoracentesis, and the gas was aspirated.

After the thoracentesis, pulmonary compliance improved and peak airways decreased, so the surgery was completed.

The postoperative CXR highlighted the residual pneumothorax.

The risk factors that have been correlated with pneumothorax development during laparoscopic surgery are operative times more than 200 minutes, EtCO<sub>2</sub> > 50 mmHg, and operator inexperience (Hawasli, 2022).

These risk factors have been demonstrated in human medicine, there are currently no triggering risk factors that are proven in veterinary medicine.

In our study, all dogs did not present surgical or anesthetic complications related to the formation of pneumothorax.

The surgeons had long clinical practice with laparoscopic techniques and performed combined laparoscopic ovariectomy and total laparoscopic gastropexy.

The medium time of pneumoperitoneum in our study was 23.6 minutes and the median EtCO<sub>2</sub> was 39.4 mmHg and the maximum data recorded was 48 mmHg in one dog.

The IAP used is 10.6 mmHg, this data in Veterinary Medicine is a good choice for laparoscopic surgery and it was related with few intraoperative complications (Leonardi et al., 2020; Scott et al., 2020).

Some surgeons in recent times used IAP less than 10 (6–8) mmHg to perform total laparoscopic gastropexy (Lacitignola et al., 2021).

In conclusion, pneumothorax is a possible complication during laparoscopic surgery. However, in our results, the odds risk of pneumothorax after laparoscopic gastropexy surgical procedure is low.

CXR had become unnecessary despite if intraoperative anesthetic and clinical complications occur.

### Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Author contributions

All authors contributed to the conception of the study, study design, acquisition of data, data analysis, and interpretation, as well as drafting and revising and approval of the submitted of the manuscript.

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