

## Mastocytoma in cats – Integrative literature review

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### Abstract

Feline mastocytoma is a round cell neoplasm with variable biological behaviour, characterized by the abnormal proliferation of mast cells, developing in the cutaneous, visceral or intestinal form. The aim was to carry out an integrative literature review on the aetiopathogenesis, epidemiology, clinical signs, diagnosis and treatment of mastocytoma in cats. The databases Periódicos Capes, Google Scholar, PubMed and ScienceDirect were used. The following terms were combined: ‘mast cell’ AND ‘feline or cat’ AND ‘mast cell tumours’ AND ‘cutaneous OR skin mast cell tumours OR spleen OR gastrointestinal OR visceral’, using the specific search form of each platform. Case reports, scientific articles and literature reviews were selected, which were freely accessible, published between 2002 and 2022, in Portuguese or English, and which portrayed the occurrence of mastocytoma in cats. Articles in other languages, dealing with other species, encyclopaedias, event proceedings and publications with access restrictions were excluded. The findings showed that mastocytoma is a frequent neoplasm in cats, commonly presenting as solitary cutaneous masses with a favourable prognosis. However, some cutaneous nodules may be associated with visceral tumours, with an unfavourable prognosis, as well as intestinal mastocytomas, due to their infiltrative nature and high metastatic potential, thus affecting the survival and well-being of these animals. There is a lack of data in the literature on this neoplasm in cats, especially in Brazil. It is therefore important to carry out further studies on the subject, with a view to improving diagnosis and treatment.

*Feline, mast cell tumour, neoplasm, skin nodule*

Mastocytoma is a neoplasm of variable biological behaviour characterized by a disordered proliferation of mast cells. In turn, mast cells are derived from bone marrow haematopoietic stem cells that express the CD34+ antigen, and differentiate into mast cells in various tissues, usually being found in the skin, lymphoid organs, lung mucosa and gastrointestinal tract, regulating and inducing inflammatory responses and allergic reactions (De Sousa Filho et al. 2016).

Mastocytoma accounts for around 20% of skin tumours in cats and is considered the second most common skin tumour in the species (Blackwood 2015; Arz et al. 2022). Gastrointestinal mastocytomas, on the other hand, are considered uncommon and account for around 4% of all gastrointestinal neoplasms in cats (Barrett et al. 2018).

The literature on mastocytomas in cats is limited (Barrett et al. 2018), which makes it difficult for clinicians to obtain the information they need to treat patients. This compromises the diagnosis and treatment of this neoplasm.

In view of the above and the relevance of this neoplasm to feline medicine, the aim was to carry out an integrative literature review in order to gather together the characteristics of the occurrence of mastocytomas in cats, mainly addressing aetiopathogenesis, epidemiology, clinical signs, diagnosis and treatment.

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## Materials and Methods

This is a descriptive study using the integrative literature review method, which began with the definition of a guiding question: ‘What data have been published on mastocytomas in cats based on their aetiopathological, epidemiological, clinical, diagnostic and therapeutic aspects, and their importance for feline medicine?’ Based on this, we sought to identify and select articles that contained relevant data and met the previously determined inclusion criteria.

The PICO strategy (acronym for Patient, Intervention, Comparison and Outcomes), conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, was used to prepare the scientific question.

We considered case reports, scientific articles, literature reviews, which were freely accessible for full reading, published between 2002 and 2022, in Portuguese or English, which directly portrayed the occurrence of mastocytoma in cats, mainly addressing aetiopathogenesis, epidemiology, ante- and postmortem diagnoses, treatments and clinical signs presented.

Exclusion criteria were encyclopaedias, event proceedings, publications with restricted access, works published in languages other than Portuguese or English and studies that dealt with species other than domestic cats.

Given the predetermined inclusion criteria, the search process began between May 20 and 28, 2022, and the database searches were carried out using the following search strategies: ‘mast cell’ AND ‘feline OR cat’ AND ‘mast cell tumours’ AND ‘cutaneous OR skin mast cell tumours OR spleen OR gastrointestinal OR visceral’. Only English terms were used, and they were included in data platforms such as Periódicos Capes, Google Scholar, National Library of Medicine (PubMed) and ScienceDirect, using the specific search form of each database.

After identifying the results, the documents with titles and abstracts were saved and downloaded in ‘BibTex’ format or in PDF (Portable Document Format) and exported to a reference manager (Mendeley®) for subsequent selection.

The first selection consisted of excluding duplicates found in the bibliographic manager (Mendeley®). Subsequently, two researchers independently selected studies by reading the title and abstract of the studies and then reading the articles in full. Subsequent to each researcher’s selections, any discrepancies between the articles included and excluded were resolved after consensus between both parties.

The second phase of screening consisted of excluding studies whose title, keywords or abstract did not contain the search terms (‘mast cell’ AND ‘feline OR cat’ AND ‘mast cell tumours’ AND ‘cutaneous OR skin mast cell tumours OR spleen OR gastrointestinal OR visceral’) and information pertinent to the scientific question. Afterwards, the articles were read in full, analysing which were suitable for the information synthesis stage.

Data on titles, authors, year of publication and which platforms/journals the papers were linked to were entered into a Microsoft Excel spreadsheet.

## Results and Discussion

The search in the Periódicos Capes database produced 20 articles when all the combinations of search terms were added together, PubMed produced 57 articles, while the Google Scholar and ScienceDirect platforms produced 751 and 55 articles, respectively.

In the bibliographic manager (Mendeley®), all the studies from the four databases (n = 883) were displayed, where there were duplicates (n = 156), these were discarded, as well as event proceedings (n = 3) and studies not available for full reading (n = 314). The initial screening of titles and abstracts (n = 410) excluded studies that did not meet the inclusion parameters (n = 367).

According to the pre-established eligibility criteria, only 43 studies were included for full reading. However, in the final assessment, 28 articles were discarded, ending up with 15 articles in the systematic review screening (Fig. 1).

Table 1 shows the titles, authors, years of publication and places of publication of the selected studies.

Table 2 provides information on the characteristics of the studies included in the qualitative synthesis on mastocytomas in cats.

The data collected from the 15 articles selected totalled 483 cats diagnosed with mastocytoma, 234 females (48.44%), 242 males (50.1%), and seven cats had no specified sex (1.44%). The average age of the cats with MCTs in the selected studies was 11.5 years (range five months to 21 years). With regard to breed, 400 animals were of no defined breed (SRD), around 82.81%, followed by 25 Siamese (5.17%), 12 Persians (2.48%), 12 Burmese (2.48%), nine Ragdolls (1.86%), seven Russian Blue (1.44%),

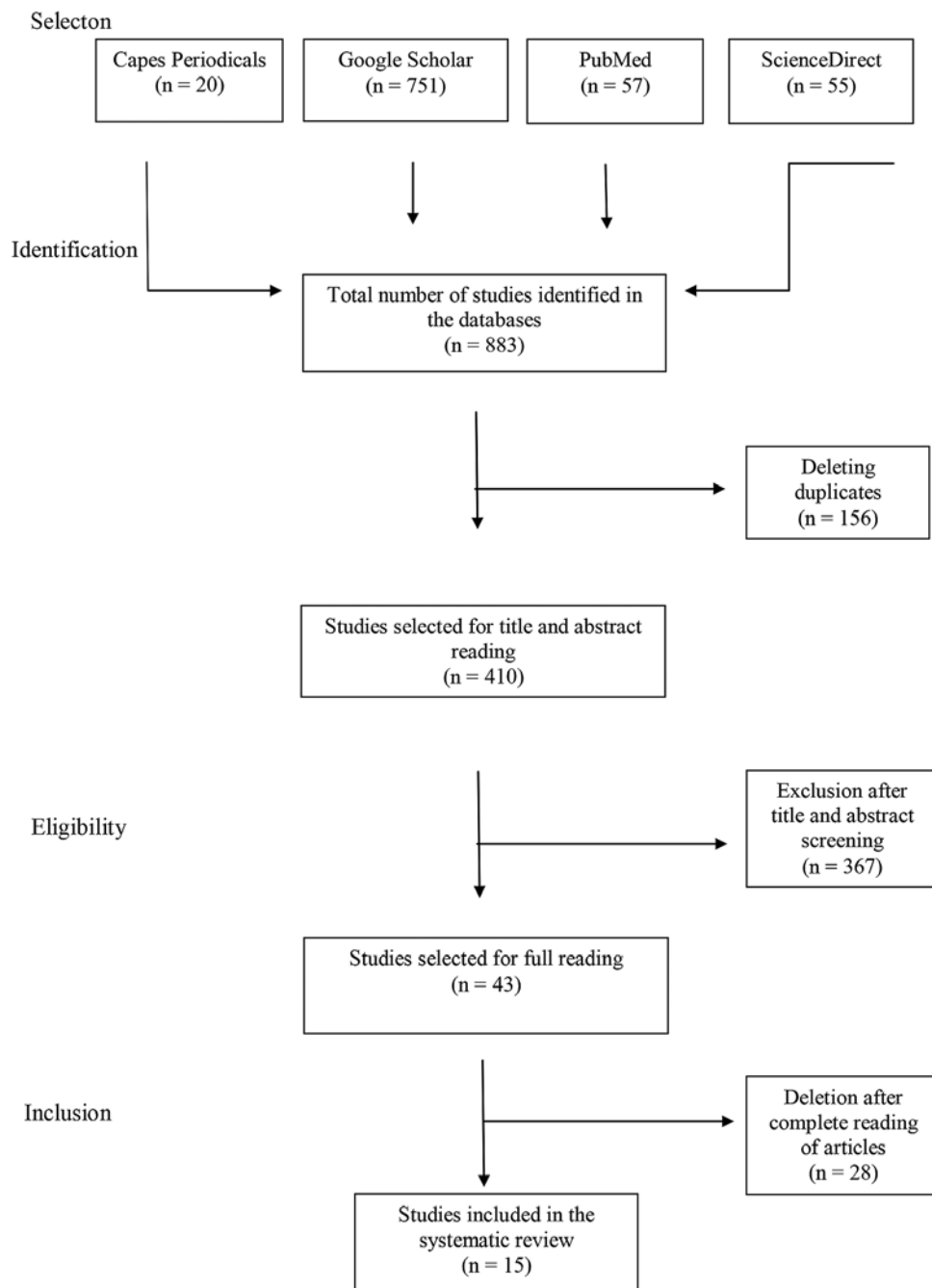


Fig. 1. Flowchart of identification and selection of articles for systematic review on mastocytoma in felines from 2002 to 2022 in the Periódicos Capes, Google Scholar, PubMed and ScienceDirect databases.

seven Maine Coons (1.44%), two Orientals (0.41%) and one each of the Abyssinian, Norwegian, British Shorthair, Havana, Sphynx, Himalayan, Devon Rex, Norwegian Forest Cat and Ocicat breeds (Table 3). As for neutered animals, 355 animals (73.49%) were neutered and 128 animals (26.5%) were not neutered.

Two studies (13.33%) described mastocytoma. The first described it as a spontaneous neoplasm with no correlation to infection with the Feline Leukaemia Virus (FeLV) or Feline Immunodeficiency Virus (FIV) (Abrams-Ogg 2006). The second author, in addition to corroborating this description, added that it was a variable biological behaviour characterized by a disordered proliferation of mast cells and that it seemed to be unrelated to the Feline Infectious Peritonitis Virus (FIP) (Barrett et al. 2018).

Table 1. Identification of authors, year of publication, title and place of publication of articles selected for systematic review on mastocytomas in felines.

Author	Year	Title	Periodical
Abrams-Ogg	2006	Chapter 22 - The cat with abdominal distention or abdominal fluid	Problem-Based Feline Medicine
Litster, Sorenmo	2006	Characterisation of the signalment, clinical and survival characteristics of 41 cats with mast cell neoplasia	Journal of Feline medicine an surgery
Lamm et al.	2009	Disseminated cutaneous mast cell tumors with epitheliotropism and systemic mastocytosis in a domestic cat	Journal of Veterinary Diagnostic Investigation
Laurenson et al.	2011	Ultrasonography of intestinal mast cell tumors in the cat.	Veterinary Radiology & Ultrasound
Henry, Herrera	2013	Mast cell tumors in cats: clinical update and possible new treatment avenues.	Journal of Feline Medicine and Surgery
Blackwood	2015	Feline mast cell tumours	In Practice (London 1979)
Melville et al.	2015	Feline cutaneous mast cell tumours: a UK-based study comparing signalment and histological features with long-term outcomes	Journal of Feline Medicine and Surgery
Dobromylskyj	2016	Feline cutaneous mast cell tumours - where are we now with prognostication?	CVE Control & Therapy Series
De Sousa Filho et al.	2016	Mastocitoma visceral felino	MEDVEP
Sabattini et al.	2016	Feline intestinal mast cell tumours: clinicopathological characterisation and KIT mutation analysis	Journal of Feline Medicine and Surgery
Sabattini et al.	2017	Kit receptor tyrosine kinase dysregulations in feline splenic mast cell tumours	Veterinary and Comparative Oncology
Kim et al.	2017	Primary intestinal mast cell tumor in a Russian Blue cat: Ultrasonographic and histopathological findings	Korean Journal of Veterinary Research
Barrett et al.	2018	Outcome following treatment of feline gastrointestinal mast cell tumours	Veterinary and Comparative Oncology
Evans et al.	2018	Treatment outcomes and prognostic factors of feline splenic mast cell tumors: A multi-institutional retrospective study of 64 cases	Veterinary and Comparative Oncology
Jung et al.	2021	Splenic mast cell tumors in two cats	Journal of Veterinary Clinics

Table 2. Characteristics of the studies included in the qualitative synthesis on MCT in cats.

References	Methodology				
	Country	Presentation	Symptomatology	Diagnosis	Treatment
Abrams-Ogg 2006	USA	MCT visceral/ intestinal	Depression, anorexia, weight loss, vomiting, dyspnoea, peritoneal fluid, fever, diarrhoea, melaena or haematochezia, palpable mass	RX, US, PAAF, HP	Splenectomy/excision of bowel mass
Litster, Sorenmo 2006	USA	MCT cutaneous/ visceral	Anorexia, vomiting and weight loss	PAAF - HP	Excisional biopsy and QXT, corticosteroids
Lamm et al. 2009	USA	MCT cutaneous	Nodular, diffuse, raised, non-itchy skin lesions	HP	Prednisolone, anti-H1 and H2, itraconazole and enrofloxacin
Laurenson et al. 2011	USA	MCT intestinal	Vomiting, anorexia, diarrhoea and weight loss	US - HP	-
Henry, Herrera 2013	USA	MCT cutaneous/ visceral	Alopecic and diffuse cutaneous nodules	PAAF, CBC, PB, RX, US, urinalysis	Splenectomy, IQT, anti-H2
Blackwood 2015	UK	MCT cutaneous	Pruritus, erythaema and ulceration	PAAF	Surgical excision
Melville et al. 2015	UK	MCT cutaneous	Skin nodules	HP	-
Dobromylskyj 2016	USA	MCT cutaneous/ visceral	Solitary cutaneous nodules	HP	-
De Sousa Filho et al. 2016	BRA	MCT visceral /intestinal	Vomiting, depression, anorexia, diarrhoea, weight loss, dehydration, haematochezia, palpable mass and thickening of the intestinal loops	CBC, PB, US, LE, HP - RX	Splenectomy/ Anti-H and H2, QXT and prednisolone
Sabattini et al. 2016	IT	MCT intestinal	Anorexia, vomiting, abdominal pain and palpable mass	HP, CBC, US	Surgical excision, IQT, corticosteroids, no therapy
Sabattini et al. 2017	IT	MCT visceral	Anorexia, vomiting and palpable mass	PAAF, US - HP	Splenectomy, QXT, IQT, corticosteroids
Kim et al. 2017	KOR	MCT intestinal	Vomiting, anorexia and diarrhoea	HP, CBC, PB, RX chest and abdominal	Surgical excision and anti-H2
Barrent et al. 2018	USA	MCT intestinal	Vomiting, anorexia, weight loss, diarrhoea, lethargy, constipation, s and hair los	US, TC, L PAAF, HP, US, RX chest	QXT, corticosteroids, surgical excision
Evans et al. 2018	USA	MCT visceral	Anorexia, weight loss, vomiting and lethargy	PAAF, HP	Splenectomy, QXT, IQT, corticosteroids,
Jung et al. 2021	KOR	MCT visceral	Anorexia and vomiting	US, HP	Splenectomy

USA = United States of America; UK = United Kingdom; IT = Italy; KOR = South Korea; BRA = Brazil; RX = radiography; US = abdominal ultrasound; FNA = fine needle aspiration biopsy; HP = histopathology; CBC = complete blood count; PB = biochemical profile; CT = computed tomography; LE = exploratory laparotomy; QXT = chemotherapy; IQT = tyrosine kinase inhibitors

Table 3. Identification of data collected in articles selected for systematic review on mastocytomas in felines, referring to breed.

Race	n (%)	Race	n (%)
SRD	400 (82.81%)	Norwegian	1 (0.2%)
Siamese	25 (5.17%)	British Shorthair	1 (0.2%)
Persian	12 (2.48%)	Havana	1 (0.2%)
Burmese	12 (2.48%)	Sphynx	1 (0.2%)
Ragdoll	9 (1.86%)	Himalayan	1 (0.2%)
Russian Blue	7 (1.44%)	Devon Rex	1 (0.2%)
Maine Coon	7 (1.44%)	Norwegian Forest Cat	1 (0.2%)
Eastern	2 (0.41%)	Ocicat	1 (0.2%)
Abyssinian	1 (0.2%)		

In terms of frequency, three authors have reported that mastocytomas account for 2–15% of neoplasms in cats (Henry and Herrera 2013; Sabattini et al. 2016; Barrett et al. 2018). In addition, two other authors have reported that it is relatively common for mastocytomas to occur in cats after lymphoid neoplasms and/or after mammary tumours (Evans et al. 2018; Jung et al. 2021). It is therefore possible to see that this neoplasm has a considerable frequency and that some animals may be more prone to developing it, as is the case with those that have already had mammary or lymphoid neoplasms.

The cutaneous form is considered to be a neoplasm that affects the animal's dermis and/or subcutaneous tissue and is considered to be common in this species (Lamm et al. 2009). Some authors have reported that it is the second most common skin tumour in this species (Litster and Sorenmo 2006; Henry and Herrera 2013). De Souza Filho et al. (2016) reported a 21% frequency of cutaneous mastocytomas among all cutaneous tumours in cats.

There is a consensus among authors that the anatomical location of cutaneous MCT is most commonly found in the head, neck and trunk (Litster and Sorenmo 2006; Lamm et al. 2009; Laurenson et al. 2011; Herrera 2013; Blackwood 2015; Henry and Melville et al. 2015; Dobromylskyj 2016; Evans et al. 2018). Additionally, some have cited the tail and paws as the least affected sites (Blackwood 2015; Melville et al. 2015; Dobromylskyj 2016). Two studies also reported that young cats are more likely to have skin lesions on the head and older cats are often affected on the trunk (Melville et al. 2015; Dobromylskyj 2016).

Only four articles (26.66%) described the macroscopy of cutaneous mastocytomas. The first described circumscribed, papular or nodular, pale to yellowish, hairy, alopecic or ulcerated lesions of variable size, which can be solitary masses of dermoepidermal location or multiple masses attached to the skin (Litster and Sorenmo 2006). The second reported diffuse, reddish, raised, alopecic, slightly firm skin lesions between 1 mm and 2 cm in diameter (Lamm et al. 2009). The third reported solitary, firm, alopecic or ulcerated masses, well circumscribed and pale, which could also be flat lesions similar to eosinophilic granulomas or discrete subcutaneous nodules (Blackwood 2015). Finally, the fourth described ulcerated lesions or small crusted papules located on the head and trunk (Evans et al. 2018).

There is a consensus among authors that the cutaneous form of feline mastocytoma is predominant in the species, but these cutaneous masses can occur as secondary lesions to primary visceral tumours (Henry and Herrera 2013; Melville et al. 2015; Dobromylskyj 2016). It is also reported that the involvement of other organs in cats with disseminated cutaneous mastocytomas is considered rare (Lamm et al. 2009).

Visceral mastocytomas are more common in cats than in dogs and around 50% of cases of cutaneous mastocytomas involve extra-cutaneous sites (Laurenson et al. 2011; Sabattini et al. 2017). In addition, there is consensus among authors that splenic visceral mastocytoma is one of the most common splenic tumours in cats, accounting for around 15–27% of all spleen neoplasms in the species (De Sousa Filho et al. 2016; Dobromylskyj 2016; Evans et al. 2018; Jung et al. 2021).

The studies by Laurenson et al. (2011) and Kim et al. (2017) described the visceral form as a neoplasm that mainly affects the spleen, liver, lymph nodes and bone marrow. However, Dobromylskyj (2016) mentioned that the visceral sites most affected are the spleen and intestines, which is associated with the fact that the author did not use the intestinal clinical classification, thus including intestinal involvement in the visceral classification. In contrast to Laurenson et al. (2011), De Sousa Filho et al. (2016), and Kim et al. (2017) presented bone marrow as the visceral tissue least affected by visceral mastocytoma.

In the studies selected, only De Sousa Filho et al. (2016) and Jung et al. (2021) described the macroscopic findings of visceral mastocytoma, reporting a solid, rounded mass in the caudal portion of the spleen and pale to orange masses in the splenic parenchyma, respectively.

Two authors corroborated this when they reported that the intestinal form is an uncommon neoplasm in clinical practice with little information in the veterinary literature (De Sousa Filho et al. 2016; Sabattini et al. 2016). Despite this, five other studies have shown intestinal mastocytoma to be the third most common primary intestinal tumour in cats (Litster and Sorenmo 2006; Henry and Herrera 2013; Blackwood 2015; Kim et al. 2017; Barrett et al. 2018). In addition, Kim et al. (2017) reported that intestinal mastocytomas are mainly diagnosed in older cats aged between 11 and 15 years.

Only three studies reported intestinal mastocytomas as solitary or multifocal lesions (Henry and Herrera 2013; Kim et al. 2017; Barrett et al. 2018). Two studies reported that the small intestine was the most commonly affected portion in the descriptions of the affected anatomical sites found in each study (Abrams-Ogg 2006; Barrett et al. 2018). One study reported focal tumour masses found mainly in the jejunum and duodenum, ileocaecocolic junction, and colon (Laurenson et al. 2011). Another one described the distal small intestine, ileocaecocolic junction, and colon (Sabattini et al. 2016). A third one found masses most commonly located in the small intestine and ileocaecocolic junction (Kim et al. 2017). Finally, tumour masses located in the stomach, small intestine, large intestine and small and large intestine have been reported (Barrett et al. 2018).

As for the symptoms of cutaneous mastocytoma, only three (20%) articles discussed the subject, with divergences between the authors. The first cited the absence of pruritus and no apparent pain in the lesions (Lamm et al. 2009), while another described intermittent pruritus, erythaema and ulceration as clinical signs present in cases of cutaneous mastocytoma (Blackwood 2015). Thus, pruritus may occur, but will not be present in all cases. Finally, a third author described a cat with disseminated, alopecic and pale cutaneous nodules as a presentation of mastocytoma (Henry and Herrera 2013).

It has also been mentioned that animals affected by the disease may show signs of systemic disease for months before diagnosis (Blackwood 2015). Furthermore, although it is common in cats, there are few studies dealing with the disease in cats, and there is a lack of information and appreciation of the disease (Dobromylskyj 2016).

For visceral mastocytomas, six (40%) studies described the clinical symptoms. Non-specific signs were reported and included anorexia (n = 5), weight loss (n = 4), vomiting (n = 6), pleural or peritoneal effusion (n = 1), depression (n = 1), lethargy (n = 1), dyspnoea (n = 1), palpable mass (n = 2) and abdominal distension (n = 1).

As for the clinical symptoms of intestinal mastocytoma, they were described in six articles (40%). The clinical signs are non-specific and mainly include anorexia (n = 6), weight loss (n = 4), vomiting (n = 6), diarrhoea (n = 4), depression (n = 1), palpable mass (n = 2), melaena or haematochezia (n = 2), pleural or peritoneal effusion (n = 1), fever (n = 1) and abdominal pain (n = 1), lethargy (n = 1), constipation (n = 1), dyspnoea (n = 1), thickening of the intestinal loops (n = 1), dehydration (n = 1) and hair loss (n = 1).

It is important to note that vomiting is caused by the release of histamine from the tumour, resulting in hypergastrinaemia, vomiting, and may also result in melaena, haematozia and gastric and duodenal ulcers (Litster and Sorenmo 2006; De Sousa Filho et al. 2016).

As for the presence of metastases, two studies reported metastases in the abdominal lymph nodes, liver, and spleen (Laurenson et al. 2011; Barrett et al. 2018). Two others cited abdominal lymph nodes and liver (Sabattini et al. 2016; Evans et al. 2018). One study dealt only with abdominal lymph nodes (De Sousa Filho et al. 2016) and another one with the liver only (Sabattini et al. 2017). In addition, four studies reported mastocytoma as a strong indication of systemic dissemination (Henry and Herrera 2013; Sabattini et al. 2017; Barrett et al. 2018; Evans et al. 2018).

With regard to the diagnosis of cutaneous mastocytoma, histological evaluation (n = 4) was the main diagnostic method, followed by cytological evaluation (n = 2) by fine needle aspiration of the mass, blood count, biochemical profile and urinalysis (n = 1), chest and abdominal X-rays (n = 1) and abdominal ultrasound (n = 1).

As for the diagnosis of visceral mastocytoma, the most commonly used methods in the studies included histological assessment (n = 6), abdominal ultrasound (n = 4), fine needle aspiration of the mass (n = 4), blood count and biochemical profile (n = 2), abdominal X-ray (n = 1) and exploratory laparotomy (n = 1).

One study cited splenomegaly, hepatomegaly, lymphadenopathy or peritoneal fluid as the main sonographic findings (Abrams-Ogg 2006). Another one only described splenomegaly as the main abdominal ultrasound finding (Jung et al. 2021). A tumour mass in the spleen was also reported, as well as a slight increase in ALT (alanine aminotransferase) in the biochemical profile (De Sousa Filho et al. 2016). In addition, splenomegaly, anaemia, eosinophilia, mastocytoma and an abnormal coagulation panel were reported (Evans et al. 2018). In view of this, Abrams-Ogg (2006) states that 50% of cats with splenic MCT will have mastocytoma, and will also have hyperglobulinaemia, coagulation abnormalities and eosinophilia.

The diagnostic methods used for intestinal mastocytoma mainly included histological assessment (n = 6), abdominal ultrasound (n = 6), blood count and biochemical profile (n = 3), abdominal radiography (n = 3), fine needle aspiration of the mass (n = 2), exploratory laparotomy (n = 2) and computed tomography (n = 1).

Abrams-Ogg (2006) described hypoechoic intestinal masses with loss of intestinal wall stratification, splenomegaly, hepatomegaly, lymphadenopathy or peritoneal fluid as the main sonographic findings. This corroborates the findings of De Sousa Filho et al. (2016), who reported hepatomegaly, splenomegaly, changes in the pancreas and intestinal lymphadenomegaly, as well as reduced motility and thickening of the walls of the small intestine.

Eccentric, hypoechoic, non-circumferential, very asymmetric or circumferential thickening of the intestinal wall was observed; however, there was no loss of stratification of the intestinal wall, only thickening (Laurenson et al. 2011). They also found thickened, hypoechoic, non-circumferential and eccentric bowel loops with thickening and loss of tunica muscularis stratification (Kim et al. 2017). Finally, only eccentric thickening of the non-circumferential wall was reported (Sabattini et al. 2016).

In terms of laboratory alterations, one study described eosinophilia and monocytosis (De Sousa Filho et al. 2016). Another reported polycythaemia, hyperproteinaemia and



increases in alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase and total bilirubin (Kim et al. 2017). Eosinophilia (Sabattini et al. 2016) and mastocytoma (Barrett et al. 2018) have also been reported individually.

It is important to note that two studies mentioned that pre-medication with anti-H1 before performing fine needle aspiration of the mass suspected of being a mastocytoma is recommended, especially in cases of suspected signs of degranulation or visceral mastocytoma (Henry and Herrera 2013; Blackwood 2015).

As for staging, three studies corroborated the recommendation of complete staging of cats with multiple cutaneous mastocytomas, mastocytoma or systemic clinical signs (Henry and Herrera 2013; Blackwood 2015; Sabattini et al. 2017). However, the lack of standards for staging feline mastocytomas when compared to dogs has been highlighted (Sabattini et al. 2017).

With regard to histopathological characteristics, there are differences between authors. It has been discussed that the Patnaik and Kiupel classification systems used in canine mastocytomas are not applicable to feline cases, as they have not been shown to be effective in identifying histological predictors of malignancy. The histopathological classification presented by one of the studies divided mastocytomas into two types, mastocytic, which is the most common form, and atypical. In addition, the mastocytic type is subdivided into well-differentiated, pleomorphic and poorly differentiated (Blackwood 2015).

Another study classified mastocytomas as well-differentiated, pleomorphic mastocytic and atypical, also describing a new histological subtype consisting of well-differentiated mast cells with prominent multinucleated cells (Melville et al. 2015). In addition, the absence of a classification system was mentioned, and the classification of cutaneous mastocytomas into: well-differentiated mastocytic type, pleomorphic mastocytic type and the atypical form was recommended by another author (Dobromylskyj 2016). In one case report, the mastocytoma was graded 2 and classified according to Patnaik's classification (Kim et al. 2021).

Only five (33.33%) articles described differential diagnoses. The first described lymphoma, adenocarcinoma, septic peritonitis and pneumothorax in the presence of eosinophils in the peritoneal fluid (Abrams-Ogg 2006). The second mentioned urticaria pigmentosa (Lamm et al. 2009). The third mentioned gastrointestinal lymphoma, intestinal adenocarcinoma, leiomyoma and leiomyosarcoma (Laurenson et al. 2011). Finally, the last reported lymphoma and mixed inflammatory lesion, respectively (Blackwood 2015; Dobromylskyj 2016).

Five studies have addressed treatment for cutaneous mastocytomas (Litster and Sorenmo 2006; Lamm et al. 2009; Henry and Herrera 2013; Blackwood 2015) with differences between the protocols proposed by the authors. The first study compared complete excisional biopsy protocols with and without adjuvant chemotherapy and found that there was no difference between the treatments. However, the authors argued that the number of animals was small and that in larger samples chemotherapy could prove more promising (Litster and Sorenmo 2006). Corroborating this study, another author suggested only surgery for the treatment of cutaneous mastocytomas (Blackwood 2015).

Another study reported treatment with prednisone, H1 (diphenhydramine) and H2 (famotidine) antihistamines, as well as itraconazole and enrofloxacin. The animal was euthanized and submitted for necropsy, which suggested visceral involvement secondary to cutaneous neoplasia (Lamm et al. 2009). Additionally, one report of disseminated mastocytoma reported splenectomy and the use of tyrosine kinase inhibitors (TKIs) and H2 antihistamines (famotidine) as a form of treatment, achieving a survival of more than 14 months with a good quality of life; however, the disease still progressed cutaneously (Henry and Herrera 2013).

As for the treatment of visceral mastocytoma, splenectomy, prednisone alone or protocols used to treat lymphoma have been suggested (Abrams-Ogg 2006). Another

study looked at splenectomy and splenectomy with the use of corticosteroids and adjuvant chemotherapy as therapeutic approaches, obtaining a higher survival rate in patients treated with splenectomy associated with corticosteroids, with no significant difference between patients treated with surgery alone and those treated with surgery plus medical therapy (Sabattini et al. 2017).

Several therapeutic protocols were categorized, which included: splenectomy, splenectomy with adjuvant chemotherapy, chemotherapy alone and supportive care with corticosteroids, and concluded that animals undergoing splenectomy have better results, with a survival of more than 24 months (Evans et al. 2018). Corroborating case reports reinforce this position, as two studies by De Sousa Filho et al. (2016) and Jung et al. (2021) opted for splenectomy as a treatment for visceral mastocytomas and obtained a survival rate of 14 months (De Sousa Filho et al. 2016) and 22 months (Jung et al. 2021). Additionally, one of the reports pointed out that the use of TKIs for splenic visceral mastocytomas in cats may not be beneficial (Jung et al. 2021).

With regard to the treatment of intestinal mastocytomas, surgical excision with margins of 5 to 10 cm has been proposed for intestinal masses (Abrams-Ogg 2006). In addition, various therapeutic protocols have been categorized, including: surgical excision of the intestinal mass, immunochemotherapy (toceranib and imatinib), corticosteroids and no therapy, obtaining good survival results (> 12 months) in all the protocols used (Sabattini et al. 2016).

Treatment involving H1 (clemastine) and H2 (famotidine) antihistamines and chemotherapy (vinblastine sulphate) in association with prednisolone for 90 days was used in one report and the patient's clinical condition worsened and euthanasia was recommended (De Sousa Filho et al. 2016). While surgical excision of the mass associated with the use of H2 antihistamines (famotidine) was able to achieve a favourable prognosis in one report, since the patient was healthy and free of metastases six months after surgical excision (Kim et al. 2017). Finally, one study reported various therapeutic protocols which included chemotherapy (lomustine or chlorambucil), chemotherapy with corticosteroids (prednisolone), surgery with chemotherapy and corticosteroids, surgery with corticosteroids and corticosteroids alone, obtaining a mean overall survival time of 531 days (Barrett et al. 2018).

In conclusion, mastocytoma is a neoplasm of great importance in feline medicine, but there is a scarcity of studies on the subject, especially in Brazil where only one study has been conducted.

The clinical classification, staging and histopathological classification of the disease are conflicting between authors. Standardization is needed for future studies, facilitating analysis and allowing meta-analyses to be carried out.

Clinical presentation and prognosis vary according to the location of the lesions. However, the treatment that seems to have the best effect, regardless of the clinical form, is surgical removal with good margins. Complementary treatments such as chemotherapy require further investigation.

New studies need to be carried out to assess all the nuances relating to mastocytomas, as there are several gaps to be filled both in the field of diagnosis and treatment.

#### **Conflict of interest**

The authors declare no conflict of interest.

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