UNIVERSIDADE DE LISBOA
FACULDADE DE MEDICINA VETERINÁRIA

RISK FACTORS AND PROGNOSTIC INDICATORS FOLLOWING REMOVAL OF OESOPHAGEAL AND GASTRIC FOREIGN BODIES IN DOGS AND CATS

MAFALDA FELÍCIO CAPELA

ORIENTADOR:
Doutor Luis Miguel Alves Carreira

TUTOR:
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Risk factors and prognostic indicators following removal of oesophageal and gastric foreign bodies in dogs and cats

ABSTRACT

Gastrointestinal foreign bodies are a common reason for presentation in small animal practice. The clinical presentation is often variable, different therapeutic interventions are available, and complications affecting the outcome may be observed. This retrospective multicentric study aimed to characterise a sample of dogs and cats with upper gastrointestinal foreign bodies and evaluate the clinical presentation, removal techniques and findings, the success rate of endoscopic removal, identify factors that could predict the need for surgery, assess the complication rate, hospitalisation period and identify potential risk factors for complications and outcome. Medical records at the Kingston Veterinary Group Hospital (UK) and Anjos de Assis Veterinary Medicine Centre (PT) were reviewed and a total of 73 dogs and cats with non-linear foreign bodies located in the upper gastrointestinal tract from the cervical oesophagus to the duodenum, and patients with linear foreign bodies anchored anywhere from the oral cavity to the duodenum were included in the study.

Results showed that patients whose owners did not witness ingestion of the foreign body were significantly more likely to have reported clinical signs ($p < 0.001$). Furthermore, witnessed ingestion was associated with a significantly shorter duration of clinical signs or time since ingestion ($p < 0.001$). Foreign objects were categorised as linear in 20.5% of the cases reported and, compared to dogs, cats were significantly more likely to have ingested a linear foreign body ($p < 0.001$). Results showed a significant association between linear foreign bodies and painful abdominal palpation ($p < 0.05$). The overall success rate of endoscopic removal was 76.9%. Successful endoscopy was not significantly associated with linear or non-linear objects, or the duration of clinical signs ($p > 0.05$). Nevertheless, when surgery was required, the removal of linear foreign bodies was significantly associated with the need for multiple surgical techniques ($p < 0.001$). The overall complication rate was 28.8%. The presence of a linear foreign body, the surgical procedure performed, and prompt *versus* delayed removal were not significantly associated with the occurrence of complications or a worse outcome ($p > 0.05$). An abnormal patient mentation and painful abdominal palpation were significantly associated with the occurrence of complications ($p < 0.05$).

In conclusion, even though undergoing surgery and the occurrence of complications were significantly associated with increased hospitalisation; performing surgery did not appear to increase the risk of complications nor affect the overall outcome. An abnormal mentation and painful abdominal palpation may be potential indicators for the occurrence of complications, thus possibly affecting the overall outcome.

Keywords: foreign body, endoscopy, surgery, complications

Fatores de risco e indicadores de prognóstico após remoção de corpos estranhos esofágicos e gástricos em cães e gatos

RESUMO

Corpos estranhos gastrointestinais são frequentes na clínica de pequenos animais. Este estudo retrospetivo multicêntrico teve como objetivo caracterizar uma amostra de cães e gatos com corpos estranhos de localização gastrointestinal superior, quanto à sua apresentação clínica, técnicas cirúrgicas, bem como avaliar a taxa de sucesso de endoscopia, identificar fatores que permitissem prever a necessidade de cirurgia, avaliar a taxa de complicações, o período de hospitalização e identificar possíveis fatores de risco para a ocorrência de complicações e prognóstico. Foram revistos os registos clínicos do Kingston Veterinary Group Hospital (UK) e do Centro de Medicina Veterinária Anjos de Assis (PT) e um total de 73 cães e gatos com corpos estranhos não-lineares no trato gastrointestinal superior, e animais que tinham corpos estranhos lineares ancorados em qualquer localização desde a cavidade oral até ao duodeno foram incluídos neste estudo.

Os resultados obtidos demonstraram que pacientes em que a ingestão não foi testemunhada tinham uma maior susceptibilidade para apresentar sinais clínicos ($p < 0.001$). Adicionalmente, a ingestão testemunhada mostrou estar significativamente associada com uma duração inferior dos sinais clínicos ($p < 0.001$). Em 20.5% dos casos os corpos estranhos foram classificados como lineares e os gatos mostraram maior susceptibilidade para ingerir um corpo estranho linear ($p < 0.001$). Verificou-se uma associação significativa entre a presença de um corpo estranho linear e dor à palpação abdominal ($p < 0.05$). A taxa de sucesso de endoscopia foi de 76.9%. Não se observou uma associação significativa entre a presença de corpos lineares ou a duração dos sinais clínicos, e o sucesso da endoscopia ($p > 0.05$). Casos em que cirurgia foi indispensável, a remoção de corpos estranhos lineares mostrou estar significativamente associada à necessidade de múltiplas técnicas cirúrgicas ($p < 0.001$). A taxa de complicações observada foi de 28.8%. Não se verificou uma associação significativa entre a presença de um corpo estranho linear, o procedimento cirúrgico realizado, ou a intervenção precoce *versus* tardia e a ocorrência de complicações, ou um prognóstico desfavorável ($p > 0.05$). Um comportamento alterado e palpação abdominal dolorosa mostraram estar significativamente associados com a ocorrência de complicações ($p < 0.05$).

Em conclusão, embora a realização de cirurgia e a ocorrência de complicações estivessem significativamente associadas a um maior período de hospitalização; a realização de cirurgia não aparentou aumentar o risco de complicações, nem afectar o prognóstico. Um comportamento alterado do paciente e palpação abdominal dolorosa poderão ser potenciais indicadores da ocorrência de complicações, possivelmente afetando o prognóstico.

Palavras-chave: corpo estranho, endoscopia, cirurgia, complicações

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHICS

LIST OF ABBREVIATIONS

CI - Confidence interval

CT - Computed tomography

FB - Foreign body

FBs - Foreign bodies

GI - Gastrointestinal

IQR - Interquartile range

LFB - Linear foreign body

LFBs - Linear foreign bodies

NA - Not available

NLFBs - Non-linear foreign bodies

OR - Odds ratio

PO - Postoperative

I. CURRICULAR TRAINEESHIP DESCRIPTION

As a component of the Integrated Master's Degree in Veterinary Medicine from the Faculty of Veterinary Medicine of the University of Lisbon, I carried out a 6-month curricular traineeship between September 2019 and March 2020, comprising over 1000 hours of experience at Kingston Veterinary Group, Hull, United Kingdom.

For the duration of the traineeship, I assisted and participated in several procedures carried out in different areas of small animal veterinary medicine. Under the guidance of Dr. David Robinson, the head of the Surgery department and my supervisor, I assisted and participated in numerous orthopaedic procedures (e.g. Cranial Tibial Closing Wedge Osteotomy, Fabello-tibial Suture, Tibial Plateau Levelling Osteotomy, Tibial Tuberosity Transposition, Fracture repairs, Pancarpal Arthrodesis), soft tissue surgeries (e.g. laparoscopic ovariectomy, exploratory laparotomies, gastrotomy, enterotomy, splenectomies, perineal hernia repair, anal sacculectomy, Brachycephalic Obstructive Airway Syndrome (BOAS) surgery, incisional/excisional biopsies, grid keratectomy, total ear canal ablation and bulla osteotomy, subdermal plexus advancement and rotation flaps) and postoperative care of the patients. Additionally, I was also provided with the opportunity to develop my surgical skills by performing surgical procedures under the supervision of senior surgeons, including dog and cat castrations, dog and cat ovariohysterectomies and superficial nodule/mass excisions. In terms of Anaesthesia, I was able to practice procedures such as induction, intubation and general anaesthetic monitoring.

In the Internal Medicine department, I accompanied clinicians during consultations. I was also able to take the lead on some occasions, which not only allowed me to develop my consulting skills but also improved my clinical case-solving skills with regards to establishing the differential diagnosis and treatment strategies. Furthermore, the same applies in terms of care and treatment of the inpatients for which I contributed by practising procedures such as drugs administration, blood sampling, blood typing, collection and transfusion, venous and urinary catheterization and running several diagnostic tests (e.g. haematology, biochemistry, urinalysis).

Regarding the Diagnostic Imaging department, I assisted the surgeons during endoscopy (rhinoscopy, bronchoscopy, gastroscopy) and ultrasound, magnetic resonance and computed tomography scans. Moreover, I was given a chance to practice patient positioning for radiographic examination on several occasions. Throughout these procedures, I was taught by senior vets how to interpret the imaging results, and reach conclusions towards diagnostic and treatment strategies in specific clinical cases.

II. LITERATURE REVIEW

1. GASTROINTESTINAL FOREIGN BODIES

Gastrointestinal foreign bodies (FBs) are commonly encountered in small animal practice. On many occasions, ingested objects will pass uneventfully through the gastrointestinal tract, with patients remaining asymptomatic. However, FBs may occasionally become impacted in both normal anatomic and pathological narrowing points in various sites of the gastrointestinal tract. The size and configuration (e.g., edges, projections, and width) of the FBs represent the main aspects that will determine whether they pass uneventfully or be retained (Tams and Spector 2011).

Foreign bodies become impacted in the oesophagus when they are either too large to pass through or their sharp edges become embedded in the oesophageal mucosa. A large number of objects that uneventfully pass through the oesophagus and enter the stomach will likely pass through the remainder of the gastrointestinal tract without any complications. However, large smooth objects (e.g., rocks, balls), nonpliable materials (e.g., leather or plastic), and objects with sharp or irregular edges may be retained in the stomach, particularly at the pylorus if they are too large to pass through (Tams and Spector 2011).

Ingestion of a foreign body (FB), when witnessed by the owner, allows them to bring animals sooner to where medical and surgical care can be provided (Hayes 2009). A shorter duration of clinical signs of obstruction, before receiving treatment, has been shown to significantly impact the successful outcome of animals presented with gastrointestinal FBs (Hayes 2009).

2. OESOPHAGEAL AND GASTRIC FOREIGN BODIES

2.1. Anatomic considerations

The oesophagus is anatomically divided into cervical, thoracic, and abdominal portions (Kyles 2012). Starting dorsally to the cricoid cartilage's caudal border, the cervical portion of the oesophagus inclines to the left of the trachea as it runs caudally till the thoracic inlet. The thoracic portion of the oesophagus is located on the left side of the trachea from the thoracic inlet to the tracheal bifurcation, at which point the oesophagus crosses the trachea returning to its dorsal position, after which it extends caudally to the diaphragmatic hiatus. The abdominal portion comprises the section of the oesophagus from the oesophageal hiatus of the diaphragm to the stomach (Kyles 2012).

Anatomic structures closely associated with the oesophagus should be acknowledged, including the aorta that obliquely crosses the left side of the midthoracic oesophagus; and the dorsal and ventral vagal trunks that run across the side of the oesophagus in the caudal thorax (Kyles 2012).

The oesophageal wall contains four layers, including the adventitia, which is the outer layer, followed by the muscularis, submucosa, and mucosa (Kyles 2012). In dogs, the muscularis is composed of striated muscle throughout the entire extension of the oesophagus, whereas in cats, the distal portion of the oesophagus is composed of smooth muscle (Kyles 2012). Blood vessels and nerves are present within the submucosa, which loosely connects the muscularis and mucosa, allowing mucosa to move freely. For this reason, in the nondistended oesophagus, the mucosa forms large longitudinal folds. These mucosal folds can be seen with positive-contrast oesophagography and, in the feline oesophagus, a herringbone pattern is seen in the terminal portion as a result of the oesophagus being folded transversely in this region (Kyles 2012).

The oesophagus has a segmental blood supply, and the oesophageal arteries and veins form an intramural plexus of anastomosing vessels in the submucosal layer, providing a rich intramural vascular supply (Kyles 2012). Damage to this intramural vascular supply can affect healing of the oesophageal incision, which is already hindered by the lack of serosal layer, and consequent slower fibrin sealing of the oesophagotomy site, along with the constant motion the oesophagus is subjected to (Kyles 2012, Radlinsky 2013).

The stomach is divided into different anatomic regions, namely, cardia, fundus, body, and pyloric portions (Cornell 2012). The stomach wall is formed of four distinct layers, from the external to the internal; they are the serosa, muscle, submucosa, and mucosa (Cornell 2012). The blood supply to the stomach is provided by the gastric and gastroepiploic arteries that supply the lesser and greater curvatures, respectively (Radlinsky 2013).

Contrarily to the healing of oesophageal incisions, gastric incisions heal quickly, and the resultant scar tissue is often resorbed (Cornell 2012). This is attributable to some factors such as the remarkably rich blood supply of the stomach; the constant regeneration of the mucosal epithelium; the reduced bacterial population as a result of the gastric acidity; and the presence of omentum that allows enhanced healing of the stomach (Radlinsky 2013).

2.2. Types of foreign bodies and location

Numerous retrospective studies have described common types of FBs and their location in dogs and cats. Dogs are more likely to be presented with gastrointestinal FBs when compared to cats. It is theorised that the reason for this difference is their slightly indiscriminate eating habits and swallowing of incompletely masticated food and exposure to toys and dental chews (Gianella et al. 2009).

Gastric foreign bodies occur more frequently in dogs than cats and account for 16% to 50% of reported gastrointestinal FBs (Boag et al. 2005, Hayes 2009). Reported FBs include plastic, bones, sharp objects (fish hooks), wood, and organic material, with plastic objects being the most commonly reported gastric FBs in dogs (Gianella et al. 2009).

Furthermore, dogs show a higher incidence of oesophageal FB entrapment (Brisson et al. 2018). Bones are by far the most commonly encountered oesophageal FBs in dogs (Pearson 1966, Houlton et al. 1985). Other reported objects include fish hooks, needles, wooden sticks, balls, toys, and chew treats (Houlton et al. 1985, Luthi and Neiger 1998, Leib and Sartor 2008). Cats are considered more particular eaters, and given their behavioural tendency to play and hunt; they more frequently present with fish hooks, string, or needle foreign bodies than bones (Radlinsky 2013).

The four areas of physiologic narrowing in the oesophagus include the upper oesophageal sphincter, the thoracic inlet, the heart base, and the distal oesophagus cranial to the gastroesophageal junction. These represent areas where extra oesophageal structures restrict oesophageal dilation. Foreign objects may potentially become impacted in any of the anatomic narrowing points aforementioned; however, they most commonly lodge at the thoracic inlet, the heart base, and the caudal oesophageal region (Tams and Spector 2011, Kyles 2012).

Retrospective case series in canine referral patient populations have revealed that oesophageal FB entrapments are most commonly located between the heart and diaphragm, followed by the base of the heart, and less commonly encountered in the cervical oesophageal region (Pearson 1966, Houlton et al. 1985). In contrast, other authors reported that fish hooks are most commonly found in the cervical oesophageal region, which suggests that type of FB may influence the site of entrapment (Michels et al. 1995, Binvel et al. 2017, Brisson et al. 2018).

3. LINEAR FOREIGN BODIES

Some specific objects such as thread, string, rope, cloth, ribbon, dental floss, carpet and nylon stockings are considered linear foreign bodies due to their configuration and can generate a particular form of intestinal obstruction (Aronson et al. 2000, Radlinsky 2013).

Typically, part of the object anchors itself at the base of the tongue or at the pylorus, and the remainder advances further in the intestinal tract (Aronson et al. 2000, Bebchuk 2002). Peristaltic waves attempt to advance the object aborally, causing the intestines to progressively gather around the object resulting in a pleated, or plicated appearance of the affected intestinal loops, also described as accordion-like pleats (Aronson et al. 2000, Riedesel 2013). This will not only result in partial or complete intestinal obstruction, but continued peristalsis as an effort to move it along may cause the object to become taut and embedded into the mesenteric border of the small intestine, potentially causing a laceration and subsequent peritonitis (Brown 2012, Radlinsky 2013).

Boag et al. (2005) reported a proportion of linear FBs as high as 36.2% in a retrospective study in dogs. However, Hayes (2009) reported a lower proportion of 16% of linear FBs in dogs, whereas in cats, these accounted for 33% of the FBs reported. Linear foreign bodies are more commonly reported in cats than dogs (Root and Lord 1971, Felts et al. 1984, Evans et al. 1994). Furthermore, in dogs, the most common anchorage point is the pylorus, with foreign material extending into the proximal jejunum and reported objects are usually fabrics, plastic and other textile materials (Evans et al. 1994, Boag et al. 2005, Hayes 2009, Hobday et al. 2014). On the other hand, in cats, the pylorus is a less common location, and linear foreign bodies are more commonly anchored around the base of the tongue, primarily single strands of thread or string (Felts et al. 1984, Hayes 2009).

The clinical presentation of an animal with a linear foreign body (LFB) is variable and depends on several factors: the location, completeness, and duration of the obstruction, as well as the vascular integrity of the involved segment (Radlinsky 2013). The most common clinical signs in dogs and cats include acute onset of vomiting, anorexia and depression (Felts et al. 1984, Brown 2012). Diarrhoea and abdominal pain may also be present (Radlinsky 2013).

Linear foreign bodies (LFBs) typically cause incomplete obstruction; thus vomiting may not be as severe and frequent as it would be if a complete obstruction were present (Aronson et al. 2000). For this reason, compared to non-linear foreign bodies (NLFBs), patients with LFBs may continue to drink and absorb free water for more extended periods, which may explain the lower serum sodium concentrations in dogs with LFBs in one study (Boag et al. 2005). Nonetheless, if clinical signs are more severe with more frequent vomiting, patients may be dehydrated, and laboratory findings may reflect a hypochloremic hypokalemic, metabolic alkalosis, as well as an increased haematocrit (Radlinsky 2013, Hobday et al. 2014).

A thorough physical examination is mandatory, especially regarding oral inspection and abdominal palpation (Brown 2012). Although part of an LFB may be visualised around the base of the tongue, sedation or anaesthesia may be necessary to properly explore the oral cavity (Radlinsky 2013). On abdominal palpation, the FB itself is typically not palpable; however, pleating of the small intestines may be felt as an irregularity or mass, in which case abdominal pain may be noted as well (Aronson et al. 2000, Radlinsky 2013).

Diagnostic imaging is the next logical step, and on plain abdominal radiographs, pleating or plication of the small bowel, and an altered enteric gas pattern with trapped intestinal gas bubbles is often seen (Root and Lord 1971, Aronson et al. 2000). Although affected intestinal loops may not become markedly distended, as the gas becomes trapped in the plicated intestine, evidence of an abnormal gas pattern of round and short-tubular; or even crescent- or comma-shaped gas bubbles may assist the diagnosis (Riedesel 2013). Even though a high proportion of cats with an LFB have a comma-shaped gas pattern; in some cases, it can also occur in cats that do not have this type of FB, which suggests that despite being an abnormal gas pattern, it is not pathognomonic for the presence of an LFB (Adams et al. 2010).

Instead of adopting a more uniformly dispersed configuration, the small bowel may appear predominantly localised or restricted to the cranial abdominal cavity (Root and Lord 1971). However, the displacement of the small bowel may also be evident in obese cats, though as a result of the accumulation of fat, both in the omentum and the falciform ligament, granting the appearance described above of the gathering of the intestine (Root and Lord 1971).

Nonetheless, if the foreign object is nonradiopaque or if it only partially obstructs the lumen, radiographic evidence of its presence may be equivocal or minimal, thus posing a diagnostic challenge (Hoffmann 2003). Obtaining the opposite lateral view enables the redistribution of gas within the gastrointestinal tract that acts as a negative contrast. As gas fills the pylorus on left lateral projection, it may enable the identification of a gastric FB with a linear component extending into the duodenum (Harness and Biller 2015). However, this technique may be ineffective if there is minimal air present within the gastrointestinal tract, in which case additional air can be introduced using an orogastric tube (Armbrust et al. 2000).

Performing an upper gastrointestinal contrast study may aid the diagnosis considering the pleating of the intestines will become more obvious and the foreign object may acquire the appearance of a radiolucent FB in the barium-filled intestine (Aronson et al. 2000). However, contrast agents should be administered with caution if intestinal perforation is plausible, in which case, a nonionic iodinated contrast agent is recommended (MacPhail 2002).

Abdominal ultrasonography is a reliable diagnostic technique for this type of FBs since intestinal plication and visualisation of the foreign material were consistent with the diagnosis of LFBs in previous reports (Tyrrell and Beck 2006). However, luminal gas and fluid presence may affect the appearance of linear material and, consequently, prevent its visualisation (Hoffmann 2003, Riedesel 2013). The most common ultrasonographic finding in a patient with an LFB is plication of the bowel around an echogenic line, which may be considered diagnostic for the presence of such a foreign object even when the object itself is not visualised (Tidwell and Penninck 1992). In the event of gastroduodenal LFBs, common sonographic signs include an abnormal tortuous path of the descending duodenum with the presence of a hyperechoic linear structure within the duodenal lumen which may inclusively be carefully traced orally to the pylorus (Hoffmann 2003). Ultrasonography may be complimentary to abdominal radiography and may provide further important information regarding peristalsis, the integrity of the bowel wall, presence of peritoneal effusions, and other potential abnormalities in the surrounding mesentery (Tyrrell and Beck 2006, Harness and Biller 2015).

Intestinal perforation is a potentially serious consequence of LFBs, resulting in secondary peritonitis (Root and Lord 1971). Ultrasonographic evidence of free gas in the abdomen and peritoneal fluid may suggest such conditions (Hoffmann 2003). Furthermore, bowel laceration and secondary peritonitis, as a consequence of LFBs, have been shown to more likely occur in dogs than cats, with a probability of nearly double that of cats (Root and Lord 1971, Evans et al. 1994).

Conservative management for LFBs in cats has been reported in one study, and it involves cutting free the linear material lodged sublingually to allow relief of the sublingual fixation, thereby enabling its passage without the need for further surgical intervention (Basher and Fowler 1987). This approach was successful in 47% of the cats in which it was attempted, with the remnant of the foreign material passing through the gastrointestinal tract in 1 to 3 days after it being freed from around the tongue. However, these patients were stable, tended to be presented soon after the onset of clinical signs, and frequently the owner was aware of its ingestion (Basher and Fowler 1987). Therefore, conservative treatment should only be considered if the clinical presentation of the patient does not warrant urgent surgical intervention; or if the LFB is lodged sublingually (Basher and Fowler 1987). Surgical intervention is mandatory if the patients are presented in poorer clinical condition with evidence of peritonitis, the LFB is anchored at the pylorus, and persistence or deterioration of clinical signs occur following conservative management. Additionally, surgical intervention is recommended for patients in which the LFB has not passed within 3 days following conservative treatment (Basher and Fowler 1987).

Endoscopy is a valuable technique for diagnosing and removing gastric and high duodenal foreign bodies, and may also enable removal of LFBs anchored at the pylorus (Radlinsky 2013). However, gastroduodenoscopy is only recommended if the LFB has been present for a brief period and if the anchorage point is the pylorus (Radlinsky 2013). The foreign body may be gently pulled out of the pylorus, or the endoscope may be advanced as close to the end of the object as possible, and retrieving it by pulling its distal end out first. Another viable option consists of pushing the most oral aspect of the foreign object into the duodenum, thereby relieving the fixation point; and monitoring its passage through the gastrointestinal tract. If the patient does not improve within 6 hours, surgical removal is advised (Radlinsky 2013).

Although conservative treatment may be successful, LFBs are considered surgical emergencies and delaying surgical intervention may result in increased morbidity and mortality. Due to the risk of perforation and subsequent peritonitis and sepsis, early surgical intervention is considered the treatment of choice (Aronson et al. 2000, MacPhail 2002). Surgical intervention to remove the foreign material is achieved through multiple enterotomies or using a single enterotomy catheter technique (Brown 2012).

A single-enterotomy catheter technique has been described for the removal of LFBs in cats (Anderson et al. 1992). A simple enterotomy is performed so that the foreign material is reached at its most proximal extent. The end is then attached to a soft catheter, which is inserted distally through the intestines, and after the enterotomy incision is closed, the catheter is milked aborally through the intestinal tract. Both the catheter and the foreign material are subsequently retrieved from the anus. By performing fewer enterotomies, this technique may reduce the risk of leakage and dehiscence; however, it should only be considered if there is no evidence of perforation or necrosis (MacPhail 2002, Radlinsky 2013). Dogs tend to be presented with fabric or plastic as LFBs, and given their wider diameter, this technique is unlikely to be successful in such cases (Brown 2012).

Multiple enterotomies are often required to remove a linear FB. Considering the risk of iatrogenic perforation from excessive tension during extraction, removing the FB through multiple enterotomies allows for segmental removal of the material, thereby minimising the risk (MacPhail 2002). In some cases, a gastrotomy, followed by multiple enterotomies, may be necessary to remove LFBs. Depending on the anchorage point of the LFB, the thread should be cut when lodged sublingually or through a gastrotomy, if lodged at the pylorus; and subsequent enterotomies performed to remove the remnant of the foreign material (Radlinsky 2013).

A careful examination of the complete gastrointestinal tract is mandatory whenever performing surgery since there may be multiple FBs present in different parts of the gastrointestinal tract (Hayes 2009). Following FB removal and decompression of the intestines, intestinal viability is assessed. Although the appearance of the intestine typically improves after the foreign object has been removed, any nonviable or questionably viable segments of the intestine should be resected and anastomosis performed (Radlinsky 2013). Rather than resecting areas of questionable viability, a planned laparotomy may be performed 24 hours later to reassess the viability of the intestinal segments (Lawson and Seshadri 2007). Assuming the patient is given supportive treatment, granting sufficient time will allow a more accurate assessment so that, ultimately, a less aggressive procedure is performed, thus minimising the risk of excessive resection and secondary short-bowel syndrome (Lawson and Seshadri 2007). Furthermore, evidence of intestinal perforation should also be assessed after the relief of plicated intestinal loops, which may also require resection of the involved segments if perforation is confirmed (Brown 2012).

The prognosis of animals with LFBs is generally good, provided there are no complications after the foreign object is removed (Radlinsky 2013). The presence of LFBs is associated with a significantly higher mortality rate in dogs compared to NLFBs (Hayes 2009). Furthermore, dogs with LFBs are more likely to have multiple intestinal procedures, which was associated with increased mortality in the same study (Hayes 2009).

Contrarily to the suggested worse outcome associated with LFBs in dogs in previous studies, Hobday et al. (2014) reported that even though animals with LFBs had longer surgical times and a higher frequency of complications such as intestinal necrosis, perforation and peritonitis; there was no difference in the outcome between animals with linear and non-linear FBs.

4. HISTORY, CLINICAL SIGNS AND PHYSICAL EXAMINATION

4.1. Oesophageal foreign bodies

Despite the fact that any breed of dog or cat may have an oesophageal FB, small-breed dogs, particularly Terrier breeds, appear to be more frequently affected (Houlton et al. 1985).

Foreign body ingestion may occur in an animal of any age; however, many affected dogs (64%) are younger than 3 years of age (Brisson et al. 2018). No obvious sex predisposition has been identified (Houlton et al. 1985).

Animals may be presented for treatment within a variable period after FB ingestion. Duration of clinical signs before presentation can vary greatly, ranging from a few hours to several weeks (Houlton et al. 1985). Furthermore, a retrospective study reported that in some patients, no clinical signs were reported by the owner or were observed during physical examination since the owner had witnessed FB ingestion right before the hospital admission (Gianella et al. 2009).

Foreign bodies in the oral cavity or pharynx usually result in per-acute clinical signs such as marked salivation, dysphagia, pawing at the mouth and neck, reluctant handling, pain, general anxiety, and often dysphonia or respiratory distress. Some of these clinical signs are similar to the ones associated with FB impaction in the oesophagus (Tams and Spector 2011).

Clinical signs related to oesophageal FB entrapment are often acute and usually include regurgitation, excessive salivation or retching, inappetence and respiratory distress (Houlton et al. 1985). Other signs such as gagging, dysphagia, odynophagia, lethargy or restlessness, and anorexia may also be present (Washabau 2012, Radlinsky 2013). Nonetheless, the severity of oesophageal damage and resulting clinical manifestations vary to some extent depending on the FB type and size; and duration, location, and type of obstruction (Radlinsky 2013, Marks 2017).

The characteristic sign of oesophageal obstruction is the rapid regurgitation of ingested food within a few minutes of eating. However, in some cases, this event may be delayed for up to 20 minutes; or even not occur at all despite the entrapped object if food passes through the obstruction and reaches the stomach (Pearson 1966). Complete obstruction often results in regurgitation of both solids and liquids. In contrast, liquids are frequently retained in those with partial obstruction (Pearson 1966, Radlinsky 2013). Physical examination is often unremarkable considering most patients are normal or just slightly depressed and dehydrated. The FB may sometimes be palpated only if lodged in the cervical oesophagus. A meticulous oral examination, particularly the area ventral to the tongue, is imperative in all cats suspected of having a linear foreign object (Radlinsky 2013).

Chronically affected animals with long-term oesophageal obstruction may still remain bright and alert despite having weight loss and periodic bouts of regurgitation and inappetence (Kyles 2012). Chronically affected patients that have been anorexic or regurgitating for longer periods will probably have a poor body condition (Radlinsky 2013). Nevertheless, oesophageal FB obstruction is considered an emergency; hence prompt removal is advised (Aronson et al. 2000).

4.2. Gastric foreign bodies

Ingestion of foreign bodies is more commonly reported in young animals, and the presence of a gastric or intestinal FB should always be suspected in a young animal presented for treatment with a history of acute or persistent vomiting. Nonetheless, the possibility of FB ingestion must always be considered a differential diagnosis in any animal presenting with suggestive signs (Tams and Spector 2011, Radlinsky 2013).

Gastric foreign bodies are usually associated with partial or complete obstruction, and depending on the degree of the obstruction, characteristic clinical signs may be present (Tams and Spector 2011).

Patients with gastric foreign bodies typically present with a history of vomiting due to outflow obstruction, gastric distension, or mucosal irritation (Radlinsky 2013). Frequent vomiting is generally associated with large foreign bodies, with more marked clinical signs if the FB is lodged in the pyloric antrum since persistent stimuli or distension of the duodenum or the pyloric antrum stimulate vomiting (Tams and Spector 2011, Radlinsky 2013). In some instances, vomiting may cause oesophageal irritation and, consequently, secondary regurgitation may be present (Cornell 2012).

On the other hand, vomiting is often absent if the FB is located in the gastric fundus and does not occlude the pylorus (Radlinsky 2013). For this reason, animals may present with a history of intermittent vomiting episodes with small foreign objects or when these are freely movable in the stomach, and therefore, continue to eat and remain active. In these cases, due to presenting minimal or no clinical signs, the FB may have been present for a long period before diagnosis (Tams and Spector 2011, Radlinsky 2013). Furthermore, the clinical signs exhibited by the animal may sometimes seem contradictory to the type or size of the FB present (Tams and Spector 2011). Occasionally, if animals are asymptomatic, gastric foreign bodies may be incidental findings on abdominal radiographs (Radlinsky 2013).

The presence of a gastric FB may also cause inappetence or complete anorexia, lethargy, and nonspecific mild abdominal tenderness. As soon as the FB is removed, the appetite is expected to return to normal (Tams and Spector 2011).

The presence of both pain and pyrexia suggests perforation, in which case signs of peritonitis may be evident, or in contrast, the patient may display minimal or no abdominal signs whatsoever (Tams and Spector 2011).

Other clinical signs such as seizures or hemolysis may be present with toxic foreign bodies. The potential toxicity of these objects depends on numerous factors, such as the leakage of these substances from their casings, the duration of contact with the mucosa, and the inherent toxicity of the chemicals themselves. Endoscopic or surgical removal of a toxic FB is imperative if the object remains in the stomach for longer than 24 hours or if it lodges in the intestinal tract (Tams and Spector 2011).

Physical examination is often unremarkable. Even though the object usually cannot be palpated due to the physiologic location of the stomach in the proximal abdomen, abdominal distension may be evident if the FB is obstructing the pylorus, causing pyloric outflow obstruction. Occasionally, abdominal pain is noted, especially in patients with obstruction, gastric perforation and secondary peritonitis, or if an LFB is present, in which case plicated intestines may be felt on abdominal palpation (Cornell 2012, Radlinsky 2013).

5. DIAGNOSTIC EVALUATION

5.1. Diagnostic imaging

Diagnostic imaging techniques are considered of great value when identifying gastrointestinal (GI) foreign bodies. The diagnosis of a retained FB in the GI tract may be relatively straightforward from the history (Tams and Spector 2011).

Survey cervical, thoracic and abdominal radiographs in lateral and ventrodorsal views should be the first study performed, considering radiopaque objects can easily be identified in most cases (Tams and Spector 2011).

Positive-contrast studies can be performed with different contrast agents to help outline GI foreign objects, each with its own limitations. Barium swallow is contraindicated if GI perforation is suspected (Gaschen 2013). Furthermore, barium aspiration is a potential complication, and therefore, barium paste is contraindicated in animals at increased risk for aspiration. An iodinated solution contrast is a viable alternative if GI perforation is suspected (Gaschen 2013).

However, due to its hypertonicity, ionic iodinated contrast agents may induce pulmonary oedema if aspirated. Therefore, nonionic iodinated contrast agents (e.g., iohexol) are the safest choice if perforation is suspected, although they are more expensive (Radlinsky 2013, Gaschen 2013).

Ultrasonography has also been recommended as a diagnostic approach, and results suggest that ultrasonography as a single test may be a more appropriate choice than survey radiography for the diagnosis of GI FBs in small animals (Tyrrell and Beck 2006). Considering it appears to be a safe, fast, non-invasive method, it may also be useful as an adjunct to radiography, potentially allowing correct identification of gastrointestinal FBs not previously visualised on survey radiographs (Tidwell and Penninck 1992, Tyrrell and Beck 2006). Thereby, it may represent a viable option to identify radiolucent gastric FBs, provided the stomach is fluid-filled, and an appropriate acoustic window is achieved (Radlinsky 2013).

Endoscopy is an effective diagnostic technique, and it is usually the next step after suggestive findings of a possible FB on plain radiographs (Radlinsky 2013). Granted that endoscopy is available, it is usually of greater value than radiographic contrast studies for it allows not only the diagnosis of the FB, but also the possibility of its removal during the endoscopic procedure; as well as assessing the integrity of the GI tract and identifying a potential perforation (Radlinsky 2013).

The use of videofluoroscopy for FB identification and removal was a viable alternative to the endoscopy technique in several clinical cases (Moore 2001).

5.2. Clinical laboratory findings

Animals with GI FBs are found to have a wide variety of electrolyte and acid-base abnormalities, both variable in nature and severity (Boag et al. 2005). Complete or partial obstruction of the gastrointestinal tract can lead to disturbances in the normal function of secretion and absorption of electrolytes in the gastrointestinal tract, which can rapidly result in disturbances of fluid balance, acid-base status, and serum electrolyte concentrations (Papazoglou et al. 2003, Boag et al. 2005). Furthermore, if the patient has chronic or profuse vomiting and diarrhoea, along with a reluctance to ingest food and drink water, intravascular volume and hydration status may also be affected, possibly contributing to further acid-base abnormalities and electrolyte imbalance (Boag et al. 2005).

Proximal GI obstructions (i.e., gastric or upper duodenal) are often considered to be likely associated with the development of a hypochloremic, hypokalemic metabolic alkalosis as a result of vomiting and subsequent loss of chloride, potassium, and hydrogen ion-rich gastric fluid. Adversely, a more distal obstruction will presumably lead to metabolic acidosis (Boag et al. 2005). Nonetheless, Boag et al. (2005) reported that the most common electrolyte and acid-base abnormalities found in a sample of dogs with GI FBs, regardless of the site of obstruction or type of FB identified, were hypochloremia and metabolic alkalosis, followed by hypokalemia, and hyponatremia.

However, as a result of vomiting and inadequate fluid intake, some patients may present laboratory findings such as elevated packed cell volume and plasma total solids, reflecting dehydration. Subsequent hypovolemia may lead to a concurrent metabolic acidosis, resulting in a mixed metabolic alkalosis and acidosis in patients with high lactate and positive base excess (Boag et al. 2005).

Patients with oesophageal FBs generally have unremarkable laboratory findings, even with acute obstructions. If oesophageal perforation has occurred, more severe abnormalities such as neutrophilic leukocytosis may be detected (Radlinsky 2013).

The presence of a gastric FB may lead to variable laboratory findings, yet again, depending on the severity and duration of the obstruction. In some cases, laboratory parameters may be normal, or only mild changes may be seen as a result of dehydration (Radlinsky 2013).

Performing laboratory analysis is essential in any animal suspected of having a gastrointestinal FB since knowledge of the electrolyte and acid-base status can be of significant relevance so that the optimal fluid therapy plan is chosen, if necessary, as well as to ensure the patient is stable before anaesthesia and eventual surgery (Boag et al. 2005).

6. TREATMENT

6.1. Oesophageal foreign bodies

Different procedures are available for the removal of oesophageal FBs, including endoscopic retrieval with grasping instruments; extraction using a balloon-type catheter (e.g., Foley); the advancement of the FB into the stomach where it can be left to dissolve or be removed by subsequent gastrotomy; or performing an oesophagotomy or a partial oesophagectomy (Houlton et al. 1985, Tams and Spector 2011, Radlinsky 2013, Deroy et al. 2015).

Except if there is a valid reason to decide otherwise, a less invasive technique such as endoscopy or fluoroscopy, with either grasping forceps or a balloon catheter should be strongly considered as the initial approach for the removal of oesophageal FBs (Pearson 1966, Kyles 2012, Radlinsky 2013).

Nowadays, several instruments are available for the removal of FBs in association with endoscopes including pronged, alligator-jaw, and rat's tooth grasping forceps; polypectomy snares; and basket retrievers (Tams and Spector 2011). The type and size of grasping instrument chosen are limited by the diameter of the working channel of the endoscope; and depends on the personal preference of the endoscopist, as well as the type of foreign object in question, for which some instruments may be more adequate than others (Tams and Spector 2011).

In cases in which, through endoscopy, the foreign object cannot be grasped and retrieved in a retrograde manner, an attempt should be made to advance it into the stomach (Pearson 1966, Tams and Spector 2011). Once pushed into the stomach, the foreign object can be removed by gastrotomy (Tams and Spector 2011, Kyles 2012).

In some cases, it is mandatory the use of surgery to remove oesophageal FBs. Surgery is indicated in the following situations: endoscopic retrieval or advancement unlikely to be successful; failure to remove the FB endoscopically; evident perforation; when there is a risk of causing or enlarging an oesophageal perforation by attempting removal with forceps; and when extraction with forceps carries a risk of laceration of major vessels if a penetrating FB is located at the base of the heart (Kyles 2012, Radlinsky 2013, Deroy et al. 2015). Furthermore, some types of foreign objects may become tightly wedged in the oesophagus, resulting in significant pressure necrosis, in which case a surgical inspection is required to assess the integrity of the oesophageal wall (Guilford 2005).

Oesophageal surgery is commonly associated with a higher prevalence of surgical site dehiscence than surgery on other portions of the gastrointestinal tract (Kyles 2012). Nonetheless, if surgical principles are ensured, and postoperative precautions are taken, oesophageal surgery can be performed successfully and complications minimised (Kyles 2012).

Surgical removal of oesophageal FBs can be achieved by performing an oesophagotomy or a partial oesophagectomy (Radlinsky 2013). Considering the anatomy of the oesophagus, the surgical approach varies according to the portion of the oesophagus where the FB is located (Kyles 2012).

The cranial thoracic oesophagus can be approached either through a left third or fourth intercostal thoracotomy when the abnormality is located cranial to the heart base; or a right third, fourth or fifth intercostal thoracotomy when located at the heart base (Kyles 2012, Radlinsky 2013). On a left-sided thoracotomy, the oesophagus is exposed by ventral retraction of the brachiocephalic trunk and subclavian vessels. In contrast, on a right-sided thoracotomy, ventral retraction of the trachea along with retraction and, if necessary, ligation of the azygos vein, provides increased exposure of the oesophagus at the heart base (Kyles 2012).

Regarding FBs lodged in the distal portion of the oesophagus, between the heart and diaphragm, oesophagotomy or partial oesophagectomy through a left eighth or ninth intercostal thoracotomy is commonly the procedure of choice (Sale and Williams 2006, Kyles 2012). Alternatively, a gastrotomy, either through a transdiaphragmatic approach or a midline coeliotomy may also be performed (Kyles 2012, Aertsens et al. 2016, Delligianni et al. 2020).

For the closure of an oesophagotomy, a two-layer simple interrupted pattern is often chosen, consisting of a first layer incorporating the mucosa and submucosa, with the knots placed intraluminally; and the second layer apposes the muscularis and adventitia with the knots placed extraluminally (Kyles 2012). Following the closure of the incision, its integrity can be tested by distending the oesophagus using saline, applying pressure and look for any sign of leakage (Radlinsky 2013).

Oesophagectomy is performed to remove devitalised or diseased oesophageal tissue that may be present as a result of the obstruction and possible secondary mucosal damage caused by the FB (Radlinsky 2013). Resection of more than 3 to 5 cm of oesophageal tissue is not recommended as it may result in excessive tension, therefore risking anastomotic dehiscence (Radlisnky 2013). However, performing a circumferential partial myotomy may reduce anastomotic tension (Kyles 2012). Omentalization of oesophagotomy or oesophagectomy sites is valuable since it aids healing of the oesophageal wound due to the distinctive vascularity of the omentum (Kyles 2012).

Once the FB is removed, endoscopy should still be performed to reevaluate the oesophagus, and thoracic radiographs taken to look for evidence of oesophageal perforation (i.e., pneumothorax) (Radlinsky 2013).

6.2. Gastric foreign bodies

Non-digestible retained gastric FBs should be removed, which can be achieved through medical treatment, endoscopy or surgery. Many types of objects can be removed with endoscopic techniques, provided these are available (Tams and Spector 2011).

Alternatively, conservative treatment may be a viable option for patients that have retained small, rounded or blunt, and nontoxic objects with minimal clinical signs. An observation period can be carried out for 3 to 7 days, during which spontaneous passage of the object may occur. However, this approach should not be considered in patients with significant clinical signs, in which case, removal should be attempted as soon as possible (Tams and Spector 2011).

Regardless of the chosen course of treatment, repeating abdominal radiographs shortly before the procedure is strongly recommended to confirm the location of the object in the GI tract (Tams and Spector 2011). This is important considering the gastric FB previously identified on radiographs may since have left the stomach and lodged more distally in the gastrointestinal tract, possibly resulting in obstruction that could warrant further intervention (Cornell 2012).

In some cases, medical treatment can be attempted by inducing emesis using apomorphine, in dogs, and xylazine, in cats; possibly resulting in the expulsion of the object (Radlinsky 2013).

The clinician should take into consideration possible complications that may occur when inducing emesis for FB expulsion, including the likelihood of oesophageal laceration;

potential lodging of the object in the oesophagus or the oropharynx; considerable risk of aspiration of the FB or gastric contents; and esophagitis with associated stricture (Radlinsky 2013, Zersen et al. 2020). This approach should only be attempted if the object itself is unlikely to cause any harm when expelled (Kirchofer et al. 2019). Additionally, if the object becomes lodged in the oesophagus and it has to be removed surgically, oesophageal surgery carries more risk than gastric surgery due to healing characteristics; thus this factor should also be taken into account (Radlinsky 2013).

Even though endoscopic removal of FBs is a less invasive procedure when compared to surgical removal, it may not be an option for all types of foreign objects due to their size, texture, shape, or number, possibly posing a limiting factor for such approach (Zersen et al. 2020).

When performing endoscopy, in order to facilitate location and removal of the FB, the stomach should be as empty of food as possible; and the patient positioned in left lateral recumbency given the tendency of objects to shift to the dependent fundus or body of the stomach (Tams and Spector 2011).

To ensure all FBs are retrieved, a complete and thorough inspection of the stomach is crucial, including a careful examination of the fundus and cardia using the retroflexion manoeuvre; as well as inspection of the proximal duodenum so that any remaining foreign material in these areas does not go unnoticed (Tams and Spector 2011).

In clinical practice, removal of gastric FBs is the most common indication for performing a gastrotomy in dogs and cats (Radlinsky 2013). Both the location of the stomach in the cranial abdomen and the anatomic structures that restrict the stomach in its normal position prevents a clear visualisation and effortless manipulation of the organ. Furthermore, there is a significant risk of gastric content spillage during the procedure, for which proper techniques should be used to minimise contamination and avoid postoperative morbidity and mortality (Cornell 2012).

The gastrotomy incision is performed on the ventral surface of the stomach in the area with the least vascularity, between the greater and lesser curvatures; and its length depends on the size of the FB to be removed (Cornell 2012).

Following removal of the FB, the stomach itself should be inspected for any signs of perforation or necrosis and, depending on the extent of the damage, if present, abnormal tissue may need to be removed or patched (Radlinsky 2013). Furthermore, during laparotomy, the entire GI tract should be inspected for other foreign material that could potentially cause obstruction or perforation, considering that more than one object is often present (Cornell 2012).

Closure of the stomach is routinely achieved by performing a continuous two-layer inverting pattern. The first layer incorporates serosa, muscularis and submucosa, providing hemostasis; followed by a second layer that incorporates only the serosa and muscularis preventing gastric content leakage (Cornell 2012, Radlinsky 2013).

After the closure of the stomach, the abdominal cavity should be lavaged using sterile saline or Ringer's lactate and suctioned dry, followed by the closure of the abdomen with sterile instruments (Cornell 2012).

7. COMPLICATIONS AND PROGNOSIS

Removal of FBs lodged in the GI tract may be associated with several short- or long-term complications according to the region of the GI tract affected, which increase morbidity and mortality rates.

Complications associated with oesophageal FBs include oesophagitis, aspiration pneumonia, oesophageal perforation, and oesophageal stricture formation. Less common and more severe complications include pneumothorax, pneumomediastinum, mediastinitis, pleuritis, pyothorax, oesophageal diverticula, fistulae, mediastinal and peritoneal abscesses (Rousseau et al. 2007, Thompson et al. 2012, Deroy et al. 2015, Brisson et al. 2018, Bongard et al. 2019).

Nonetheless, patients undergoing procedures for gastrointestinal FB retrieval may still develop postoperative reflux oesophagitis, oesophageal stricture, and aspiration pneumonia as a result of a higher risk of gastric reflux since they may not have been properly fasted prior to being anaesthetised for immediate intervention (Tams and Spector 2011).

III. INTRODUCTION AND STUDY AIMS

Foreign body ingestion is a common reason for presentation in small animal practice. However, considering the wide variety of objects recovered and the different locations of the GI tract where these may become impacted, the clinical presentation is often variable. In some situations, animals show no clinical signs; hence the duration of FB impaction can vary greatly before presentation and diagnosis (Gianella et al. 2009).

According to the nature of the FB, and the risk for potential complications, different therapeutic interventions may be performed, including intensive monitoring, induction of emesis, and endoscopic and/or surgical removal. Nevertheless, treatment recommendations are usually based on the experience of the attending veterinarian rather than on evidence of peer-reviewed literature (Pratt et al. 2014).

The purpose of this retrospective multicentric study is to characterise a study sample of dogs and cats with upper gastrointestinal foreign bodies, regarding signalment, clinical presentation, FB location and type (linear or non-linear), range of objects recovered, surgical findings and removal techniques, complications and outcome.

The study aimed to evaluate and compare the advantages and disadvantages of endoscopy *versus* conventional surgery for the retrieval of upper gastrointestinal FBs in dogs and cats.

IV. MATERIALS AND METHODS

1. INCLUSION CRITERIA

To conduct this retrospective study, medical records at the Kingston Veterinary Group Hospital (United Kingdom - UK) and Anjos de Assis Veterinary Medicine Centre - CMVAA (Portugal - PT) were searched for all the dogs and cats treated for a gastrointestinal foreign body between January 2017 and March 2020.

Patients with non-linear FBs located in the upper GI tract, from the cervical oesophagus to the duodenum; and patients with linear FBs anchored anywhere from the oral cavity to the duodenum were included in this study.

Also, patients with FBs in the oral cavity or the small and large intestines were included only if those objects extended to or from another portion of the GI tract.

Patients that passed the FB without any intervention or were submitted only to medical treatment or other conservative approach were excluded from the study.

2. CLINICAL DATA

The medical records of the patients were consulted, and data retrieved included signalment (breed, gender, age and bodyweight); history regarding the type and duration of reported clinical signs, and potentially witnessed ingestion. Physical examination findings such as rectal temperature, abdominal palpation and mentation, along with performed diagnostic techniques, were also obtained. The duration of clinical signs was either the time since known ingestion or from the start of clinical signs. Additionally, information regarding discharge upon the first presentation, as opposed to prompt admission for treatment, was also retrieved from the medical history. Performed interventions for removal were categorised as: 1) endoscopy, 2) surgery, or 3) both procedures. Surgical and endoscopic findings included location and type of objects recovered, as well as anatomic pathological abnormalities consequent to the FB. Patients were categorised into 2 groups: LG (group with a linear FB) and NLG (group with a non-linear FB). Linear FBs were classified as objects anchored at one anatomic site, extending to one or more aboral sites in the GI tract; and discrete objects were characterised as non-linear FBs. Data regarding complications (considered as major and minor), length of hospitalisation, and outcome were also obtained. For descriptive purposes, complications were categorised as minor or major according to severity.

3. STATISTICAL ANALYSIS

Data was collected and recorded using Microsoft® Excel 16.45. The statistical analysis was performed using R 4.0.3 (R Core Team, 2020).

Absolute frequencies and percentages were determined for categorical variables using two-way contingency tables. Pearson's Chi-squared test was performed to determine possible statistical associations between these variables. When expected frequencies were lower than 5, Fisher's Exact test was performed. The degree of association between the variables was analysed by calculating the odds ratio. Additionally, the Cochran Armitage test for trend in proportions was performed further to assess the statistical association between the presence of pain, and increased degrees of pain on abdominal palpation and the presence of a linear FB. The Shapiro-Wilk normality test was performed to assess the distribution of continuous variables including age, bodyweight, duration of clinical signs, and hospitalisation period. Data regarding the aforementioned variables were not normally distributed; hence results were reported as median (interquartile range). The association between the categorical variables and the hospitalisation period was determined by performing the Wilcoxon-Mann-Whitney test or the Kruskal-Wallis test, depending on whether the variables had two or more than two levels, respectively. Pairwise comparisons between surgical procedures' hospitalisation period were determined using the Holm-Bonferroni method. Statistical significance was accepted in all tests if $p < 0.05$.

V. RESULTS

1. STUDY SAMPLE

The study used a total sample of seventy-three animals (n = 73) that met the inclusion criteria, divided in 57 dogs and 16 cats. Regarding the gender, 46 were male (23 entire and 23 neutered); and 27 were female (10 entire and 17 neutered). For dogs, the sample consisted of mainly cross breeds (n = 12). Other breeds represented included Labrador Retriever (n = 7), Poodle (n = 5), Boxer (n = 4), Bull Terrier (n = 4), and Yorkshire Terrier (n = 4), among others. For cats, breeds included Domestic shorthair (n = 13), Maine Coon (n = 2), and Sphynx (n = 1) (appendix 1).

The median age of dogs was 3.1 years (3.6 IQR) with a range of 3 months to 17 years, and the median age of cats was 2.9 years (4.0 IQR) with a range of 8 months to 12 years. The median bodyweight of dogs was 11.2 kg (17.8 IQR) with a range from 2.80 to 54 kg, and the median bodyweight of cats was 5 kg (1.4 IQR) with a range from 3.25 to 7.1 kg (table 1).

Table 1. Patient details at presentation

	Dogs (n=57)	Cats (n=16)
Age (years)		
Median (IQR)	3.1 (3.6)	2.9 (4.0)
Range	0.25 - 17.4	0.67 - 12.0
Bodyweight (kg)		
Median (IQR)	11.2 (17.8)	5.0 (1.4)
Range	2.80 - 54.0	3.25 - 7.1

IQR - Interquartile range

2. PATIENT HISTORY, CLINICAL SIGNS AND DIAGNOSIS

Fifty-three patients (72.6%) had clinical signs described by the owner, whereas for the remaining 20 patients (27.4%), no clinical signs were present.

Clinical signs described by the owner included vomiting (42/73), anorexia (22/73), nausea (18/73), diarrhoea (17/73), hypersalivation (13/73), melena (9/73), hyporexia (6/73), polydipsia (5/73), meteorism (4/73), regurgitation (2/73), retching (2/73), dysphagia (1/73), painful cervical palpation (2/73), hematochezia (1/73), and dehydration (1/73).

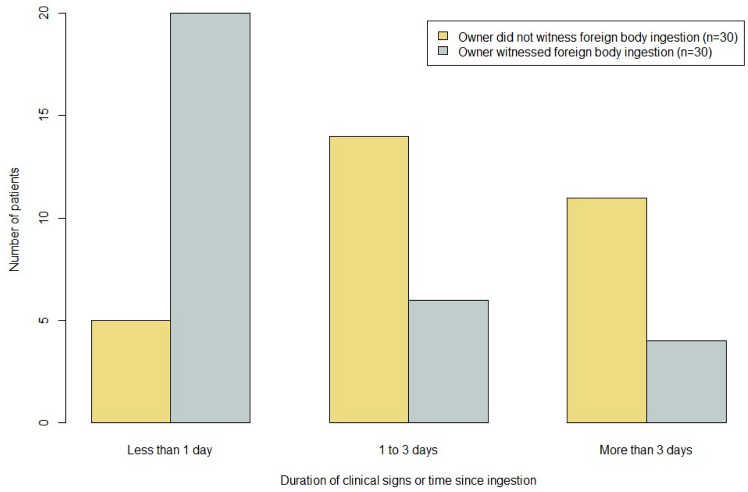
From the 73 patients included in this study, in only 62 cases, information regarding witnessed ingestion of the FB was available. In 48.4% (30/62), ingestion of the FB was witnessed by the owner, and in 51.6% (32/62) of the cases, the owner did not witness ingestion. Regarding the presence or absence of clinical signs, for patients in which ingestion of the FB was not witnessed by the owner, the presence of clinical signs was more frequently reported (table 2). There was a statistically significant association between whether ingestion of the FB was witnessed and the presence of clinical signs. Patients in which the ingestion of the FB was not witnessed by the owner were more likely to have clinical signs when compared to those in which the owner witnessed ingestion ($p < 0.001$; OR 22.6; 95% CI [2.94; 1033.05]).

Table 2. Descriptive data for patients concerning the presence or absence of clinical signs and witnessed ingestion by the owner

	Absence of clinical signs	Presence of clinical signs
Owner witnessed FB ingestion (n = 30)	13 (43.3%)	17 (56.7%)
Owner did not witness FB ingestion (n = 32)	1 (3.1%)	31 (96.6%)

Duration of clinical signs or time since ingestion of the FB before presentation was reported for 60 cases in this study and subsequently categorised as less than 1 day (n = 25), between 1 to 3 days (n = 20), and more than 3 days (n = 15) (graphic 1). In situations in which ingestion of the FB was witnessed by the owner, patients were more commonly presented to the hospital less than 1 day after having clinical signs or having ingested the object. On the other hand, when ingestion was not witnessed, patients were more commonly presented only after 1 to 3 days of having clinical signs or having ingested the FB ($p < 0.001$) (graphic 1).

Graphic 1. Duration of clinical signs or time since ingestion before presentation



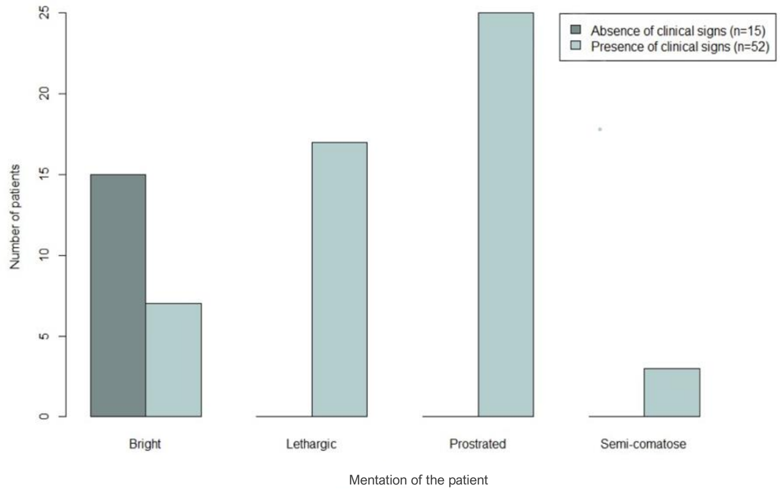
Median duration of clinical signs or time since ingestion was 1 day (2.0 IQR) for dogs (n = 45), and 2 days (4.5 IQR) for cats (n = 15).

75% of dogs were presented for treatment less than 3 days after ingestion or duration of clinical signs, whereas 75% of cats were presented after more than 3 days. Furthermore, witnessed ingestion was reported in 52.2% of dogs and in 37.5% of cats ($p = 0.31$).

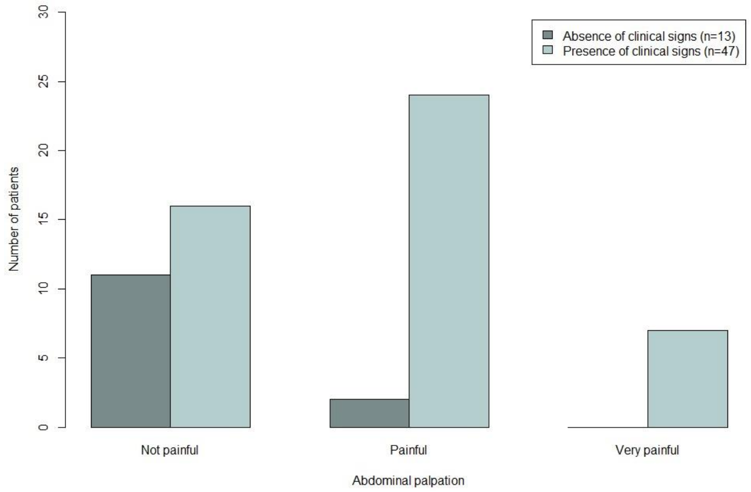
The mentation of the patient at presentation was reported in 67 cases and categorised as bright (22/67), lethargic (17/67), prostrated (25/67), and semi-comatose (3/67). Information regarding abdominal palpation was reported in sixty cases, and categorised as not painful (27/60), painful (26/60), and very painful (7/60). There was a statistically significant association between the presence of clinical signs and both the mentation ($p < 0.001$) and the presence of pain on abdominal palpation ($p < 0.01$).

Patients with no clinical signs such as vomiting or anorexia, for which the mentation at presentation was reported, were all considered to be bright upon presentation, despite having a FB. Contrarily, patients for which the owner described clinical signs were more frequently considered to be prostrated (graphic 2). Regarding abdominal palpation at initial evaluation, it was more frequently considered not painful when no other clinical signs were present; and more frequently considered painful when clinical signs were present (graphic 3).

Graphic 2. Number of patients with presence or absence of clinical signs and mentation reported at presentation



Graphic 3. Number of patients with presence or absence of clinical signs and abdominal palpation reported at presentation



The rectal temperature at initial evaluation was reported in 73 patients, a median of 38.6°C (IQR 0.7) for dogs; and 38.5°C (IQR 1.5) for cats, considered to be within normal range. Haematological and biochemical parameters were measured shortly after admission in 75.3% (55/73), and in 78.1% (57/73) patients, respectively. Diagnostic imaging was performed in 93.1% (68/73) cases and included radiographic imaging (n = 68), abdominal ultrasonography (n = 41), CT scan (n = 1), and contrast study (n = 1). Radiographic imaging of patients included in this study sample are represented in figures 1, 2, 3 and 4.

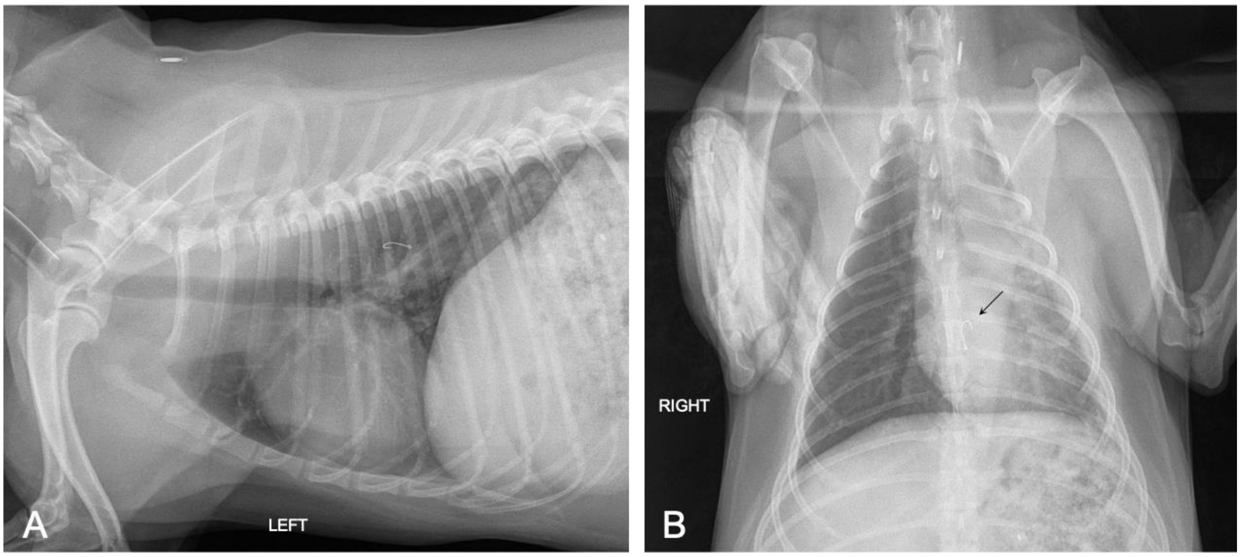


Figure 1. Left lateral (A) and ventrodorsal (B) thoracic radiographs of a dog with a fish hook (black arrow) lodged in the thoracic oesophagus at the heart base. Original photograph

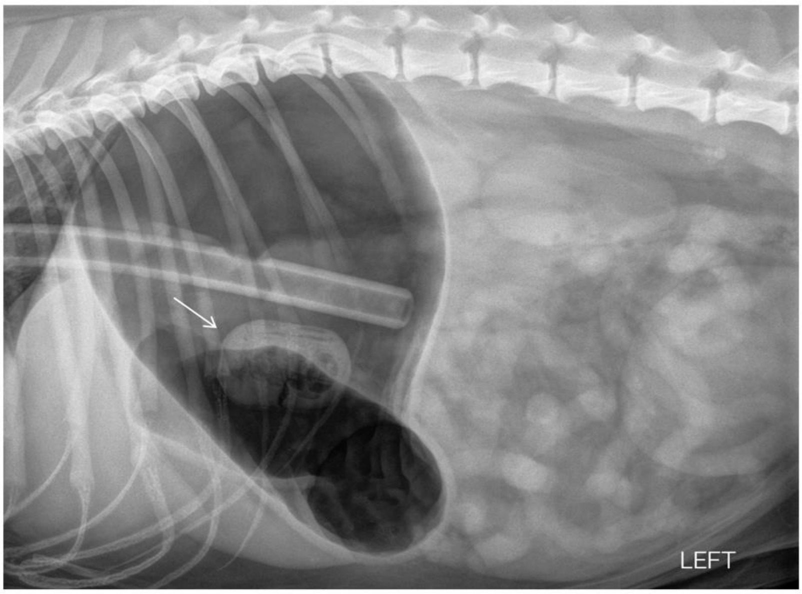


Figure 2. Left lateral abdominal radiograph of a dog with a plastic object (white arrow) located in the stomach. Original photograph
Administration of gas creates more contrast which allows for improved visualisation of the foreign object.

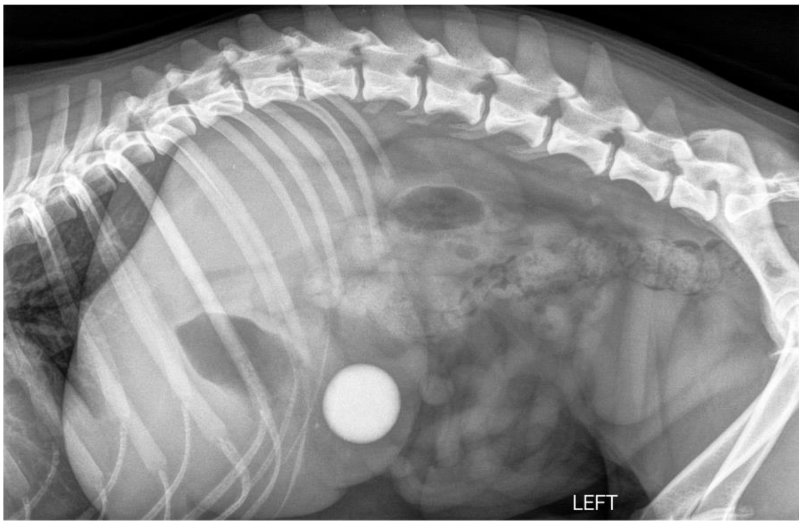


Figure 3. Left lateral abdominal radiograph of a dog with a bouncy ball located in the stomach. Original photograph

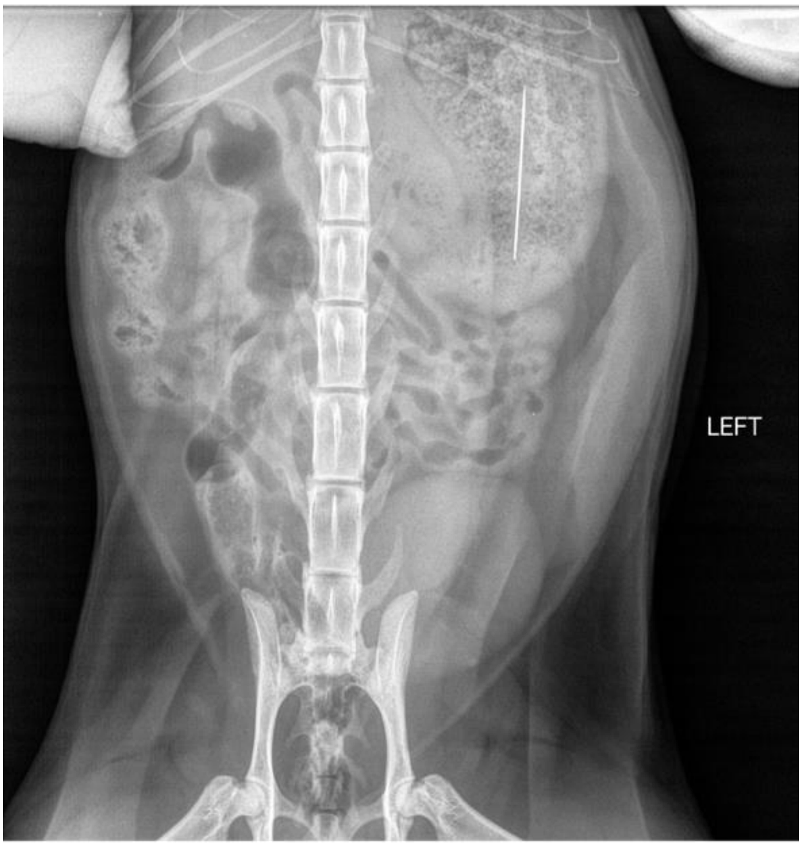


Figure 4. Ventrodorsal abdominal radiograph of a cat with a needle and thread located in the stomach. Original photograph

3. LOCATION AND TYPE OF FOREIGN BODY

Types of foreign objects recovered are summarised in table 3. Considering this study sample, dogs most commonly ingested plastic (n = 6) and wooden skewers or fragments (n = 6), followed by linear objects (n = 5), fish hooks (n = 5), toys (n = 5) and textile materials (n = 5). On the other hand, the great majority of cats included in this study ingested linear objects (n = 8).

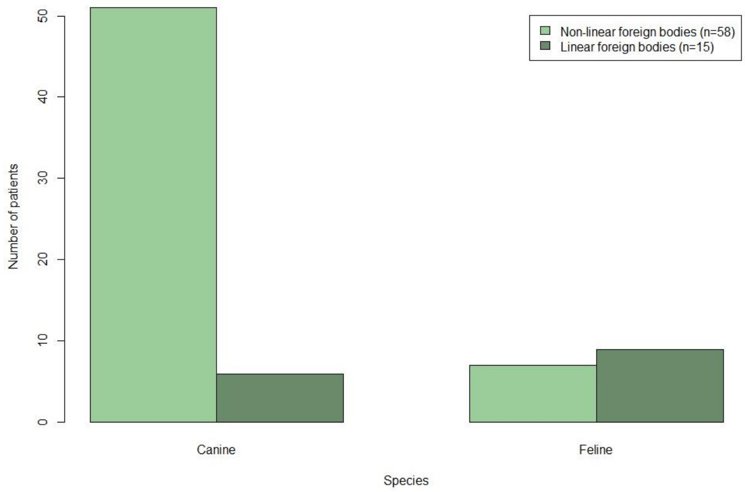
Table 3. Type of FB recovered from the patients included in this study sample

Type of foreign body	Dogs	Cats
Plastic	6	2
Wooden skewers/wood fragments	6	-
String/Ribbon/Rope/Dental floss	5	8
Fish hook	5	-
Toys	5	-
Textile material (socks, underwear, blanket)	5	-
Bouncy ball/Tennis ball/ball	4	-
Bone (pork chop, beef bone fragment, sharp fragment)	3	-
Metal objects	3	1
Button	1	1
Needle	2	-
Needle and thread	-	2
Grass and leaves	2	-
Organic material (peach and loquat fruit core, corn cob, piece of carrot, piece of chicken, almond)	1	2
1 of each: cork, flash drive, fishing line, hose fragment, make up sponge, glass, stone, lolly stick, dustbin contents	9	-

Based on the type of material (string, ribbon, rope, dental floss, plastic, textile materials) and the configuration assumed by the FB, these were subsequently categorised as linear FBs (15/73; 20.5%) or non-linear FBs (58/73; 79.5%).

There was a statistically significant association between the species and the type of FB (linear and non-linear) present. Even though dogs were over-represented in this study sample, 9 cats (56.2%) had linear FBs, whereas only 6 dogs (10.5%) had linear FBs (graphic 4). When compared to dogs, cats were more likely to have a LFB ($p < 0.001$; OR 10.4; 95% CI [2.48; 48.94]).

Graphic 4. Number of dogs and cats with linear and non-linear FBs

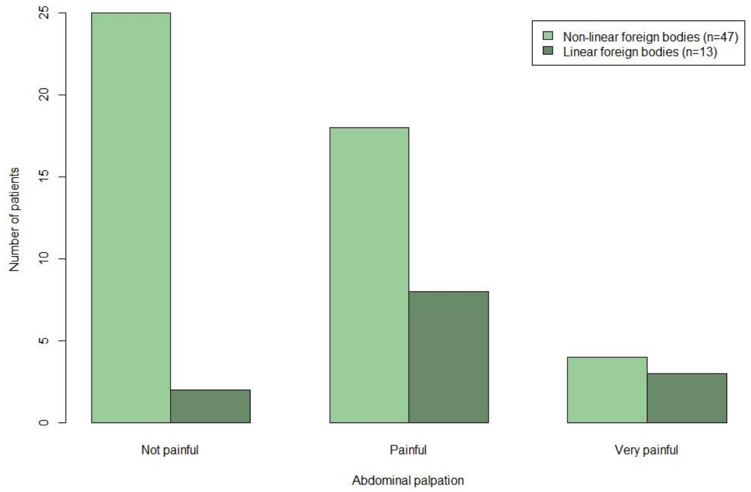


There was no statistically significant association between the type of FB and the presence or absence of clinical signs ($p = 0.053$). Nevertheless, 93.3% (14/15) of patients with LFBs had clinical signs, whereas clinical signs were reported in 67.2% (39/58) of patients with NLFBs. Interestingly, there was a statistically significant association between the type of FB and both the presence of pain on abdominal palpation ($p < 0.05$) and the mentation at presentation ($p < 0.01$).

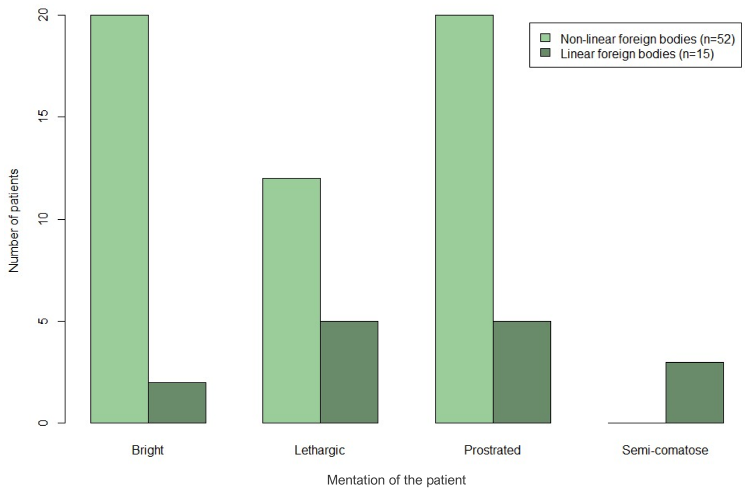
The abdominal palpation in patients with LFBs was more frequently reported as painful (61.5%), and more frequently reported as not painful in the NLFBs group (53.2%) (graphic 5). Furthermore, there was a statistically significant trend in proportions suggesting that according to the presence and the increased degree of pain on abdominal palpation, higher the probability of the presence of an LFB ($p < 0.05$).

As to the mentation at presentation, patients with LFBs were more commonly considered lethargic or prostrated, whereas patients with NLFBs were more commonly considered bright or prostrated (graphic 6). Interestingly, patients considered to be bright were more likely to have a non-linear FB ($p < 0.01$) and the 3 patients considered to be semi-comatose all had LFBs.

Graphic 5. Number of patients with linear and non-linear FBs and abdominal palpation reported at presentation



Graphic 6. Number of patients with linear and non-linear FBs and mentation reported at presentation



Foreign objects were recovered from various sections of the GI tract, from the oesophagus to the large intestine. For this reason, the location of the FB was categorised as single or multiple, according to the extent to which one or more than one anatomical sections were involved, respectively. Sixty-two patients (84.9%) had a FB present in a single anatomical location, and 11 (15.1%) had a FB present in multiple anatomical locations.

From the fifty-eight NLFBs included in this study, in 56 cases (96.6%) a single anatomical location was affected, whereas in only 2 cases (3.4%) multiple anatomical locations were affected. On the other hand, from the 15 LFBs considered, in 6 cases (40%) the FB was in a single location, and for the remaining 9 cases (60%) it was in multiple locations. Foreign bodies causing the involvement of multiple anatomical locations were significantly more likely to be of a linear nature rather than non-linear ($p < 0.001$; OR 37.9; 95% CI [6.09; 436.94]).

The specific location of linear and non-linear FBs recovered from the dogs and cats included in this study are illustrated in figures 5 and 6, respectively.

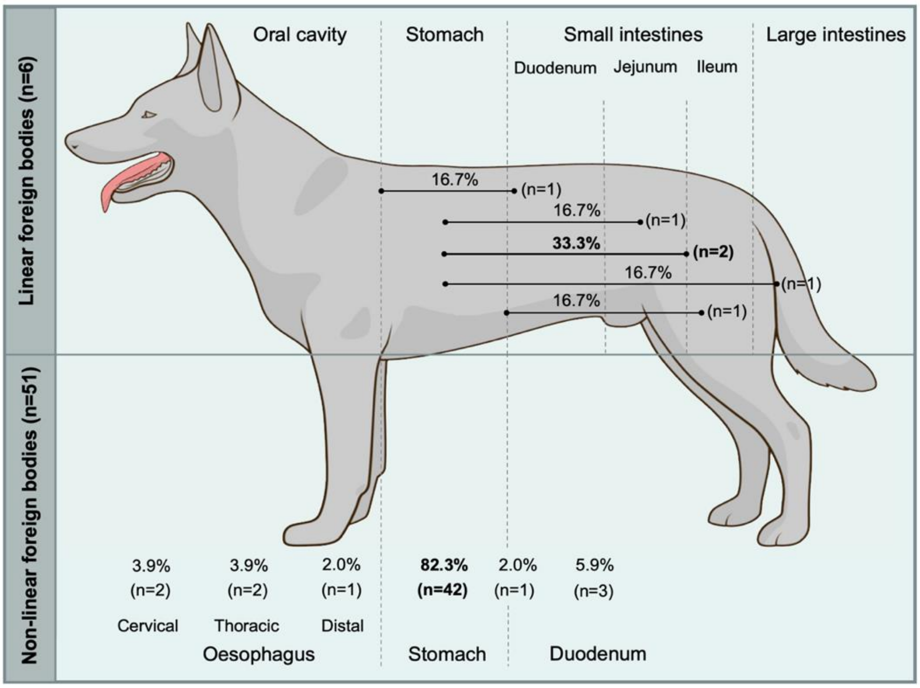


Figure 5. Location of 6 linear foreign bodies (at the top) and 51 non-linear foreign bodies (at the bottom) in 57 dogs. Original drawing
The dots and lines represent the anchorage point of the linear FB and its extension throughout the GI tract, respectively.

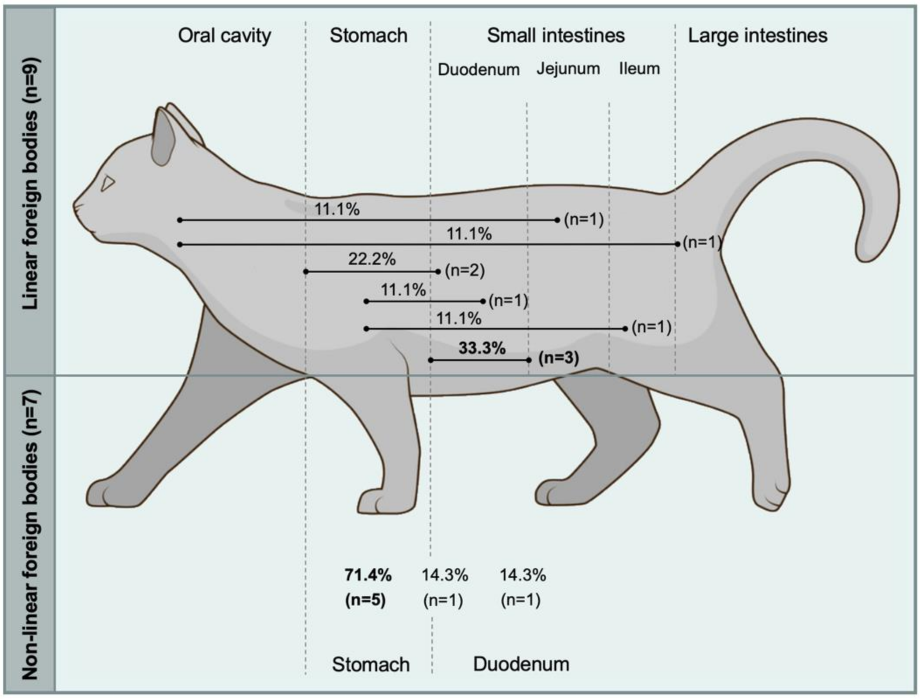


Figure 6. Location of 9 linear foreign bodies (at the top) and 7 non-linear foreign bodies (at the bottom) in 16 cats. Original drawing
The dots and lines represent the anchorage point of the linear FB and its extension throughout the GI tract, respectively.

Regarding the specific anatomical location on the GI tract, the most common anchorage point for LFBs in dogs was the pylorus (4/6), with the foreign material extending into the small intestines, whereas NLFBs were substantially more frequently found in the stomach (figure 5). On the other hand, the most common anchorage points for LFBs in cats was the duodenum (3/9), followed by the pylorus (2/9) and the base of the tongue (2/9); whereas NLFBs were also more commonly found in the stomach (figure 6).

4. REMOVAL TECHNIQUES AND SURGICAL FINDINGS

Removal of the foreign objects was either achieved through endoscopy, surgery, or both procedures when endoscopy was unsuccessful as a first attempt, and subsequent conversion to surgery was performed to remove the FB, which was ultimately accomplished for all patients included in this study.

Of the 73 patients included in this study, in 26 cases (35.6%) endoscopy was performed as a first attempt, resulting in the successful removal of the FB in 76,9% of the cases (20/26), while for the remaining 23.1% (6/26) surgery was required, following unsuccessful endoscopic removal. For the remaining 47 patients in this study (64.4%), surgery was chosen as the first attempt for removal. Therefore, surgery was ultimately performed in 53 patients (72.6%).

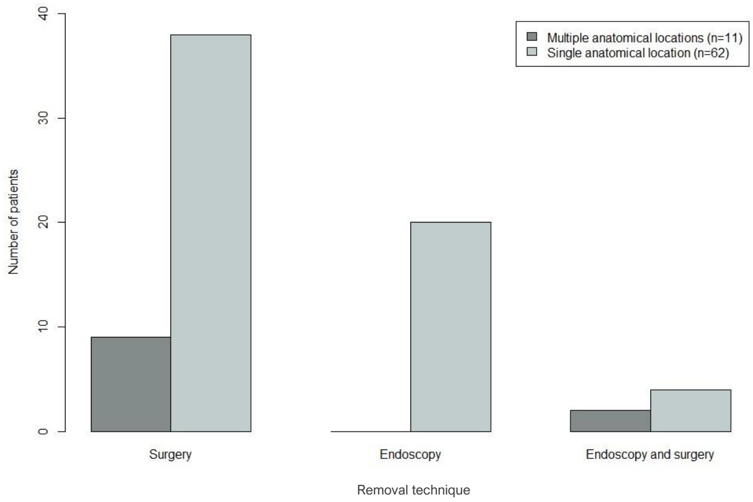
Factors that were considered to potentially affect the success of endoscopic removal, when attempted, included the type of FB; the duration of clinical signs or time since ingestion; the single or multiple locations of the FB; and whether patients were initially discharged home upon the first presentation, instead of being immediately admitted for treatment.

When considering the type of FB, in the LFB group (n = 15), endoscopy was attempted in 26.7% of the patients (4/15) leading to the successful removal of the object in 75% of those (3/4); while in the remaining 73.3% of the patients (11/15) surgery was promptly performed. In contrast, in the non-linear FB group (n = 58), in 37.9% of the patients (22/58) endoscopy was performed as a first attempt, allowing successful removal in 77.3% of cases (17/22); and the remaining 62.1% (36/58) underwent surgery originally. There was no statistically significant association between the type of FB and the need for surgery following unsuccessful endoscopic removal ($p = 0.81$).

Regarding the duration of clinical signs or time since ingestion (less than 1 day; 1 to 3 days; more than 3 days), there was no statistically significant association between patients that had clinical signs for longer periods and unsuccessful endoscopic removal, or the need for surgery ($p = 0.19$). Nevertheless, in the group of patients with a duration of clinical signs or time since ingestion of less than 1 day, endoscopy was chosen as the first attempt in 44% of the cases (11/25), with achieved successful removal in 90.9% (10/11) cases. In contrast, in the group of patients included in the categories of 1 to 3 days; and more than 3 days, endoscopy was initially performed in 20% of the cases (4/20); and in 40% of the cases (6/15), respectively; with a success rate of 50% in both groups.

In terms of the location of the FB, there was a statistically significant association between the location of the FB and unsuccessful endoscopic removal or the need for surgery ($p < 0.05$). Even though surgery was more frequently chosen as the first course of treatment, regardless of the FB being present in single or multiple locations, endoscopic removal, when attempted, was only successful for patients with a FB present in a single location (graphic 7).

Graphic 7. Number of patients with single or multiple locations and respective removal technique



Sixty-three patients (86.3%) were initially admitted for treatment after presentation, whereas 10 patients (13.7%) were discharged home in a first instance before being admitted for treatment later on due to no resolution of the clinical signs. There was no statistically significant association between patients being discharged following their first presentation, and requiring surgery to remove the FB after returning to seek treatment ($p = 0.39$).

Nonetheless, in the group of patients that were discharged initially ($n = 10$), although endoscopy was first attempted in only 20% of the cases (2/10) whilst the remaining 80% of the patients (8/10) underwent early surgery; endoscopy allowed for the removal of the object in 50% (1/2) of those in which it was attempted. Contrarily, in the group of patients that were initially treated ($n = 63$), 38.1% of the patients (24/63) underwent endoscopic removal, and in 79.2% of cases (19/24), successful removal was achieved; and for the remaining 61.9% (39/63) surgery was performed as the first attempt.

There was no statistically significant association between unsuccessful endoscopy or need for surgery and continuos variables including age ($p = 0.51$), bodyweigth ($p = 0.82$), rectal temperature ($p = 0.09$), and duration of clinical signs or time since ingestion ($p = 0.09$).

Patients that underwent surgery, either as a result of unsuccessful endoscopy; or the first choice of treatment, according to the anatomical location and number of surgical techniques required to remove the FB; were categorised as having single or multiple surgical techniques performed. Of the 53 patients for which surgical removal was required, in 84.9% of the cases (45/53) a single surgical technique was sufficient, whereas in the remaining 15.1% (8/53) multiple surgical techniques were necessary.

Of the twelve (n = 12) LFBs removed through surgery, in 50% of the cases (6/12) a single surgical technique was sufficient, whereas the remaining 50% (6/12) required multiple surgical techniques. In contrast, of the 41 NLFBs that were recovered through surgery, 95.1% of cases (39/41) were removed through a single surgical technique; and for 4.9% of the cases (2/41) multiple surgical techniques were required. Moreover, there was a statistically significant association; hence patients with LFBs removed through surgery had an increased risk of requiring multiple surgical incisions, as opposed to patients with NLFBs ($p < 0.001$; OR 17.8; 95% CI [2.49; 219.52]).

Predictably, all of those that required multiple surgical techniques had a FB present in multiple locations ($p < 0.001$).

Surgical techniques performed in this study sample to remove linear and non-linear FBs are illustrated in detail in figure 7.

Overall, regardless of the species and the type of FB, gastrotomy alone (71.7%) was the most commonly performed surgical technique (figure 7).

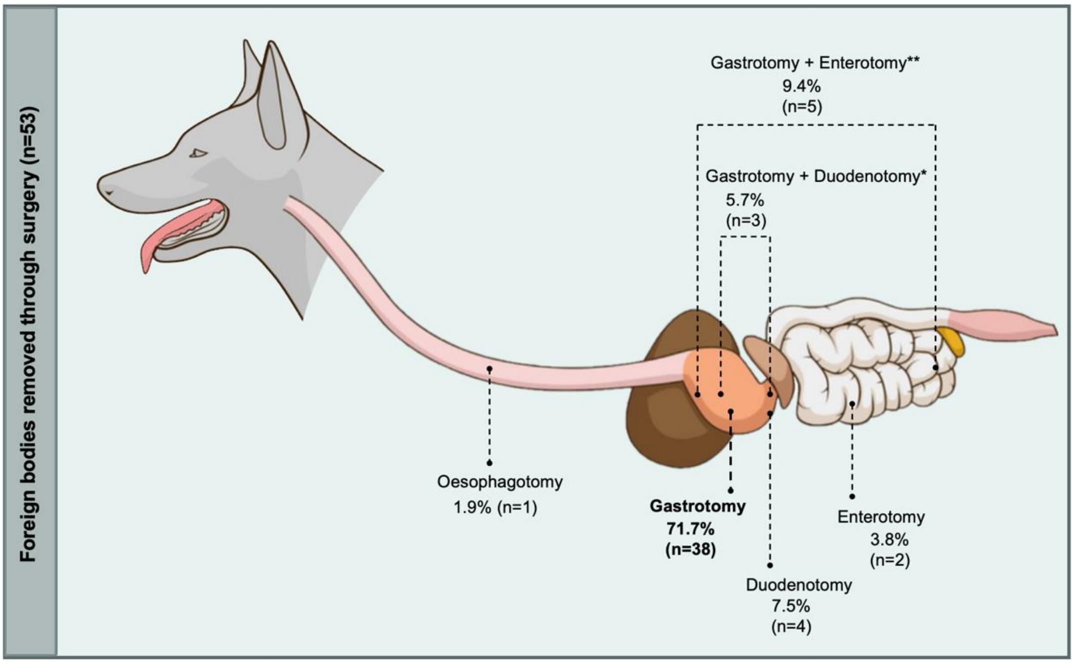


Figure 7. Surgical techniques performed in both dogs and cats (n = 53). Original drawing
*one of these patients (n=1) also required both an enterotomy and enterectomy
**one of these patients (n=1) required multiple enterotomies

5. COMPLICATIONS, HOSPITALISATION PERIOD AND OUTCOME

Complications, either postoperative or as a direct result of FB entrapment, were described in 28.8% of the patients (21/73), whereas the remaining 71.2% (52/73) recovered without any complications whatsoever.

Complications observed were categorised as major and minor according to their nature and clinical relevance and are summarised in detail in appendix 2. Major complications included intestinal necrosis (n = 3), intestinal intussusception (n = 2), intestinal perforation (n = 2), and laceration of the mesenteric border (n = 2). Regarding minor complications, the most commonly reported was wound oedema (n = 4).

Factors that were considered to potentially be associated with the occurrence of complications included the type of FB; the presence of clinical signs; the duration of clinical signs or time since ingestion; the mentation, and the presence and degree of pain on abdominal palpation at presentation; whether patients were initially discharged home upon the first presentation; and the surgical procedure for removal.

Complications were reported in 40% of the patients with LFBs (6/15), whereas in patients with NLFBs, complications were reported in 26% of the cases (15/58). However, there was no statistically significant association between the type of FB and the occurrence of complications ($p = 0.34$).

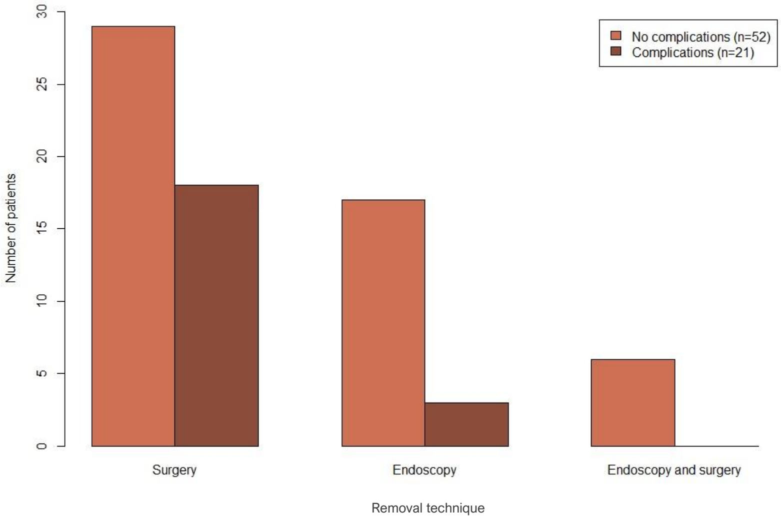
Regarding the presence or absence of clinical signs, complications were observed in 34% of the cases that had clinical signs (18/53) and in 15% of the cases with no clinical signs (3/20); however, there was no statistically significant association ($p = 0.15$).

Contrarily, there was a statistically significant association between the occurrence of complications and both the mentation ($p < 0.05$) and presence of pain on abdominal palpation at presentation ($p < 0.05$). Complications were reported in patients that were considered bright (2/22; 9%); lethargic (7/17; 41%); prostrated (9/25; 36%); and semi-comatose (2/3; 66%). It was observed that an abnormal mentation was generally associated with a higher frequency of complications ($p < 0.05$). Similarly, the frequency of complications was generally found to increase in line with a higher degree of pain on abdominal palpation ($p < 0.05$).

Regarding whether patients were initially discharged home upon the first presentation instead of being immediately admitted for treatment, complications were observed in 30% of the patients that were discharged on a first instance (3/10), and in 28.6% of the patients that were initially admitted for treatment (18/63); however, this difference was not statistically significant ($p = 1$).

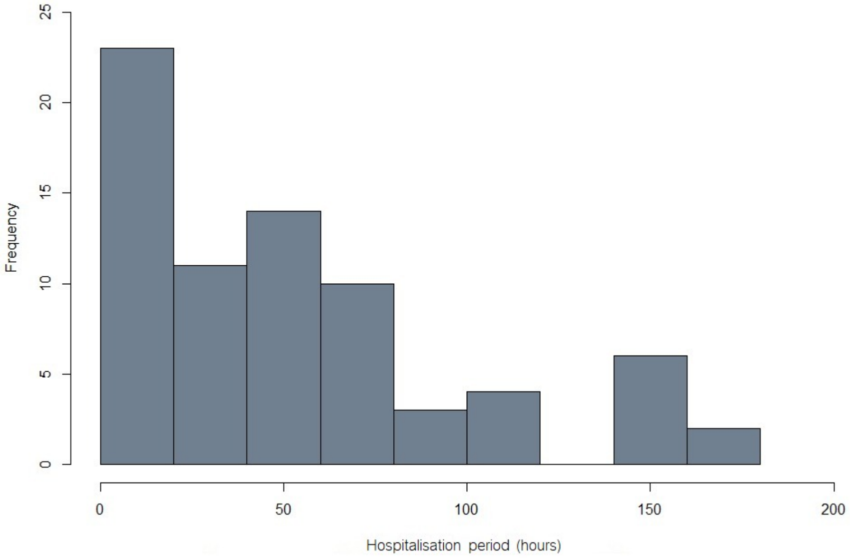
Considering the surgical procedure performed for removal, complications were reported in 15% of patients (3/20) in which successful endoscopy was achieved and in 38% of patients (18/47) that underwent surgery as the first course of treatment. Interestingly, all the 6 patients that had surgery following unsuccessful endoscopy recovered without any complications (graphic 8). Despite the above, there was no statistically significant association (p = 0.11); hence patients that underwent surgery were not more likely to have complications postoperatively.

Graphic 8. Number of patients with complications following each removal technique



Additionally, there was no statistically significant association between the occurrence of complications and continuos variables including age (p = 0.98), bodyweigth (p = 0.30), rectal temperature (p = 0.14), and duration of clinical signs or time since ingestion (p = 0.58).

Graphic 9. Histogram of the hospitalisation period



The median hospitalisation period was 48 hours (66 IQR), and 75% of the patients were hospitalized for less than 72 hours. The distribution of the study sample regarding hospitalisation period is represented in graphic 9.

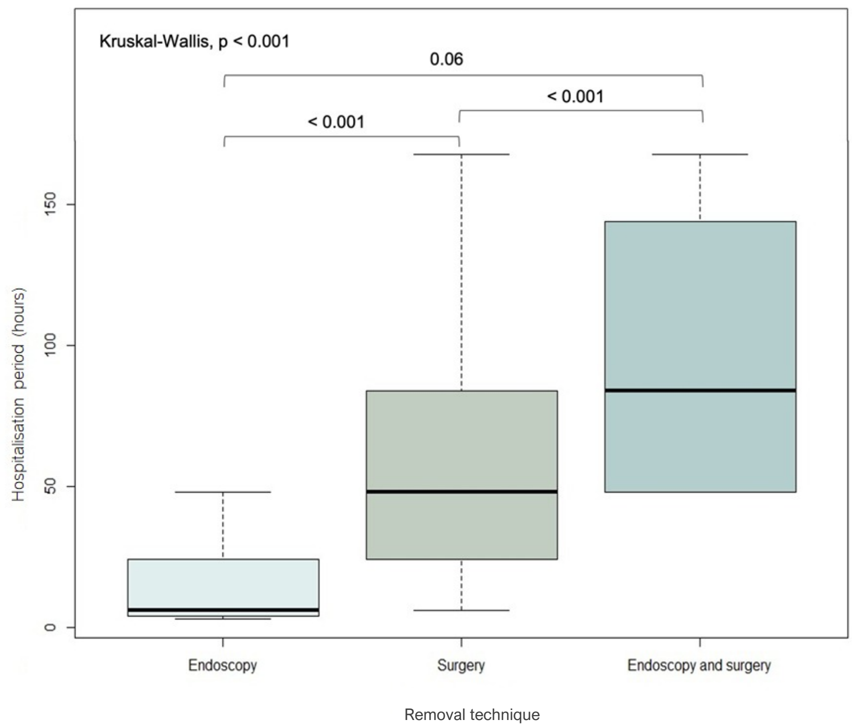
The presence of clinical signs, the type of FB, the location of the FB (single or multiple), the surgical procedure, the surgical techniques (single or multiple), and the occurrence of complications were considered to potentially affect the hospitalisation period postoperatively. Patients with clinical signs had a significantly increased hospitalisation period (median 48h), compared to those with no clinical signs (median 24h) ($p < 0.05$).

The type of FB was not significantly associated with the duration of the hospitalisation period ($p = 0.75$), with a median duration of 48 hours, regardless of a linear or a non-linear FB. Foreign bodies found in multiple locations resulted in a significantly longer hospitalisation period for those patients (median 72h) compared to FBs found in a single location of the GI tract (median 24h) ($p < 0.01$).

Patients with the longest hospitalisation period were the ones that had both procedures performed (median 84h), followed by those in which surgery alone was performed (median 48h), and lastly, those that underwent endoscopy alone (median 6h) (graphic 10).

A statistically significant difference was observed between the endoscopy group and the surgery group ($p < 0.001$), as well as between the endoscopy group and both procedures group ($p < 0.001$). However, there was not a statistically significant difference between the surgery group and both procedures group ($p = 0.06$). Therefore, the observed difference in the hospitalisation period was found to be associated with undergoing surgery, regardless of performed as a first approach or subsequent to unsuccessful endoscopy.

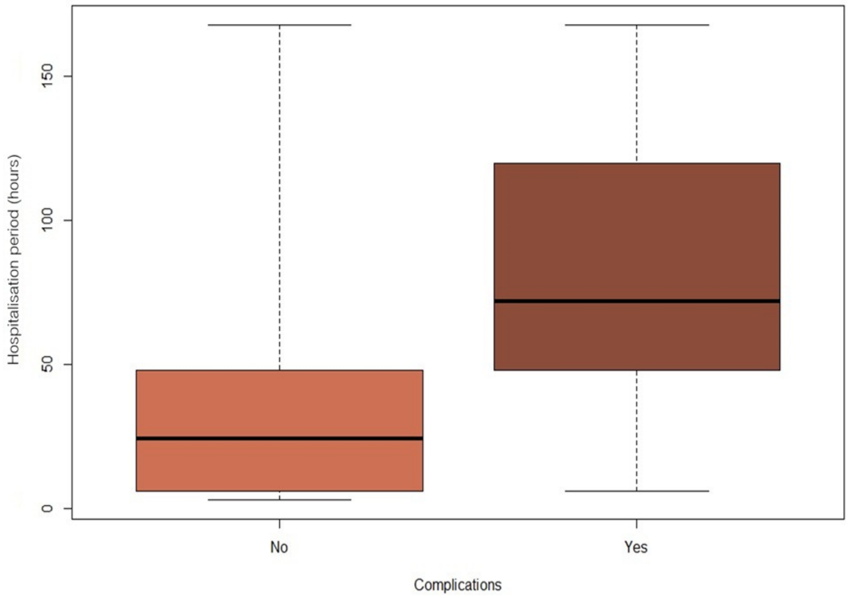
Graphic 10. Box-and-whiskers plots of the hospitalisation period between endoscopy, surgery, and both procedures



Cases in which surgery was performed, multiple, as opposed to single surgical techniques, were not found to be significantly associated with an increased hospitalisation period ($p = 0.29$), with a median of 48 hours in both groups.

The occurrence of complications significantly increased the hospitalisation period to a median of 72 hours, compared to the median hospitalisation period of 24 hours for patients that recovered without any complications whatsoever ($p < 0.001$) (graphic 10).

Graphic 11. Box-and-whiskers plots of the hospitalisation period between the occurrence and absence of complications



All patients included in this study survived following the removal of the FB, except for one (n = 1) patient that was euthanised at the owners' request subsequent to the development of an oesophageal stricture. Therefore, the survival rate for this study sample was 98.6% (n = 72).

VI. DISCUSSION

1. STUDY SAMPLE

This study sample included both dogs and cats, and similarly to the studies by Binvel et al. (2017) and Hayes (2009), the proportion of dogs was substantially superior to the proportion of cats. When considering which animals were entire or neutered, there was a higher proportion of both neutered males and females in this study compared to other studies (Gianella et al. 2009, Binvel et al. 2017).

The study sample consisted of dogs from 22 different breeds and 12 cross breed dogs. In line with other studies, the frequency of cross breed dogs was higher than pure breed ones; moreover, Labrador Retriever and Yorkshire Terrier were amongst the most common breeds (Gianella et al. 2009, Brisson et al. 2018). Even though West Highland White Terriers were not represented in this study sample; along with Yorkshire Terriers, these were breeds shown to be overrepresented, compared to the hospital sample, in both the aforementioned studies with regards to oesophageal and gastric FBs.

Patients included in this study had a median age of approximately 3 years (3.1 years for dogs; and 2.9 years for cats), which is similar to the median age of 4 years reported for dogs in previous studies (Gianella et al. 2009, Hobday 2014, Brisson et al. 2018), although, higher than the mean age of 1.8 years reported for cats by another author (Hayes 2009).

Median bodyweight for dogs (11.2 kg) was similar to the mean bodyweight of 13.8 kg reported by Hayes (2009), although inferior to the median bodyweight of 18.9 kg reported by Gianella et al. (2009). With regards to cats, the median bodyweight in this study (5 kg) was substantially higher than the mean bodyweight of 2.8 kg in the study by Hayes (2009).

2. CLINICAL PRESENTATION

The patient history obtained included the presence and duration of clinical signs, if present, or time since ingestion; and whether owners had witnessed or were aware of FB ingestion.

Clinical signs are often reported by the owners following FB ingestion, although in some cases, the animal may not display any clinical signs whatsoever (Gianella et al. 2009). Similarly to the results obtained in previous studies, some of the most commonly reported clinical signs in this study included vomiting, anorexia, nausea, and diarrhoea (Gianella et al. 2009, Hayes 2009, Hobday et al. 2014, Brisson et al. 2018).

The majority of the patients (72.6%) included in this study had clinical signs as a result of FB ingestion, and only a smaller number (27.4%) was asymptomatic. In the study by Gianella et al. (2009), the proportion of patients that had no clinical signs was not only inferior to the one seen in this study, but also for all of those cases; ingestion had been witnessed by the owner. The same is not valid for the patients included in this study since in 56.7% of the cases, despite ingestion having been witnessed, clinical signs were still reported by the owner upon presentation. The reason for this may be related to owners opting to wait for the animal to pass the FB on its own, and for the resolution of clinical signs, rather than seeking prompt medical care.

Nevertheless, in this study, patients in which ingestion of the FB was not witnessed by the owner were more likely to have clinical signs when compared to those in which the owner was aware of FB ingestion ($p < 0.001$).

The proportion of cases in which the owner did not witness FB ingestion was extremely high in this study (51.6%) compared to the 5.8% reported by Brisson et al. (2018). In contrast, in 48.4% of the cases in this study, the owner did witness ingestion, whereas in the study by Hayes (2009) in only 26% of the cases the owner was aware of FB ingestion.

In addition to the presence or absence of clinical signs, the duration of clinical signs or time since ingestion was also taken into consideration. Generally, patients were presented for treatment less than 1 day after having clinical signs, or having ingested the object; similarly to the results reported in the study by Gianella et al. (2009). Prompt presentation to the hospital was more common when owners had witnessed ingestion when compared to owners that were unaware of FB ingestion, in which cases, patients had a longer duration of clinical signs before diagnosis and treatment. Furthermore, the results of this study showed a significant association between witnessed ingestion and a shorter duration of clinical signs, or time since ingestion ($p < 0.001$). Owners aware of FB ingestion presenting animals for treatment significantly earlier has been previously reported in one study (Hayes 2009).

Witnessing the ingestion of a FB may encourage the owner to seek veterinary care before clinical signs develop, which may play an important role in the outcome of the patient. This finding is supported by other studies, which results found that a longer duration of clinical signs was significantly associated with a higher risk of complications (Rousseau et al. 2007, Gianella et al. 2009), and with the success rate of removal techniques (Hayes 2009). Additionally, witnessing the ingestion of the FB may provide valuable information regarding the type of object and, potentially contribute to better assess and recommend therapeutic options.

The presence of other clinical signs was significantly associated with both the mentation of the patient at presentation ($p < 0.001$), and the presence of pain on abdominal palpation ($p < 0.01$). Patients with no clinical signs were all bright at presentation, and most of them showed no evidence of pain on abdominal palpation, despite having a FB. Contrarily, as expected, patients with reported clinical signs such as vomiting, anorexia, and nausea were more commonly lethargic or prostrated and had painful abdominal palpation, possibly as a result of such clinical signs (graphics 2 and 3).

Interestingly, cats had a longer median duration of clinical signs, or time since ingestion when compared to dogs, 2 days and 1 day, respectively. Hayes (2009) also reported a longer duration of clinical signs for cats compared to dogs with GI FBs, although higher than seen in this study for both species, 6.2 and 4.8 days, respectively.

Even though witnessed ingestion by the owner was not significantly associated with the species, owners reported having witnessed the ingestion of the FB in 52.2% of dogs and in 37.5% of cats, which might explain the delayed presentation associated with cats, despite the presence of clinical signs.

Median rectal temperature (38.6°C for dogs and 38.5°C for cats) was similar to the median rectal temperature of 38.7°C reported for dogs in one study (Brisson et al. 2018).

3. LOCATION AND TYPE OF FOREIGN BODY

A wide variety of objects were recovered from the patients included in this study (table 3). The most common objects ingested by dogs were plastic and wooden skewers or fragments, followed by linear objects, fishhooks, toys and textile material. On the other hand, cats mostly ingested string or other linear material, followed by plastic, needle and thread, and organic material.

Plastic was a very common FB recovered from the GI tract of both dogs and cats in this study, specifically the most common in dogs; and the second most common in cats following linear FBs. Plastic material has been reported as one of the most common FBs ingested by dogs and cats in previous studies (Gianella et al. 2009, Hayes 2009).

However, as in this study, Hayes (2009) reported that linear FBs such as string, rope, and fishing line, were the most common among cats. Interestingly, Dollo et al. (2019) reported that the most common FBs retrieved from the oesophagus and stomach of cats were trichobezoars, which were not reported in any of the cats included in this study.

Bone FBs were recovered from only 3 dogs in this study, and only in 1 patient was located in the oesophagus. Several authors have reported bone to be the most common oesophageal FB in dogs (Rousseau et al. 2007, Thompson et al. 2012, Deroy et al. 2015, Brisson et al. 2018, Bongard et al. 2019).

However, Gianella et al. (2009) reported a lower incidence of this type of FB compared to other authors, yet quite common and mainly located in the oesophagus. This may be explained by a greater variety of objects encountered nowadays or a growing awareness of the owners regarding the dangers inherent to these FBs (Gianella et al. 2009).

Nevertheless, compared to the aforementioned studies, the substantially lower proportion of bone FBs observed in the present study may only reflect the lower number of oesophageal FBs included. Regarding the type of FB, as in linear or non-linear, linear FBs such as string, ribbon, and rope, and in two cases, a plastic bag and a blanket, represented 20.5% of the FBs included in this study.

Gastrointestinal FBs have been previously reported to be linear in 33% to 50% of feline patients; and in 16% to 33% of canine patients (Bebchuk 2002, Boag et al. 2005, Hayes 2009). In the present study, the proportion of LFBs found in cats was 56.2%, whereas, for dogs, the proportion of LFBs was 10%. Even though these results are in line with previous studies, the difference seen in these proportions may reflect differences in samples regarding first-opinion or referral veterinary hospitals included in these studies or the categorisation of the object as a linear FB (Hayes 2009).

Nevertheless, results showed a statistically significant association between species and the type of FB, with cats being significantly more likely to have an LFB when compared to dogs ($p < 0.001$). The higher proportion of LFBs in cats, compared to dogs, has consistently been reported in the literature (Root and Lord 1971, Felts et al. 1984, Bebchuk 2002, Hayes 2009).

Clinical signs were reported in 93.3% of patients with LFBs, and in 67.2% of patients with NLFBs; however, the type of FB was not significantly associated with the presence or absence of clinical signs.

Except for one case, all patients with LFBs had reported clinical signs, with the most common being vomiting, diarrhoea and anorexia. Previous reports suggested that LFBs cause a partial obstruction; hence clinical signs may not be as severe as with NLFBs (Aronson et al. 2000). Contrarily, Hobday et al. (2014) reported that, compared to NLFBs, dogs with LFBs had more frequent reports of anorexia, vomiting, lethargy and pain on abdominal palpation. The same pattern was observed in this study sample, with vomiting and anorexia reported in 73.3% and 40% of patients with LFBs, *versus* 53.4% and 27.6% of patients in the NLFB group, respectively. Despite the observed difference in proportions, there was no statistically significant association.

On the other hand, the type of FB was significantly associated with the mentation ($p < 0.01$) and the presence of pain on abdominal palpation ($p < 0.05$). Patients that were bright upon presentation were significantly more likely to have an NLFB ($p < 0.01$), whereas patients with LFBs were more frequently reported as lethargic or prostrated, with painful abdominal palpation.

Furthermore, a statistically significant trend in proportions was observed in this study, suggesting that, according to the presence and increased degree of pain on abdominal palpation, higher the probability of a FB of a linear nature ($p < 0.05$).

Both these findings regarding the patient's mentation and abdominal palpation are comparable to other studies whose results showed that patients with LFBs had more frequent reports of lethargy and pain on abdominal palpation, than those with NLFBs (Basher and

Fowler 1987, Hobday et al. 2014). The increased proportion of patients with LFBs considered lethargic or prostrated, and with evidence of pain on abdominal palpation may reflect the discomfort and possible subsequent pain associated with vomiting, anorexia or diarrhoea, as well as with major complications observed in some of these cases, including intestinal intussusception, perforation or necrosis; and laceration of the mesenteric border, often associated to this type of FBs (Hobday et al. 2014).

The location of the FB was categorised as single or multiple, according to the extent to which one or more than one anatomical sections were involved, respectively. Even though 84.9% of the patients in this study had a FB present in a single location, compared to the 15.1% in which multiple locations were affected; when considering the type of FB in question, the involvement of multiple locations was more frequently observed with LFBs (60%), rather than with NLFBs (3.4%) ($p < 0.001$). Linear FBs typically have an anchorage point, from which they extend into the GI tract; therefore, linear material can often be found throughout more than one anatomical sections.

Linear FBs are typically anchored at the pylorus or around the base of the tongue (Aronson et al. 2000, Bebchuk 2002). In the study by Hayes (2009), 67% of the LFBs in dogs were anchored at the pylorus, whereas 63% of the LFBs in cats were anchored at the base of the tongue. Similarly, both Boag et al. (2005) and Hobday et al. (2014) also reported a higher proportion of LFBs in dogs anchored at the pylorus compared to other anchorage points such as the oral cavity, the duodenum or the jejunum.

In the present study, the most common anchorage point for LFBs in dogs was the pylorus, and interestingly, unlike previous studies, in none of the dogs with LFBs included the foreign material was anchored in the oral cavity (Hobday et al. 2014). In cats, LFBs were more commonly anchored at the duodenum, followed by the pylorus and the base of the tongue (figures 5 and 6). In contrast to another study (Hayes 2009), the base of the tongue was not the most common anchorage point for LFBs in cats represented in the current study.

Physical examination should include thorough oral inspection, as in some situations, foreign material anchored around the base of the tongue may be missed on initial evaluation (Basher and Fowler 1987, Brown 2012). One study reported that, in 3% of dogs and 25% of cats, an LFB was evident under the tongue or protruding from the anus during clinical examination (Hayes 2009). Even though there were only two cases (2 cats) in this study in which the LFB was anchored around the base of the tongue, in both patients, oral inspection was carried out during physical examination, and a string was visible under the tongue. Yet again, this emphasises the importance of oral inspection, especially in cats, to ensure no linear material is anchored around the base of the tongue and missed on clinical presentation.

Furthermore, in the study aforementioned, a foreign object or an intestinal abnormality was evident during abdominal palpation, in the conscious or the anaesthetised patient, in 76%

of dogs and 58% of cats with gastrointestinal FBs; however, the same findings were only reported in three cases (4%) of the present study, and all of those were non-linear FBs.

Non-linear FBs were most commonly located in the stomach, in both dogs and cats. Even though oesophageal FBs were uncommon in this study, they were only found in dogs (5/51; 9.8%), which is in line with the previously reported higher incidence of oesophageal FB entrapment in dogs compared to cats (Brisson et al. 2018).

Regarding the specific portion of the oesophagus, in 2/5 cases the objects were located in the cervical oesophagus; 2/5 in the thoracic oesophagus (1 at the thoracic inlet, 1 at the heart base); and 1/5 in the distal oesophagus. The distal oesophageal region, caudal to the heart base, was the least common location for oesophageal FBs in the present study, despite being the most commonly reported location in the literature regarding impacted oesophageal FBs in dogs (Gianella et al. 2009, Juvet et al. 2010, Deroy et al. 2015, Brisson et al. 2018). Moreover, in the studies mentioned above, the FBs recovered were mainly bone, contrary to what was observed in this study where this type of FB was uncommon, and the one case in which it was located in the oesophagus (1/5) it was lodged in the cervical oesophageal region.

On the other hand, fish hooks accounted for 3/5 of the oesophageal FBs in this study, each lodged in different portions of the oesophagus (1 in the cervical oesophagus, 1 at the heart base, and 1 in the distal oesophagus). In contrast to other types of FBs, fish hooks are often found to become lodged in the cervical rather than in the distal oesophagus, possibly due to their configuration considering that as sharp objects, they can be rapidly embedded and retained in the proximal oesophageal region after swallowing (Michels et al. 1995, Binvel et al. 2017, Brisson et al. 2018). Nevertheless, the observed difference in proportions regarding the location of oesophageal FBs, compared to what has been reported previously, might result from the fewer cases of oesophageal FBs included in the present study.

4. REMOVAL TECHNIQUES AND SURGICAL FINDINGS

For every patient included in this study, a removal technique such as endoscopy, surgery, or both, was carried out to remove the FB. In 47/73 patients, surgery was chosen as the therapeutic approach for removal, whereas endoscopy was attempted as a less invasive technique in 26/73 cases. Compared to other studies, endoscopy was attempted in a lower proportion of cases, and such may be related to both the clinical decision and the experience of the attending veterinarian with endoscopic techniques.

The overall success rate of endoscopic removal of FBs in this study was 76,9%.

Regarding oesophageal FBs specifically, endoscopy was first attempted in 80% of the patients, allowing for successful removal in 75% of those (3/4).

The success rate of endoscopic removal for oesophageal FBs in this study is comparable to the studies by Juvet et al. (2010) and Deroy et al. (2015), which described a successful endoscopic removal of oesophageal FBs in dogs in 68% and 77% of cases, respectively. However, this success rate is lower than the reported for oesophageal FBs by other authors (Rousseau et al. 2007, Gianella et al. 2009, Brisson et al. 2018). Nevertheless, the substantially lower number of oesophageal FBs included in this study precludes an accurate comparison of endoscopic removal success rates between studies.

Differences observed between authors regarding the success rate of endoscopic removal may be explained by the diversity of objects found between study samples, as well as the degree to which they may be embedded in the oesophageal wall. Other potential explanations could be the location of the object itself within the oesophagus; or a faster decision to convert to a surgical technique, after struggle in removing the FB endoscopically (Deroy et al. 2015).

Brisson et al. (2018) found that large breed dogs, patients with a higher rectal temperature, and those with bone FBs, were significantly more likely to require surgery to remove oesophageal FBs. These findings are not comparable to the results observed in this study, in which age, bodyweight and rectal temperature were not significantly associated with the success of endoscopic removal or the need for surgery to retrieve oesophageal or upper GI FBs ($p > 0.05$).

Oesophageal FBs can be removed either endoscopically by drawing them through the oral cavity; or by dislodgement pushing them into the stomach for dissolution (bones or organic material) or posteriorly removed through gastrotomy (Gianella et al. 2009, Deroy et al. 2015). In the studies by Gianella et al. (2009) and Brisson et al. (2018), the great majority of FBs were endoscopically removed through the oral cavity. In contrast, Leib and Sartor (2008) reported a low oral retrieval rate for oesophageal FB chew treats, with most of those having to be pushed into the stomach, which the authors speculated to be likely attributable to the smooth surfaces of the chew treats, not allowing a firm grasp by the flexible forceps. In the present study, however, oral retrieval of the FB was the chosen approach whenever endoscopy was performed.

Fish hooks accounted for 5/73 FBs encountered in the present study, of which 3 were located in the oesophagus, and 2 were located in the stomach, promptly removed through gastrotomy. Endoscopic removal was successful in 67% of the oesophageal fish hooks, which is comparable to the endoscopic retrieval success rate of 66% to 82% reported for oesophageal and gastric fish hooks (Michels et al. 1995, Binvel et al. 2017).

Both these studies reported a significantly higher failure rate of endoscopic removal associated with treble-barb hooks, compared to single-barb. Furthermore, when dealing with fish hooks firmly embedded in the oesophageal or gastric wall, surgical removal is recommended to avoid causing potential damage by endoscopic removal (Michels et al. 1995, Binvel et al. 2017). Although endoscopic retrieval of penetrating oesophageal FBs located at the base of the heart carries a great risk of laceration of major vessels, and in such cases, surgical retrieval is recommended; in the present study, a penetrating oesophageal fish hook at the heart base was successfully removed through endoscopy without any complications (Michels et al. 1995).

Furthermore, 1 patient in this study had a fish hook located in the distal oesophagus near the oesophageal hiatus, and following unsuccessful endoscopy, a gastrotomy performed through a coeliotomy allowed the successful removal of the FB. This is considered a valuable technique, and compared to a thoracotomy, it is a less complex procedure with reported good outcomes (Aertsens et al. 2016).

Even though Michels et al. (1995) did not found the location of the oesophageal fish hook to be associated with successful endoscopic removal; Brisson et al. (2018) found that oesophageal FBs located in the cervical oesophagus were significantly more likely to be removed through endoscopy, compared with those located in the distal oesophagus.

This may be explained by the fact that the study by Michels et al. (1995) included only fish hook FBs, and a higher proportion of those was located in the cervical oesophagus. However, Brisson et al. (2018) reported a wider range of objects, mainly bone FBs, with the distal oesophageal region being the most common location. Furthermore, 52% of the FBs located in the cervical oesophagus were fish hooks, which may have contributed to an easier endoscopic removal, and infrequent need for surgery in those patients (Brisson et al. 2018). Indeed, in this study, the one case in which endoscopy was unsuccessful at removing an oesophageal FB was a fish hook located in the distal oesophagus.

Additionally, a combined approach of surgical exposure of the oesophagus to cut the barbs from the hook, followed by endoscopy to remove the shank of the hook, was suggested in one study to eliminate the need for an oesophagotomy (Michels et al. 1995). However, the mean time for combined endoscopic and surgical removal was significantly longer compared to the mean time for endoscopic and surgical removal alone (Michels et al. 1995).

Considering all the cases included in the present study, factors that were regarded to potentially affect the success of endoscopic removal, when attempted, included the type of FB (linear or non-linear); the duration of clinical signs or time since ingestion; the single or multiple locations of the FB; and whether patients were initially discharged home upon the first presentation.

Regarding the type of FB (linear or non-linear), endoscopy was attempted in 26.7% of the patients with LFBs, and 37.9% of the patients with NLFBs. The success rate of endoscopic removal was very similar between groups, 75% and 77.3%, in the LFBs and the NLFBs groups, respectively. In contrast, Hobday et al. (2014) reported lower success rates of endoscopic removal and a greater difference between groups.

In the present study, there was no statistically significant difference between groups; hence the type of FB was not considered to affect the success of endoscopic removal or the need for surgery. Nevertheless, the 3 patients with LFBs that were successfully removed through endoscopy had the linear material anchored at the duodenum; whereas, likely, linear material anchored further along the GI tract may not allow for successful endoscopic removal (Hobday et al. 2014).

A longer duration of clinical signs or time since ingestion was not significantly associated with unsuccessful endoscopic removal, or the need for surgery. Nevertheless, the success rate of endoscopic removal for patients with a duration of clinical signs or time since ingestion of both 1 to 3 days; and more than 3 days (50% in both groups), was substantially inferior to the one observed for patients with a duration of clinical signs or time since ingestion of less than 1 day (90.9%). The success rate of FB removal was reported to decline with the increasing duration of clinical signs in one study (Hayes 2009).

When taking into consideration patients that were discharged home upon the first presentation, and those that were initially admitted for treatment, the success rate of endoscopic removal was 50% in the discharged home group; and 79.2% in the initially treated group; however, this difference was not statistically significant. Although patients that were discharged following their first presentation did not appear to more likely require surgery after returning to seek treatment, the observed difference in the success rate of endoscopic removal may only reflect surgeon availability and preference; availability of advanced surgical techniques; and case management variations (Maxwell et al. 2020).

Amongst the aforementioned variables, the location of the FB (single or multiple) was the only factor associated with the success of endoscopic removal, or the need for surgery ($p < 0.05$).

Endoscopic removal was unsuccessful in all the cases of FBs present in multiple locations in which it was attempted. Of those, 2/11 were NLFBs located in the stomach and duodenum, possibly deemed to be causing obstruction, which might have motivated the decision to convert to surgery. Another possible explanation is that even if obstruction was considered, an attempt was still made to remove it endoscopically; however, unsuccessful. The remaining 9/11 were LFBs; however, this type of FB was not significantly associated with unsuccessful endoscopy; moreover, some cases of LFBs were successfully removed through endoscopy. Therefore, failure to retrieve LFBs endoscopically in these cases might have been related to a further extension of the linear material beyond the duodenum into the small intestines, making endoscopic access difficult.

Surgery was performed in 64.4% of the patients as a first attempt to remove the FB. Additionally, 23.1% of patients underwent surgery following unsuccessful endoscopic removal, of which 1 was a fish hook deeply embedded in the oesophagus; 1 was a linear FB; and the remaning 4 were gastric FBs that were deemed too large to pass through the cardiac sphincter. Therefore, surgery was ultimately performed in 72.6% of the patients (53/73) included in this study.

Gastrotomy alone was the most commonly performed surgical technique, regardless of species and type of FB (figure 7). A high frequency of this surgical technique is expected considering not only the higher prevalence in this study of NLFBs located in the stomach but also the high frequency of LFBs anchored at the pylorus (figures 5 and 6).

Oesophagotomy was promptly performed in one patient (n = 1) to remove a ball located in the thoracic portion of the oesophagus. A non-surgical method such as endoscopic removal prior to surgical intervention is the recommended treatment, whereas oesophagotomy is advised if endoscopic retrieval is unsuccessful or an oesophageal perforation is evident (Michels et al. 1995, Sale and Williams 2006, Deroy et al. 2015). For this specific patient, however, surgery was required since the object was too adherent to the oesophageal wall for endoscopic dislodgement, in which case, surgical removal should be considered to avoid causing potentially deleterious damage by endoscopic removal (Deroy et al. 2015). Moreover, oesophagotomy is considered an effective and valuable surgical technique that can be performed with good outcomes (Sale and Williams 2006, Deroy et al. 2015).

Patients that underwent surgery were categorised as having single or multiple surgical techniques, according to whether one or more than one surgical technique was required to remove the foreign object, respectively. For the great majority of the patients, a single surgical technique was sufficient, whereas multiple surgical techniques were uncommonly required (figure 7).

When considering the type of FB (linear or non-linear), in the cases that had surgery, patients with an LFB had an increased risk of requiring multiple surgical incisions compared to those with NLFBs ($p < 0.001$).

Similar results have been described in previous studies where dogs with LFBs required significantly more gastrotomies, enterotomies, and intestinal resection and anastomosis, compared with dogs with NLFBs; which is consistent with the linear nature of the FB and, therefore, a single gastrointestinal incision may not allow its removal (Hayes 2009, Hobday et al. 2014).

To remove linear FBs extending into the small intestines, multiple enterotomies may be required, which ultimately allows for segmental removal of the FB, therefore minimising the risk of iatrogenic perforation (MacPhail 2002). However, an increased number of GI surgical incisions increases surgical time and risk of contamination; hence it is intuitive to minimise the number of GI incisions; which was the case in all except one patient in the present study, in which multiple enterotomies were required to remove an LFB (Hayes 2009).

5. COMPLICATIONS

Postoperative complications, or those resulting from FB impaction, were observed in 21/73 patients included in this study, resulting in a complication rate of 28.8%.

Minor complications were observed in 13/21 patients and included, among others, wound oedema and seroma, oesophageal mucosal abrasions, and dysphagia. On the other hand, major complications were observed in 8/21 patients and included intestinal necrosis, intestinal intussusception, intestinal perforation, and laceration of the mesenteric border. In the present study, of the 21 patients in which complications occurred, 3 were oesophageal FBs, 6 were LFBs, and the remaining 12 were NLFBs located in the stomach and duodenum (appendix 2).

In the studies by Gianella et al. (2009) and Dollo et al. (2019) regarding endoscopic removal of oesophageal and gastric FBs, the reported complication rates were 12.7% and 15.4%, respectively. Additionally, both studies reported that complications were more commonly observed in cases of oesophageal FBs compared to gastric FBs, attributable to the likelihood of more detrimental consequences resulting from persistent FBs located in the oesophagus rather than in the stomach (Dollo et al. 2019).

Differences observed between reported complication rates in these studies and the one reported here may be explained by the smaller sample size with fewer cases of oesophageal FBs; as well as the inclusion of LFBs and associated major complications in this study, unlike the aforementioned studies. Additionally, with regards to the present study, the complication rate reflects the overall observed complications, whereas a lower complication rate would be expected if only major complications were considered.

The presence of oesophageal FBs may result in complications including oesophagitis, aspiration pneumonia, oesophageal perforation, and oesophageal stricture formation. Less commonly reported and more severe complications include pneumothorax, pneumomediastinum, bronchoesophageal fistula, aortoesophageal fistula, cardiopulmonary arrest, and death (Thompson et al. 2012, Deroy et al. 2015, Bongard et al. 2019, Dollo et al. 2019). On the other hand, gastric perforation and secondary peritonitis are potential complications associated with gastric FBs (Gianella et al. 2009, Cornell 2012). Regarding oesophageal FBs specifically, complication rates vary between authors and removal methods, ranging from 8% to 38% (Sale and Williams 2006, Rousseau et al. 2007, Leib and Sartor 2008, Gianella et al. 2009, Brisson et al. 2018).

Even though complications were observed in 60% of the patients with oesophageal FBs, reported complications included oesophageal mucosal abrasions and postoperative dysphagia, which were not considered major complications and resolved without further intervention (appendix 2). Consequently, the small number of oesophageal FBs included in the present study and the type of complications reported precluded further assumptions to be made regarding the rate of complications associated with oesophageal FBs.

Oesophageal stricture formation is the most common long-term complication associated with oesophageal FBs (Rousseau et al. 2007, Leib and Sartor 2008, Brisson et al. 2018, Wyatt and Barron 2019). Oesophageal strictures in dogs and cats are complications of severe oesophagitis, usually associated with gastric reflux during anaesthesia; severe and chronic vomiting of gastric content; and as a result of FB trauma either through mechanical injury, or chemical injury due to putrefaction of food lodged in the oesophagus proximal to the FB (Harai et al. 1995, Melendez et al. 1998). Reported rates for oesophageal stricture formation following oesophageal FB removal range from 8% to 15% (Rousseau et al. 2007, Deroy et al. 2015, Brisson et al. 2018).

In one study, higher rates of oesophageal stricture formation (19.4%) were attributable to the severe oesophageal damage in one study, which the authors speculated to be a result of the unique characteristics of a dental chew treat impaction (Leib and Sartor 2008). Conversely, other authors reported lower rates of oesophageal stricture formation ranging from 2.1% to 2.6% (Burton et al. 2017, Wyatt and Barron 2019).

Improved endoscopic retrieval techniques, more standardised feeding protocols, and the use of gastroprotectants postoperatively, or the shorter duration of FB impaction prior to intervention, were suggested to contribute to a lower stricture formation rate observed in a recent study (Brisson et al. 2018). On the other hand, the observed difference between studies may be explained by variations in the sample size and, therefore, complications uncommonly observed, such as oesophageal stricture, may be subject to sampling bias (Wyatt and Barron 2019).

Interestingly, only 1 dog in the present study was postoperatively diagnosed with an oesophageal stricture, following the removal of a FB located in the stomach, rather than in the oesophagus. The medical records showed that this particular patient had the FB removed without any complications; however, developed regurgitation 13 days postoperatively. Oesophagoscopy was performed, and moderate to severe oesophagitis was subjectively assessed, as well as narrowing of the oesophageal sphincter surrounded by a fibrotic ring, at which point an oesophageal stricture was diagnosed. Considering that the foreign material was located in the stomach and removed through gastrotomy, the occurrence of oesophageal stricture in this patient may be explained by the passage or permanence of the FB in the oesophagus prior to diagnosis, possibly leading to oesophageal damage. Another explanation is that the oesophageal stricture was secondary to oesophagitis caused by gastric reflux during anaesthesia, which is the most commonly reported cause of oesophagitis in dogs and cats (Galatos et al. 1994, Leib et al. 2001, Sellon and Willard 2003).

Regarding the sample of this study, several factors were considered to potentially be associated with the occurrence of complications, including the type of FB; the presence of clinical signs; the duration of clinical signs or time since ingestion; the mentation, and the presence and degree of pain on abdominal palpation at presentation; whether patients were initially discharged home upon the first presentation; the surgical procedure performed.

Previous studies suggest that patients with LFBs have a higher frequency of postoperative complications and a worse outcome compared to those with NLFBs (Evans et al. 1994, Boag et al. 2005, Hayes 2009). In the present study, complications were reported in 40% of the patients with LFBs, and in 26% of the patients with NLFBs. Reported complications of patients with LFBs included intestinal necrosis and perforation, intestinal intussusception, and laceration of the mesenteric border, which are frequently reported complications associated with this type of FB (Basher and Fowler 1987, Evans et al. 1994, Hobday et al. 2014, Maxwell et al. 2020).

Despite the difference in frequency observed between groups and the fact that major complications were mostly reported in patients with LFBs, there was no statistically significant association between the type of FB and the occurrence of complications. This finding is comparable to another study in which, despite the higher frequency of intestinal necrosis, intestinal perforation, and peritonitis in dogs with LFBs, compared to those with NLFBs, there was no difference in outcome between the two groups (Hobday et al. 2014).

Additionally, in contrast to the reported significantly higher mortality rates in patients presenting with LFBs in the study by Hayes (2009), all of the patients with LFBs in this study made a full recovery, regardless of the occurrence of major postoperative complications.

Patients with clinical signs reported by the owner were not more likely to have complications following FB removal, compared to those that were asymptomatic. However, results showed that an abnormal mentation and the presence of pain on abdominal palpation were generally associated with a higher frequency of complications ($p < 0.05$).

Amongst the patients in which complications were reported, 18/21 had an abnormal mentation categorised either as lethargic, prostrated, or semi-comatose; and 10/21 had a painful or very painful abdominal palpation. Therefore, this difference may be attributable to the discomfort and possible pain induced by major complications that occurred in these cases caused by the FB, including intestinal necrosis and perforation, intestinal intussusception, and laceration of the mesenteric border (Hobday et al. 2014). Patients that were discharged home following the first presentation and were only addmited for treatment later on upon a second presentation, were not more likely to develop postoperative complications, or any complications caused directly by the FB impaction, compared to those that were promptly admitted for treatment.

In a recent study regarding gastrointestinal FBs (Maxwell et al. 2020), the authors hypothesised that dogs with a delayed intervention (> 6 hours after presentation) would have an improved postoperative outcome as a result of a prolonged resuscitation period, allowing an improvement in intestinal reperfusion; as opposed to those with immediate surgical intervention (< 6 hours after presentation). However, results showed that the timing of surgical treatment for GI obstruction was not associated with the outcome of patients, including the incidence of postoperative complications and survival to discharge (Maxwell et al. 2020). Nevertheless, not only the timing of surgical intervention for those discharged initially was longer in the present study, ranging from 24 hours to 7 days; but also in the study by Maxwell et al. (2020), those with a delayed intervention were still admitted and provided medical treatment, whereas, in the current study, delayed intervention meant that patients were discharged home on a first instance.

With regards to the procedure performed to remove the FB, complications were reported in 15% of the patients in which endoscopic removal was successful; in 38% of the patients in which surgery was the first approach; and, interestingly, all the 6 patients that underwent both procedures had a successful recovery without any complications (graphic 8). However, the observed difference was not statistically significant.

Even though Deroy et al. (2015) reported a low overall complication rate, similar between the two methods, following the removal of oesophageal FBs in dogs; Burton et al. (2017) reported an increased risk of death in dogs with oesophageal FBs that underwent surgery after unsuccessful endoscopic removal, as well as in those in which endoscopy was repeated after surgery was recommended yet declined by the owners.

Differences in the incidence of postoperative complications and the subsequent outcome may be explained by study sample variations, practitioners of varying experience and, consequently, variations in surgical technique and postoperative care (Hobday et al. 2014). Nevertheless, results of this study suggest that undergoing surgery, even though it is a more invasive procedure with inherent risks, did not appear to increase the likelihood of postoperative complications or the outcome of affected patients.

Numerous studies have reported that a longer duration of clinical signs or duration of FB entrapment is significantly associated with the occurrence of complications and a poorer outcome (Rousseau et al. 2007, Gianella et al. 2009, Hayes 2009, Thompson et al. 2012, Brisson et al. 2018, Sterman et al. 2018, Bongard et al. 2019). Brisson et al. (2018) found old age to be associated with a poorer prognosis on dogs with oesophageal FBs; whereas Hayes (2009) did not find age to be significantly associated with the outcome of dogs and cats with GI FBs. Gianella et al. (2009) reported that bone FBs and bodyweight of less than 10 kg were risk factors for postoperative complications, specifically oesophageal and gastric perforation. Contrarily, other studies reported no significant association between bodyweight or type of FB, and the occurrence of postoperative complications or outcome of affected patients (Hayes 2009, Burton et al. 2017, Sterman et al. 2018, Bongard et al. 2019).

The results of the current study showed no statistically significant association between age, bodyweight, and duration of clinical signs or time since ingestion; and the occurrence of complications or a poorer outcome.

6. HOSPITALISATION PERIOD AND OUTCOME

The median hospitalisation period for this study sample was 2 days, which is comparable to the median hospitalisation period of 2.8 days for dogs, and 2.2 days for cats reported in one study (Hayes 2009).

The hospitalisation period postoperatively was considered to potentially be affected by the presence of clinical signs; the type of FB; the location of the FB (single or multiple); the surgical procedure; the surgical techniques (single or multiple); and the occurrence of complications. Patients with reported clinical signs such as vomiting, nausea or anorexia had a significantly longer hospitalisation period, compared to those that were asymptomatic ($p < 0.05$).

Hobday et al. (2014) reported that dogs with LFBs had a significantly longer hospitalisation period compared to those with NLFBs; however, this is not comparable to the findings of the present study, in which the type of FB was not significantly associated with the hospitalisation period, with a median duration of 48 hours for both groups. Nevertheless, Hobday et al. (2014) did not find a significant difference regarding the outcome between the two groups.

Patients with a FB impacted in multiple anatomical locations had a significantly longer hospitalisation period, compared with those with the FB located in a single location ($p < 0.05$). However, surgery was ultimately performed to remove all FBs impacted in multiple locations, either as a first approach or following unsuccessful endoscopic removal; therefore, this difference may only reflect a longer hospitalisation period for patients in which surgery was performed, compared to those in which endoscopy was carried out.

Furthermore, results showed a significant association between the removal procedure performed and the subsequent hospitalisation period until discharge. Patients that had both procedures performed had the longest hospitalisation period, followed by those in which surgery alone was performed, and those in which endoscopy alone was performed had the shortest hospitalisation period. Additionally, the observed difference between groups concerning the hospitalisation period was found to be associated with undergoing surgery, regardless of performed as a first approach or after unsuccessful endoscopy. For this reason, undergoing surgery, a more invasive procedure compared to endoscopy, appears to increase the duration of hospitalisation up to discharge, which was also reported by Brisson et al.

(2018). On the other hand, for patients that underwent surgery, cases in which multiple surgical techniques were required, as opposed to a single surgical technique, did not seem to increase the hospitalisation period.

The occurrence of complications significantly increased the hospitalisation period to a median of 72 hours, compared to the median hospitalisation period of 24 hours for those that made a full recovery without any complications whatsoever ($p < 0.001$). This finding is supported by another study in which patients with major complications had a prolonged hospitalisation period (Dollo et al. 2019). Reported survival rates for dogs and cats following the removal of gastrointestinal FBs range from 88% to 99% (Boag et al. 2005, Gianella et al. 2009, Hayes 2009, Hobday et al. 2014, Brisson et al. 2018). In accordance with these studies, the survival rate observed in the current study was 98.6%.

Furthermore, Hobday et al. (2014) reported the same survival rate of 96% for both the groups of linear and non-linear FBs, which is comparable to the findings reported here considering there was no difference between LFBs and NLFBs with regards to complications, hospitalisation period, and overall outcome of the patients.

It should be noted that the one patient that did not have an excellent outcome did not have complications intra or postoperatively resulting in death, but was rather euthanised at the owners' request following the development of a complication. An oesophageal stricture was diagnosed in this dog and a balloon dilation was performed; however, following the recurrence of regurgitation episodes, euthanasia was suggested and agreed by the owners.

Oesophageal stricture formation increases morbidity and mortality rates of patients following FB removal (Leib and Sartor 2008). Management of oesophageal strictures may include feeding protocols, gastrotomy feeding tubes, corticosteroids and balloon dilations (Rousseau et al. 2007, Gianella et al. 2009, Thompson et al. 2012, Deroy et al. 2015, Burton et al. 2017). A stricture dilation procedure is expensive, and repeated dilations may be necessary (Harai et al. 1995, Melendez et al. 1998, Leib et al. 2001). However, favourable outcomes for patients with oesophageal stricture managed successfully with medical treatment alone were reported by Burton et al. (2017) and Rousseau et al. (2007). Consequently, medical management may be a valuable option for patients in which balloon dilation is not feasible (Wyatt and Barron 2019).

Even though undergoing surgery and the occurrence of complications were significantly associated with increased duration of hospitalisation, all of the patients included in this study survived to discharge. Therefore, the overall outcome of this study sample following the removal of upper gastrointestinal FBs appears to be very good.

VII. CONCLUSION

Gastrointestinal foreign bodies are commonly encountered in small animal practice. Considering the wide variety of objects frequently recovered, the clinical presentation of affected patients may be variable, depending on the degree, location, duration of the obstruction, and the presence of pathophysiologic abnormalities (Papazoglou et al. 2003, Maxwell et al. 2020).

Results of this study showed that patients whose owners did not witness FB ingestion were significantly more likely to have clinical signs. On the other hand, witnessed ingestion was associated with a significantly shorter duration of clinical signs or time since ingestion until presentation to the hospital. These findings suggest owners who witness ingestion of a FB tend to seek veterinary care sooner, which may be crucial for both the success rate of removal techniques and a good outcome of the patient without complications (Rousseau et al. 2007, Gianella et al. 2009, Hayes 2009).

Notwithstanding the observed wide variety of objects recovered from the gastrointestinal tract, in line with previous studies, cats were significantly more likely to have ingested a linear FB compared to dogs (Root and Lord 1971, Felts et al. 1984, Hayes 2009). In the current study, even though there was no significant association between the type of FB and the presence of clinical signs, results suggest a trend in proportions as according to the presence and increased degree of pain on abdominal palpation, higher the likelihood of a FB of a linear nature.

Previous studies reported lower success rates of endoscopic removal associated with linear FBs (Hobday et al. 2014) and increased duration of clinical signs (Hayes 2009). Contrarily, not only the success rate of endoscopic removal observed in this study was very similar between LFBs and NLFBs, there was also no significant association with the duration of clinical signs. However, FBs impacted in multiple anatomical locations were significantly associated with failure of endoscopic removal.

Amongst the patients that underwent surgery to remove the FB, gastrotomy was the most commonly performed surgical technique. Additionally, patients with LFBs were significantly more likely to require multiple surgical techniques compared to those with NLFBs.

The overall complication rate observed in this study was low (28.8%), with the majority of the cases being considered minor complications. Furthermore, major complications were frequently associated with linear FBs.

In contrast to what was suggested by Boag et al. (2005) and Hayes (2009), in the current study, patients with LFBs were not more likely to have complications following removal.

Reported clinical signs were not associated with the occurrence of complications; however, results showed that an abnormal mentation and painful abdominal palpation were significantly associated with complications, possibly attributable to the discomfort and pain induced by major complications observed in these cases (Hobday et al. 2014).

Neither the type of procedure performed nor its promptness was associated with the occurrence of complications postoperatively or a worse outcome.

The hospitalisation period was significantly increased in patients with reported clinical signs, as well as in those that underwent surgery to remove the FB and those in which complications were reported. On the other hand, the presence of an LFB, as opposed to an NLFB, did not appear to increase the hospitalisation period or have a detrimental effect on the outcome.

Even though undergoing surgery and the occurrence of complications were significantly associated with increased hospitalisation period, the outcome following removal of an upper gastrointestinal FB was considered excellent, as shown in previous studies (Gianella et al. 2009, Hayes 2009, Hobday et al. 2014). Undergoing surgery did not appear to be a risk factor for the occurrence of postoperative complications. Nevertheless, results suggest that an abnormal mentation and painful abdominal palpation may be potential indicators for the occurrence of complications, thus possibly affecting the overall outcome.

The retrospective nature of this study had inherent limitations considering the information was retrieved from the available medical records, making it challenging to objectively standardise the results. Furthermore, the involvement of two different institutions, with practitioners of varying experience, results in variations in case management strategies.

Further limitations include the small sample size, and the exclusion of clinicopathological and imaging diagnostic techniques, whose results could potentially provide additional valuable information regarding complications and outcomes of patients with gastrointestinal FBs. Complications observed were categorised as minor or major for descriptive purposes; however, statistical analysis did not include such categorisation, which may have resulted in an overestimation of the complication rate in this study sample.

Additional studies with a larger study sample and more standardised inclusion criteria could prove beneficial in further establishing risk factors and prognostic indicators for patients following upper gastrointestinal foreign body ingestion.

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IX. APPENDICES

Appendix 1. Breeds of dogs and cats represented in this study sample

Breed	Patients (n = 73)
Cats (n = 16)	
Domestic shorthair	13
Maine Coon	2
Sphynx	1
Dogs (n = 57)	
Boxer	4
Bull Terrier	4
Cocker Spaniel	3
Cross breed	12
French Bulldog	2
Labrador Retriever	7
Pequinois	2
Poodle	5
Yorkshire Terrier	4
Basset Hound, Border Collie, Bull Mastiff, Cavalier King Charles Spaniel, Chihuahua, Cockapoo, Doberman, Fox Terrier, German Shorthaired Pointer, German Wirehaired Pointer, Golden Retriever, Jack Russel Terrier, Newfoundland, Pug	1 of each

Appendix 2. Data from 21 patients (15 dogs and 6 cats) with complications (6 linear foreign bodies and 15 non-linear FBs)

Patient number	FB type	FB location	Duration of clinical signs	Type of complication	Hospitalisation period	Death or euthanasia
1	Fish hook	Thoracic oesophagus	< 1 day	Oesophageal mucosal abrasions	1 - 3 days	-
2	Fish hook	Cervical oesophagus	< 1 day	Dysphagia (PO for 2 days)	1 - 3 days	-
3	Bouncy ball	Thoracic oesophagus	NA	Dysphagia (PO for 8 days)	> 3 days	-
4	Wood fragments	Stomach	1 - 3 days	Oesophageal stricture	3 - 6 days	Euthanasia
5	Bone	Stomach	< 1 day	Gastritis	3 - 6 days	-
6	Fish hook	Stomach	< 1 day	Erosive gastritis	< 1 day	-
7	Wooden skewer	Stomach	> 3 days	Abdominal fistula	3 - 6 days	-
8	String*	Stomach and duodenum	< 1 day	Intestinal intussusception	3 - 6 days	-
9	Plastic*	Duodenum	1 - 3 days	Intestinal intussusception	< 1 day	
10	Organic material	Duodenum	1 - 3 days	Intestinal necrosis	3 - 6 days	-
11	Textile material*	Stomach, duodenum and jejunum	1 - 3 days	Intestinal necrosis	1 - 3 days	-
12	Ribbon*	Stomach and ileum	1 - 3 days	Intestinal perforation	> 6 days	-
13	Organic material	Stomach	> 3 days	Intestinal necrosis and perforation	> 6 days	-
14	String*	Intestines	> 3 days	Laceration of the mesenteric border	> 6 days	-
15	String*	Duodenum and ileum	1 - 3 days	Laceration of the mesenteric border	3 - 6 days	-
16	Plastic	Stomach	1 - 3 days	Peritonitis	> 6 days	-
17	Wooden skewer	Stomach	< 1 day	Wound oedema	3 - 6 days	-
18	Organic material	Stomach	< 1 day	Wound oedema	3 - 6 days	-
19	Organic material	Duodenum	1 - 3 days	Wound oedema	3 - 6 days	-
20	Needle and thread	Stomach	< 1 day	Wound oedema	1 - 3 days	-
21	Organic material	Duodenum	NA	Wound seroma	3 - 6 days	-

* Linear foreign bodies; FB - Foreign body; NA - Not available; PO - Postoperative