Trabajo fin de Grado en Veterinaria

Title: Canine splenic masses, literature review and clinical case series.

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Convocatoria: Especial

Academic year: 2022-2023

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ABSTRACT

Predicting the likely histopathologic diagnosis of canine splenic masses can guide appropriate decision making. This study explores the percentage of malignant versus benign splenic masses and the incidence of hemangiosarcoma. For this purpose, we performed a comparison between literature reviews and our clinical cases. The records of the GICOREC-IUSA oncology service (2003-2022) were reviewed. We included 20 dogs that underwent splenectomy and with histopathologic report.

KEY WORDS

Spleen, dog, splenomegaly, masses, neoplastic, no neoplastic, total splenectomy.

1. INTRODUCTION

This work consists of two parts. First a bibliographic review of the described incidence of splenic masses correlating it with clinical presentation, diagnosis, clinical evolution. The second part will consist of a series of operated clinical cases of splenic masses treated in the oncology service of GICOREC-IUSA of the ULPGC, comparing it with what is described in the literature. Is of general use that concerning splenic masses, the rule of two thirds twice is almost an axioma: two thirds of splenic masses are neoplastic and two thirds of them are HSA. Nevertheless, other publications disagree with this rule, and our clinical case series is far from it.

This research corresponds to a monographic literature review since a compilation of information is carried out with the purpose of generating new knowledge or general concepts about the splenic masses present in dogs. The objectives were based on the search for information on the most common spleen masses that are diagnosed in the clinic, in which the results were analyzed and interpreted to leave research where the prevalence of malignant versus benign splenic masses can be evidenced.

For the execution of the bibliographic review of literature on splenic masses present in the spleen of diagnosed canines, a bibliographic search was implemented in academic databases such as Scopus, Google Scholar, PubMed and Faro ULPGC, using terms such as "neoplasms", "diseases or pathologies", "spleen", "dogs" and their equivalents in English.

OBJECTIVES

a) To investigate in the literature reviews the actual incidence of splenic masses based on its histopathologic nature.
b) To correlate clinical presentation, diagnosis and clinical evolution with the histologic nature of splenic masses.
c) To evaluate a series of patients surgically treated for splenic masses in GICOREC-IUSA in relation with previously described series.
d) To evaluate the evidence in the recent literature of the two-thirds rule.

2. LITERATURE REVIEW

2.1. Splenic masses

2.1.1. Background and current status of the subject:

Prevalence of splenic masses in literature is 53% of spleen tumor according to a study by Eberle *et al.*, 2012, on 249 cases in dogs. Furthermore, of this group, 73.5% had splenic hemangiosarcoma (HSA). This review will focus on those splenic masses of neoplastic or non-neoplastic origin, as well as whether it is malignant or benign. According to Ettinger (2017), Dogs with splenomegaly and splenic masses usually follow the two-thirds rule: 2/3 of dogs have splenic neoplasia and of these, 2/3 have HSA. According to this rule HSA is the most frequent malignant splenic cancer in canines, however it is not the only differential diagnosis of splenic mass. Therefore, 1/3 do not have cancer.

Splenic diseases can be classified into two groups, neoplastic and non-neoplastic. Among the neoplastic ones, HSA is traditionally considered the most frequent pathology found mainly in canine patients between 8 and 10 years of age. The large breeds and most predisposed to suffer from this type of disease, although they can also occur in smaller breeds such as the pitbull. Lymphosarcomas and fibrosarcomas can also be found in this group, although in a smaller proportion (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

Non-neoplastic diseases include diseases such as splenic hematoma, benign nodular hyperplasia, splenic rupture, infarcts, splenic torsion and congestive splenomegaly, which are usually treated with surgical removal (splenectomy) (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

Pathological splenic changes may be identified incidentally during routine examination of a dog without associated clinical signs or in a patient evaluated for nonspecific signs such as vomiting, inappetence, or unexplained weight loss. Some of the most observed signs are secondary to a diagnosis of hemoperitoneum from splenic mass rupture. Pathological changes of the spleen with associated hemoperitoneum have been extensively described, with an emphasis on HSA and other malignant neoplastic lesions. Studies have found the frequency of malignant splenic masses to be as high as 241 of 500 (48%) to 59 of 100 (59%) (Johnson *et al*., 1989).

2.1.2. Etiology and epidemiology

Although etiology of the disease varies depending on the type of lesion, it has been reported that the disorder of the biochemical pathways involved in angiogenesis along with genetic factors plays a role in HSA development (Thamm, 2007).

Splenic pathologies are frequent in the canine species, but the real prevalence is still unknown. All splenic processes do not develop symptomatology and, when they do, it is difficult to determine whether it is caused by the splenic disease or if the spleen involvement is a consequence of the primary disease. There are some studies that determine the incidence of all types of splenic disease, but the results are highly variable.

According to the study conducted by Spangler and Kass, 1997, it is concluded that among 500 spleens examined, 257 of 500 (51,4%) were classified nonneoplastic and 241 (48,2%) were neoplastic; 2 (0,4%) were unclassified.

Lee *et al.,* 2018; performed a pre-surgical evaluation of splenic tumors in dogs, considering clinical and imaging characteristics. The final study population was 44 dogs, which underwent total splenectomy between 2012 and 2017. There were 12 dogs with malignant splenic tumors and 32 with benign splenic tumors.

In 55% of all cases the splenomegaly had a non-neoplastic substrate, in 45% being represented by neoplastic processes. Regarding neoplastic processes, 90.8% were malignant and 9.2% were benign. This information has been extracted from Adina *et al.,* 2021 publication, which studied the spleens of 194 dogs.

The work performed by Cleveland and Casale, 2016, sought to determine the frequency of malignancy and survival rate of dogs undergoing splenectomy. In the end, 105 patients were obtained of which 63 were females, 42 males. Of the 31 dogs with malignant neoplasia, 18 (58%) had HSA, 3 (10%) had histiocytic sarcoma, 3 (10%) had lymphoma, 2 (6%) had a malignant fibrohistiocytic nodule (grade 3) and 2 (6%) had osteosarcoma. One (3%) dog each had leiomyosarcoma, liposarcoma and metastatic adenocarcinoma. Of the 74 dogs with benign splenic nodules or masses,

37 (50%) had a primary diagnosis of nodular lymphoid hyperplasia, 16 (22%) had a hematoma, 11 (15%) had focal intraparenchymal hemorrhage and necrosis, 3 (4%) had extramedullary hematopoiesis, 2 (3%) each had abscess and myelolipoma and 1 (1%) each had hemangioma, splenitis and a fibrohistiocytic nodule (grade 2). Five of the dogs with benign lesions (3 with nodular lymphoid hyperplasia and 2 with hematoma) were incidentally found to also have an indolent form of a marginal zone lymphoma, for which splenectomy was curative (Cleveland and Casale, 2016).

O'Byrne and Hosgood, 2019, conducted a study comparing the prevalence of malignant and benign diseases of the spleen and the type of disease in dogs classified by breed size, taking medical records from 234 dogs over a nine-year period, which underwent splenectomy for the presence of splenic masses due to the presence of splenic masses. Within this study they evaluated the number of malignant versus benign splenic pathologies. As a result, 129 dogs (55.13%) had malignant splenic disease and 105 (44.87%) had benign splenic pathologies. Of the 129 dogs with splenic neoplastic pathologies, HSA was the main neoplastic pathology, manifesting in a total of 87 canines. The main non-neoplastic pathology was splenic hematoma, which occurred in 89 of the 105 dogs diagnosed.

The study conducted by Panissidi and DeSandre-Robinson, 2021, in the Department of Surgery, Florida aimed to record splenic alterations in dogs that underwent splenectomies; as a result, a total sample of 45 cases was obtained, of which 25 dogs (55.5%) were males and 20 (44.5%) were females. There were 21 dogs (46.6%) with malignant splenic tumors and 24 (53.3%) with benign splenic tumors.

Following table (Table 1.) shows a comparison of all the results collected in the previous literature reviews.

			William *et al*., 1997	Mokhyeon *et al*., 2018	Adina et al., 2021	Cleveland and Casale, 2016	Kadie *et al.*, 2019
	Total patients →		500 but 2 were excluded	57 but 13 were excluded	194	213 but 108 were excluded	234
NEOPLASTIC	Benign	Leiomyoma	1 (<1%)				
		Lipoma	9 (2%)	1 (2,3%)			
		Hemangioma	17 (3%)	4 (9,1%)	7 (8,1%)		
		Myelolipoma			1 (1,2%)	2 (3%)	
		Extramedullary hematopoiesis				3 (4%)	89 (86%)
		Focal intraparenchymal hemorrhage				11 (15%)	
		Necrosis					11 (10%)
		Abscess					2 (2%)
		Myelolipomatosis					2 (2%)
		Fibrosis					1 (1%)
	Malignant	Hemangiosarcoma	122 (24%)	6 (13,6%)	44 (50.6%)	18 (58%)	87 (67%)
		Lymphosarcoma	20 (4%)				1 (1%)

		Undifferentiated sarcoma	17 (3%)				18 (14%)
		Fibrosarcoma	9 (2%)		6 (6,9%)		
		Leiomyosarcoma	9 (2%)				1 (1%)
		Mesenchymoma	9 (2%)				
		Myxosarcoma	8 (2%)				
		Histiocytic sarcoma	5 (1%)	1 (2,3%)	12 (13,8%)	3 (10%)	11 (8%)
		Osteosarcoma	3 (<1%)			2 (6%)	
		Plasma cell myeloma	1 (<1%)				
		Myeloproliferative disease	3 (<1%)				
		Liposarcoma	1 (<1%)				
		Malignant histiocytosis	6 (1%)		4 (4,6%)		
		Metastatic carcinoma	1 (<1%)				
		Metastatic neoplasia		1 (2,3%)			
		Lymphoma		4 (9,1%)	8 (9,2%)	3 (10%)	9 (7%)
		Splenic mast cell tumor			2 (2,3%)		

		Splenic metastasis of adenocarcinoma			2 (2,3%)		
		Splenic metastasis of mesothelioma			1 (1,2%)		
		Plasmacytoma					1 (1%)
		Metastatic phaeochromocytoma					1 (1%)
		Malignant fibrohistiocytic nodule				2 (6%)	
		Leiomyosarcoma, liposarcoma and metastatic adenocarcinoma				1 (3%)	
NONNEOPLASTIC	Nodular splenomegaly	Nodular hyperplasia/ Hematoma	105 (21%)				
		Hematoma	59 (12%)	4 (9,1%)	43 (40,2%)	16 (22%)	
		Nodular hyperplasia	42 (8%)	18 (41%)			
		Splenitis	3 (1%)	1 (2,3%)	2 (1,9%)		
	Uniform splenomegaly	Congestion/torsion	25 (5%)	4 (9,1%)	28 (26,2%) / 2 (1,9%)		

		Arterial thrombosis/ infarction	15 (3%)				
		Lymphoid atrophy	2 (<1%)				
		Plasmacytosis	2 (<1%)				
		Myeloid metaplasia	2 (<1%)				
		Lymphoid hyperplasia	2 (<1%)			37 (50%)	
		Reactive hyperplasia			26 (24,3%)		
		Non-specific changes			5 (4,7%)		
		Accessory spleen			1 (0,9%)		
A dog was diagnosed with three masses, each with a different diagnosis.		Hemangioma, splenitis and fibrohistiocytic nodule				1 (1%)	

Table 1. Classification of neoplastic and non-neoplastic splenic lesions

2.1.3. Clinical signs

The symptomatology with splenic masses is very variable. It is common to diagnose small or medium-sized nodules/masses incidentally after routine ultrasound, since splenic disease is usually asymptomatic and not palpable (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

The main reasons for consultation in large masses are usually due to abdominal distension or pressure signs, or even displacement and pressure of thoracic organs. Large masses are palpable in the middle abdomen. Other patients present in consultation with an acute picture of collapse due to rupture, which leads to hemorrhage, of the lesion (Martínez De Merlo, Casado Díaz and Nieto Oberhuber, 2009). In cases of spleen rupture and presence of hemoperitoneum, tachycardia, increased capillary refill time, pale mucous membranes, abdominal distention and pain and jaundice are evident. When there is cardiac involvement, there may be diminished heart sounds, hemopericardium, jugular pulse, ventricular tachyarrhythmias, ascites, dyspnea and exercise intolerance (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

Dogs with malignant tumors may present non-specific symptoms such as depression, anorexia, weight loss or symptoms secondary to the presence of metastases (usually pulmonary or hepatic).

In very severe cases, the patient may go into hypovolemic shock, which includes depression, hypotension, pallor of mucous membranes and increased heart and respiratory rate (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

2.1.4. Diagnosis

Among the different methods of diagnostic imaging are techniques such as magnetic resonance imaging (MRI), computed axial tomography (CAT), ultrasound and radiography, which make it possible to determine the extent, size, location and distribution of the disease.

The complete diagnostic plan in a patient with a splenic mass should include hematology and serum biochemistry, thoracoabdominal radiographs and ultrasound,

abdominocentesis (in cases of ascitic effusion) and coagulation test. All this diagnostic plan can orient the nature of the mass, but it will always be necessary for a definitive diagnosis to perform citology and/or histopathology (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

The blood count and biochemistry of a dog with a splenic mass vary greatly depending on the nature of the lesion, due to the strong influence of the spleen on the analytical parameters, especially on the blood count (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

Anemia is usually the most frequent alteration. As the spleen is an organ strongly related to hematopoiesis and red blood cell metabolism (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

It is not possible to know exactly the origin of the mass only by diagnostic imaging alone, but its use can help to establish a differential diagnosis considering the location and displacement of other adjacent abdominal structures. Their definitive diagnosis is made by means of a histopathological study (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

In veterinary medicine, abdominal **ultrasonography** is frequently used in the preoperative evaluation of animals suspected of splenic disease. Splenic masses are often identified by abdominal palpation and/or abdominal ultrasonography/radiography (Tillson, 2003).

Ultrasonography is a very helpful technique for cytologic and histopathologic sampling. It is important to note that the ultrasound appearance of the mass does not allow a definitive diagnosis to be made, since almost all differential diagnoses of splenic masses can produce similar ultrasound findings. Hematomas, hemangiomas and HSA are usually characterized by the presence of ill-defined lesions with anechogenic or hypoechogenic cavities. In these cases, it is necessary to correlate ultrasound findings with clinical history and laboratory findings to establish a presumptive diagnosis. The rest of the splenic nodular lesions (benign or malignant) usually present a solid and

heterogeneous pattern, but it is frequent to observe also hypoechogenic areas (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

The accuracy of imaging diagnosis has been greatly improved with the development of computed tomography (CT), which is, currently, widely used in veterinary medicine. However, few studies describing the CT appearance of splenic masses in veterinary medicine have been reported (Fife *et al.*, 2004).

In the **cytologic study**, the most reliable results are obtained by taking the samples guided by ultrasound. The performance of cytology of splenic masses is controversial, some authors consider that complications are minimal. Thus, they describe that it is very rare for fine needle puncture to cause significant bleeding. Likewise, they consider that the risk of rupture of vascular masses or dissemination of neoplastic or infectious processes is not important either, due to the minimally invasive characteristics of the technique (Martínez de Merlo, Casado Díaz and Nieto Oberhuber, 2009).

Therefore, ultrasound-guided fine needle aspiration and biopsy are used for cytologic or histologic evaluation of splenic tissue samples. This provides information that may eliminate the need for surgical intervention such as benign character or the presence of systemic disease (Ballegeer *et al.,* 2007). Compared to the biopsy technique, fine needle aspiration has a lower risk due to the needle's characteristic of not causing rupture or hemorrhage and its characteristics such as not requiring sedation or anesthesia of the animal (Stockhaus and Teske, 2001).

In this case report, the diagnostic method used in our cases was abdominal ultrasound to observe the presence or absence of splenic mass.

2.1.5. Treatment

As many authors mention, the treatment of choice for spleen pathologies is usually splenectomy, accompanied by antibiotic therapy and chemotherapy depending on the type of disease that is present, therefore, the lack of knowledge on the part of inexperienced veterinary personnel causes both diagnosis and treatment to be performed incorrectly, thus compromising the patient's life (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

The best choice of treatment is partial or total splenectomy. Splenectomy is a routine surgical procedure that is undertaken in dogs most frequently because of abdominal discomfort and hemorrhage in the presence of splenomegaly. This surgical procedure is performed when the spleen presents neoplasms (HSA, lymphosarcoma), congestion (hematoma, torsion, gastric volvulus dilatation, right congestive heart failure), immune-mediated disease (immune-mediated thrombocytopenia and immune-mediated hemolytic anemia), infections (fungal, bacterial and rickettsial) or the individual is going to be a frequent donor. The surgical approach to the spleen is simplified by its peripheral location in the abdomen, loose mesenteric attachment and relatively long vascular pedicle. From the perspective of the veterinary pathologist, the prevalence of splenic disease in dogs, as indicated by splenomegaly and subsequent splenectomy, is relatively high (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

Only splenectomy as a treatment for HSA provides a very limited survival time; it is advisable to perform it followed by chemotherapy because of its high metastatic capacity, which increases the patient's lifetime. Occasionally it is necessary to perform blood transfusions to correct abnormalities in the blood
to correct hematologic or coagulation abnormalities (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

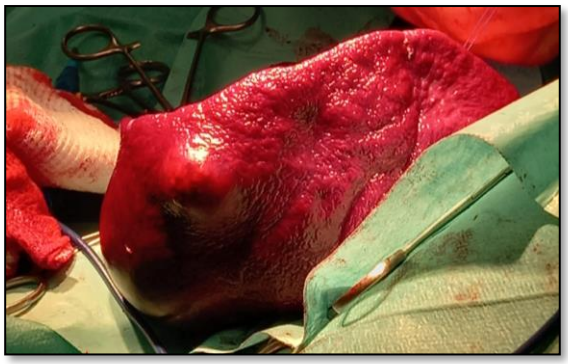

Photo 1. Splenic mass (nodule)

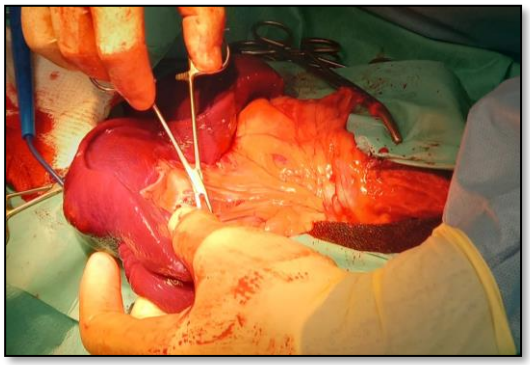

Photo 2. Ligation and section of splenic vessels.

2.1.6. Prognosis

Long-term prognosis of splenic tumors varies with the histopathologic results and, usually, such results are unknown prior to surgery (Ivančić, Long and Seiler, 2009). Dogs with malignant splenic tumors generally have a grave prognosis. After splenectomy, the median survival time of dogs with non-neoplastic splenomegaly was reported to be greater than 36 weeks (Johnson *et al.*, 1989).

The object of this study was to document the diagnosis of splenic disease in dogs undergoing splenectomy for a splenic mass and to compare the prevalence of malignant versus benign splenic disease in dogs.

2.2. Histologic classification of splenic masses.

Abdominal masses can occur due to pathological causes (neoplasms, hyperplasia, hematomas, abscesses, among others) or physiological such as iatrogenic.

2.2.1. Splenic lesions

2.2.1.1. Splenomegaly.

Splenomegaly is defined as an increase in the normal size of the spleen, which can be caused by several which can be presented factors such as, neoplasia, leukemias, portal hypertension, toxemias, hematomas, abscesses, torsion, anesthesia and infections, therefore, it is not possible to establish a specific diagnosis by means of ultrasound or radiography and complementary tests are required (Corbin *et al*., 2017).

Depending on the causes that lead to the presentation of splenomegaly, it can be classified in two ways, generalized or symmetrical and focal or asymmetrical.

Generalized or symmetrical splenomegaly is caused by congestion or infiltration of the spleen, sometimes due to the use of tranquilizers or anesthetics,
which causes splenomegaly due to an increase in blood volume within this organ. Splenic torsion, splenic vein thrombosis, portal vein thrombosis, portal hypertension and hemolytic disorders are other described causes that also produce generalized splenomegaly (Nyland and Mattoon, 2014).

Focal, asymmetric splenomegaly is associated with trauma, hematomas, abscesses, nodular hyperplasia and neoplasms, as it causes loss of parenchymal

continuity, due to the presence of one or more nodule growths or masses in the spleen, may be malignant or benign and it is not possible to distinguish between the two by ultrasound (Hernández Pérez and Palma Díaz, 2017).

2.2.1.2.Splenic torsion

This pathology is one of the main causes of congestive splenomegaly, it is a rare life-threatening condition characterized by rotation of the spleen around the gastrosplenic and nephrosplenic ligaments leading to occlusion of venous drainage and arterial supply (Hughes, Johnson and Genain, 2020).

Primary splenic torsion (spleen only), not very common, is a cause of splenomegaly especially in dogs. Large and giant breeds (Doberman, Labrador, Rottweiler, Dane and Mastiff) are the most affected, but it can occur in breeds such as Poodle, Pincher, Pekingese (Gómez, Feijoo and Wolberg, 2014).

Its clinical presentation can be acute or chronic. Dogs with acute splenic torsion usually present with vomit, abdominal pain, diarrhea, anorexia and lethargy (JM and MH, 2013).

Omental torsion should be included as a differential diagnosis for dogs with acute abdominal pain and gastrointestinal signs. Imaging studies can help in the diagnosis, but exploratory laparotomy is probably the best diagnostic and therapeutic diagnostic and therapeutic intervention in these cases (García-Pertierra *et al.*, 2018).

2.2.1.3.Splenic infarct

Splenic infarction is an uncommon pathology, its most frequent causes include thromboembolic state, splenomegaly and cardiac disease (Kim, 2020).

Its appearance, as in hematomas, is variable and depends on the time since the infarction occurred. Initially hypoechogenic lesions are observed, which ultrasonographical cannot be distinguished from other focal splenic lesions. Once the infarct is reduced and heals, it looks hyperechogenic. Differential diagnoses include splenic hematoma, abscess and neoplasms (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

2.2.1.4. Abscess

They produce focal or multifocal lesions, whose presentation is less than 1%. When present they correspond to an emergency, as they can rupture and cause peritonitis (Finkelstein Hetzel, 2012). This pathology can be associated with other conditions such as torsion, which can compromise spleen drainage, resulting in congestion, hypoxia and necrosis of the splenic parenchyma with possible abscess formation (Johnston and Tobias, 2018).

Its appearance varies, it may present as a hypoechogenic lesion with poorly demarcated hyperechoic borders; it may present as more complex lesions with cystic and solid cystic and solid components, presenting as hyperechoic areas due to hemorrhage, necrosis or gas formation (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

The use of tools such as ultrasound or radiography helps us to identify the presence or not of gas bubbles or areas of calcification, although their definitive diagnosis is confirmed by guided aspiration, cytology and culture. Total splenectomy remains the most effective therapy. Although there are many predisposing factors for splenic abscess, the true etiology remains obscure (Abdellatif *et al.,* 2014).

2.2.2. Splenic neoplasms

2.2.2.1. Malignant splenic neoplasms:

2.2.2.1.1. Hemangiosarcoma

This pathology represents between 0.3 and 2% of all canine tumors. It typically presents as a soft, nodular mass, dark red in color due to hemorrhagic and necrotic areas (Ghiis Chang, Rosa Perales and Luis Tabacchi, 2017).

HSA most frequently affects patients with a range between 9 to 13 years of age, however there are studies where it developed from 5 months to a few years of life (Ghiis Chang, Rosa Perales and Luis Tabacchi, 2017). A perioperative mortality rate of 7.6% and 16% has been reported in dogs with a hemoperitoneum secondary to splenic HSA (Johnson *et al.,* 2018). Median survival times with surgery alone for dogs diagnosed with splenic HSA are 19 to 86 days (Cleveland and Casale, 2016). German

Shepherds, Labrador Retrievers and Golden Retrievers have been overrepresented in the literature for the development of splenic HSA (Brown *et al*., 1985).

In most HSA a clinical sign observed is anemia. They have the facility of rupture, giving rise to a picture of internal hemorrhage (Pacheco Dos Santos, 2018).

Although HSA is the most frequent neoplasm located in the spleen, it should not be taken as the only differential diagnosis.

2.2.2.1.2. Splenic lymphoma

It is considered a disease of idiopathic origin. There are genetic factors that predispose to the presentation of lymphoma; among the breeds that genetically have more tendency to suffer from this pathology are the Boxer, St. Bernard, Basset Hound, English Bulldog, Chow Chow, Shepherd, Cocker Spaniel, etc. (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

It may be present in animals from 1 to 8 years of age. Clinically it is common to observe anorexia, abdominal distension, polydipsia, vomiting and lethargy (Finkelstein Hetzel, 2012).

Metastasis is frequent and the clinical picture is variable depending on the location, malignancy and metastatic foci. To reach a definitive diagnosis, a biopsy is necessary. Its treatment requires surgical intervention and chemotherapy (Ghiis Chang, Rosa Perales and Luis Tabacchi, 2017).

2.2.2.1.3. Splenic histiosarcoma

Malignant neoplasm characterized by proliferation of histiocytic cells. It is considered a mesenchymal soft tissue neoplasm. This neoplasm can also appear as primary lesions in the liver, tongue and stomach wall. It is considered a neoplasm of unknown etiology. There is no race or sex predisposition (Moncayo and Aranda, 2018), although other authors mention a greater predisposition to suffer the neoplasm in large breeds (Wellman, 2007).

Clinical signs include weight loss, depression, anorexia, recurrent fever, lethargy, lymphadenomegaly, inappetence, dyspnea, neurological signs and splenomegaly (Moncayo and Aranda, 2018).

Histopathology is usually sufficient for diagnosis, although sometimes the definitive diagnosis requires immunohistochemical techniques or electron microscopy (Moncayo and Aranda, 2018).

2.2.2.1.4. Splenic stromal tumors

According to Valli, Bienzle and Meuten, 2016, they are primary splenic mesenchymal neoplasms and are suspected to originate from multipotent stem cells. Have a high metastatic rate and grave prognosis with a median survival time of 2.5 months after splenectomy (Weinstein *et al,* 1989).

2.2.2.1.5. Splenic histiocytic sarcoma

It is an aggressive dendritic cell neoplasm with a severe prognosis. It is considered a rare neoplasm that represents less than 1% of canine cancers (Vail *et al,* 2001). The incidence of histiocytic sarcoma in adults in unclear (Kommalapati *et al.,* 2018).

In addition, other types such as metastatic neoplasia and carcinoma, malignant histiocytosis, liposarcoma, myeloproliferative disease, plasma cell myeloma, osteosarcoma, myxosarcoma, mesenchymoma, leiomyosarcoma and undifferentiated sarcoma have been sporadically described.

2.2.2.2. Benign splenic neoplasms:

2.2.2.2.1. Splenic nodular hyperplasia

Is one of the noncancerous lesions commonly found in the spleen, with a prevalence between 10 and 20% of total splenic lesions. Because they do not present evident clinical signs, it is common to find this pathology during surgical interventions or necropsies, mainly in geriatric patients (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

The ultrasound result is very variable, there may appear isoechogenic lesions, hypoechogenic, hyperechogenic or simply no alterations. The diagnosis is made by

histopathological analysis and treatment is surgical removal (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

2.2.2.2.2. Splenic hematoma

Splenic hematoma may occur because of abdominal trauma, coagulation disorders or may be associated with neoplasms. coagulation disorders or may be associated with neoplasms such as HSA or lymphosarcomas (Bretón Jaimes, Arcila Quiceno and Albarracín Navas, 2021).

Affected patients generally do not suffer splenic rupture, so their prognosis is good, but it worsens if there is concomitant hemoperitoneum. They usually decrease in size progressively and disappear with time (Finkelstein Hetzel, 2012). The rupture of a hematoma means urgent attention, since the patient is cured by a significant loss of blood in the abdomen (hemoperitoneum) (Fernandez, Lang and Maritato, 2019).

2.2.2.2.3. Splenic hemangioma

The most common benign primary neoplasm of the spleen is a hemangioma. These tumors form by proliferation of vascular channels. Isolated hemangiomas are seen most commonly, although occasionally multiple may be present. Most hemangiomas are asymptomatic and incidentally discovered. Splenic hemangiomas are benign and do not need follow-up to monitor stability (Abbott *et al.,* 2004).

In addition, other types such as subcapsular hematoma, extramedullary plasmacytoma, benign nodular lymphoid hyperplasia, myelolipoma and angioma have been sporadically described.

3. MATERIALS AND METHODS

For the preparation of this work, a bibliographic review of several studies on cases of dogs with splenic masses has been carried out. For this purpose, the following web pages have been of great use: PubMed and Faro ULPGC. In addition, different clinical cases were observed in the GICOREC-IUSA center. The aim of this study is to compare the clinical cases described with the bibliographic reviews.

3.1. Clinical study

Twenty dogs were included in this study, with an average age of 11,6 years (range 7-14), with twelve males and eight females and different breeds (German Shepherd, Rottweiler, Golden Retriever, Labrador Retriever, Schnauzer, Bobtail, English Cocker Spaniel, American Stafford Terrier, French Bulldog and mixed). All the dogs were screened and diagnosed with splenic mass.

Twenty splenectomies were performed, the information obtained from each splenic mass was analyzed.

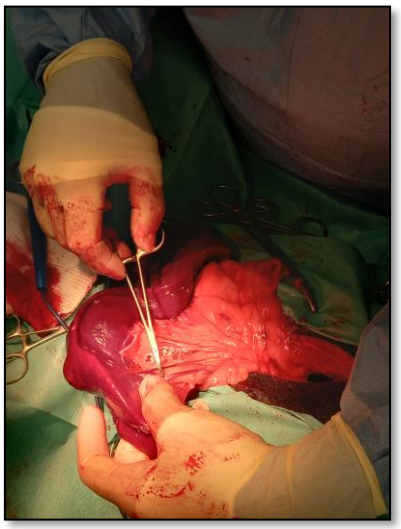

Photo 3. Case number 5

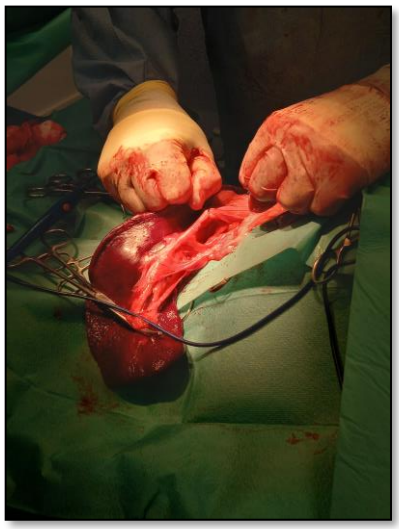

Photo 4. Case number 4

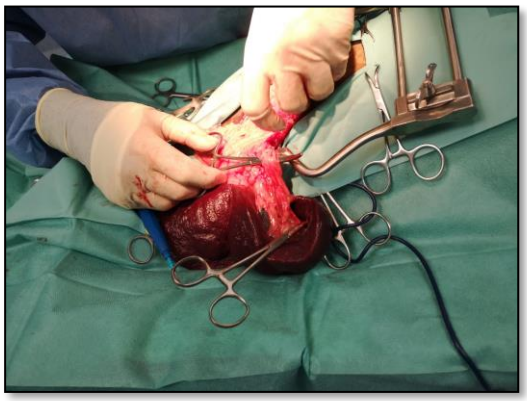

Photo 5. Case number 1

3.2. Results

The data presented in *Table 2* show the results of the macroscopic and microscopic (histopathological) examination of the spleens of twenty patients sent to the anatomopathological diagnostic service of the University of Las Palmas de Gran Canaria (ULPGC) during a period of nineteen years (2003-2022).

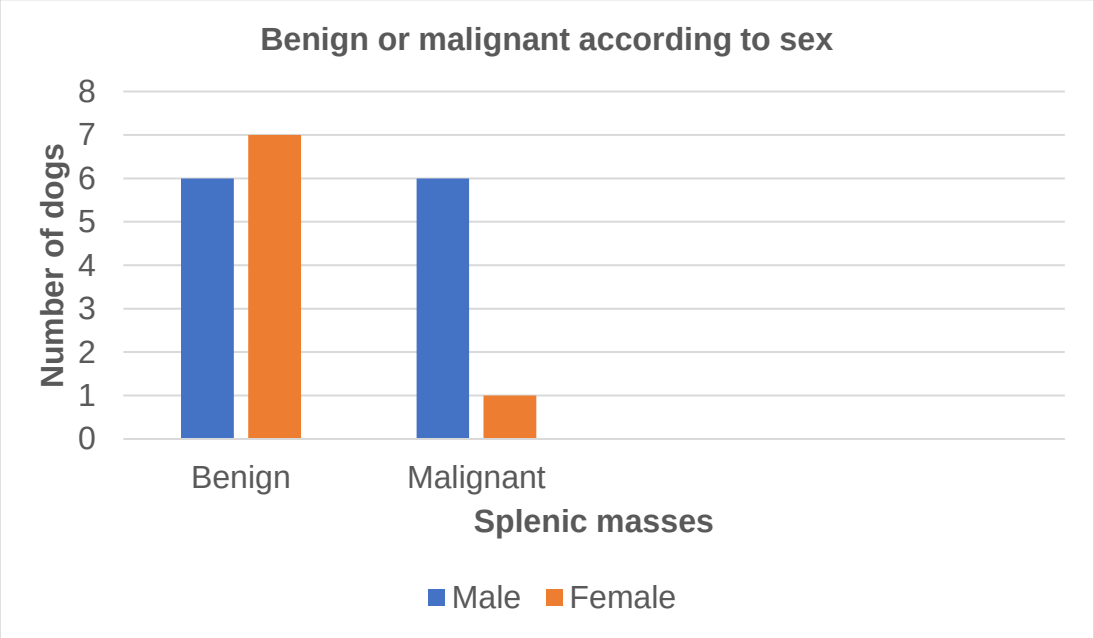

Table 2. Splenic masses benign or malignant according to sex.

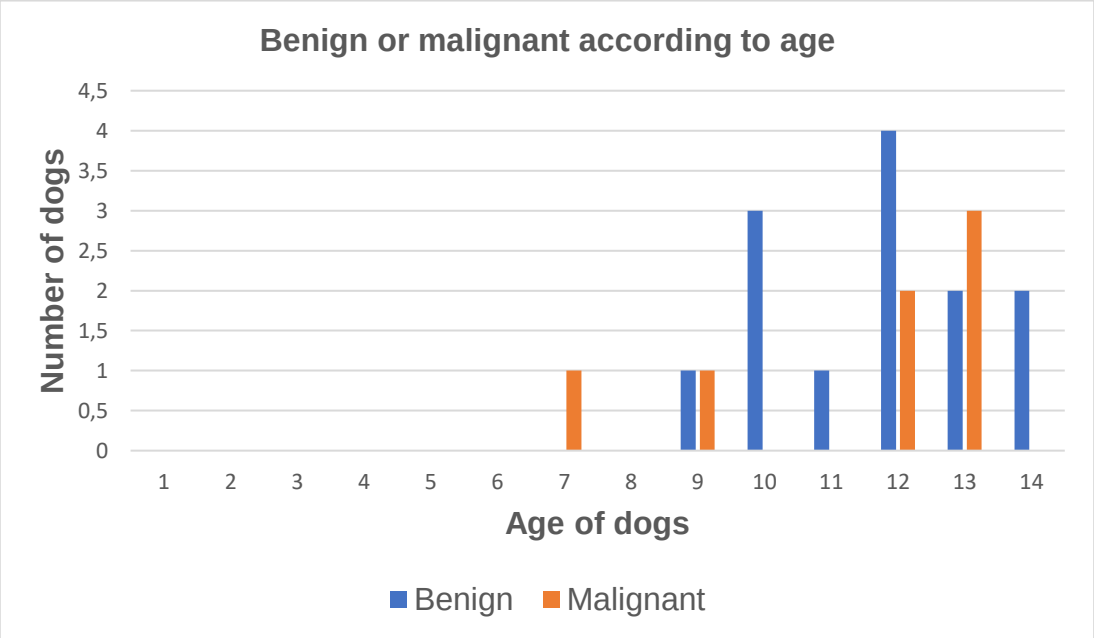

Table 3. Splenic masses benign or malignant according to age.

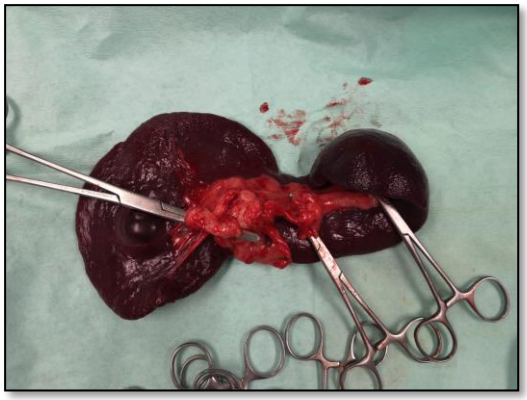

Photo 6. Case number 1. Splenic subcapsular hematoma

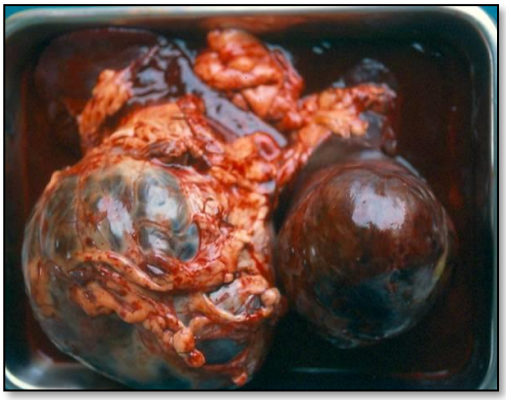

Photo 7. Case number 18. HSA

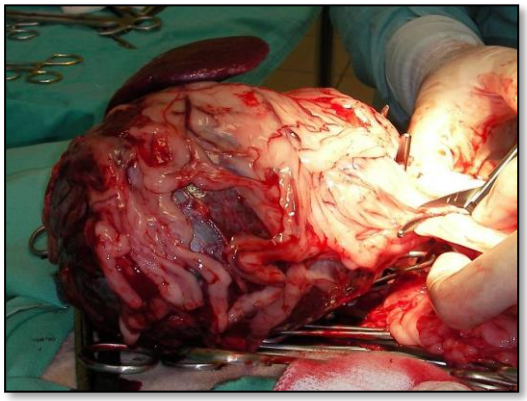

Photo 8. Case number 13. Splenic angioma

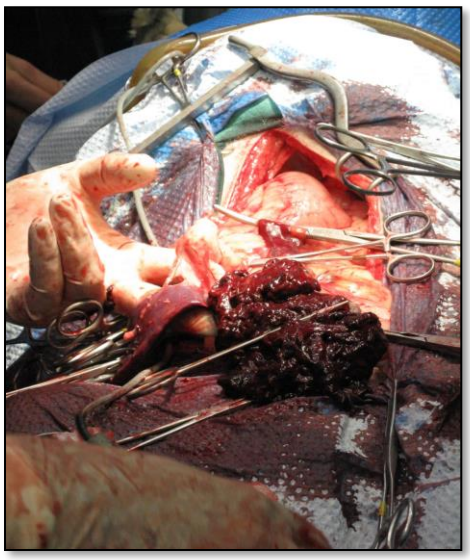

Photo 9. Case number 12. Mielolipoma

According to histological classification, fourteen of twenty masses (65%) were anatomically classified as non-neoplastic and six of twenty (35%) were diagnosed as neoplastic masses.

Case number	Age (years)	Sex (M/F)	Specimen Histopathology
1	12	M	Splenic subcapsular hematoma (B)
2	14	M	Splenic hemangioma (B)
3	13	M	Splenic sarcoma (M)
4	12	F	Splenic hematoma (B)
5	12	M	Splenic nodular hyperplasia (B)
6	9	M	Splenic benign nodular lymphoid hyperplasia (B)
7	13	M	Splenic fibrosarcoma (M)
8	10	M	Splenic extramedullary plasmacytoma (B)
9	12	M	Hemangiosarcoma (M)
10	7	M	Hemangiosarcoma (M)
11	12	F	Splenic nodular hyperplasia (B)
12	11	F	Splenic mielolipoma (B)
13	10	M	Benign splenic angioma (B)
14	13	M	Splenic fibrosarcoma (M)
15	14	F	Splenic hematoma (B)
16	13	F	Splenic hematoma (B)
17	10	F	Splenic hemangioma (B)
18	10	F	Hemangiosarcoma (M)
19	12	M	Splenic histiosarcoma (M)
20	13	F	Splenic mielolipoma (B)

Table 4. Clinical cases data.

			Clinic cases
		Total patients →	20
NEOPLASTIC	Benign (65%)	Splenic subcapsular hematoma	1 (7.7%)
		Hemangioma	2 (15.4%)
		Hematoma	3 (23.1%)
		Splenic nodular hyperplasia	2 (15.4%)
		Splenic extramedullary plasmacytoma	1 (7.7%)
		Splenic benign nodular lymphoid hyperplasia	1 (7.7%)
		Splenic mielolipoma	2 (15.4%)
		Benign splenic angioma	1 (7.7%)
	Malignant (35%)	Hemangiosarcoma	3 (42.85%)
		Fibrosarcoma	2 (28.57%)
		Splenic histiosarcoma	1 (14.28%)
		Sarcoma	1 (14.28%)

Table 5. Percentage of splenic masses.

65% of our patients were affected by splenic masses and treated by splenectomy. They presented benign lesions in the histopathological study. The remaining 35% were also affected and treated, presenting malignant lesions in the histopathological study. Splenectomy was curative in all of them.

The usual belief in everyday clinic practice when observing a splenic mass is to figure that it is an HSA. This fact is very important, as it frequently influences the owner's decision that the veterinarian reports the poor prognosis of most splenic masses and results in euthanasia of the patient without any histologic information. We must emphasize that it is very important to adequately report the possibilities so that the owner can decide. Majority of the literature, except for Splanger and Kass, 1997; Lee

et al., 2018; Pîrvu *et al.,* 2021; Cleveland and Casale, 2016, refers that almost all are HSA and that this view prevails in veterinary decision making.

4. DISCUSSION

The main argument of the discussion is that we cannot rely on the majority of studies that affirm the “double two-thirds” rule for canine splenic masse lesions. Is a commonly quoted descriptor for canine splenic mass lesions, stating approximately two-thirds are malignant and approximately two-thirds of the malignancies are HSA (Johnson *et al.,* 1989). however, other studies have shown the proportion of malignant canine splenic mass lesions to be approximately 50% (Spangler and Kass, 1997), and others again show that in the context of a haemoabdomen, 63-70% of canine splenic mass lesions will be HSA (Hammond and Pesillo-Crosby, 2008). Owing to the low predictive value that prevalence in the order of 50-70% will create, many authors have attempted to refine the predicted diagnosis of a canine splenic mass lesions based on readily available clinical data.

Considering the other literature reviews that report otherwise, and our cases with data similar to those reviews, we believe that it would be positive for pets, if our guild would stop following the dogma of the 2/3 rule. In order to achieve a wider range of action, we should carry out more exhaustive and individual studies, and with a good exchange of information with the owner to make the best decision together.

More recent publications, confirm that non-neoplastic cases outnumber neoplastic cases. In the article by Lee *et al.,* 2018, the results were 61.4% for non-neoplastic and 38,6% for neoplastic. Pîrvu *et al.,* 2021, the results were 55.7% for non-neoplastic and 44.8% for neoplastic, and finally, the article by Cleveland and Casale, 2016, 51.4% were non-neoplastic and 42.8% were neoplastic. This coincides with the results collected from the twenty GICOREC-IUSA patients, resulting in 70% for non-neoplastic and 30% for neoplastic patients. Our results coincide with the four previously mentioned articles reporting the percentage of benign and malignant splenic masses in dogs. There may be some difference in percentage as each article was performed with a different total number of patients.

The article that breaks with this norm is that of O’Byrne and Hosgood, 2019, whose results were 44.87% non-neoplastic versus 55.13% neoplastic patients. This result does not agree with the other studies reporting the incidence of benign and malignant splenic masses in dogs. The difference may be due to case selection bias, as each of

the investigations was performed with a different number of patients responding to different qualities, for example, some considered age, breed, sex... and others did not.

Of note, the HSA results for Lee *et al.,* 2018; Cleveland and Casale, 2016, were respectively 14% and 17.1% for total patients with splenic masses. This coincides with our result, being for HSA 15% of the total patients. O'Byrne and Hosgood, 2019 article shows that the percentage for HSA of the total number of patients was 37.2% and therefore, it does not coincide with the rest of the articles or ours.

We can also highlight the fibrosarcoma that appears only in two of the five bibliographic reviews. For Splanger and Kass, 1997, it was 1.8% and for Pîrvu *et al.,* 2021, 3.1% of the total number of patients. If we compare the results with our cases, they do not coincide since we obtained 10% of fibrosarcoma of the total of the twenty cases. But obviously, the small number of patients in our study must be taken in account.

Comparing the benign masses in our cases with the literature reviews, hematoma and splenic nodular hyperplasia are noteworthy. Splenic hematoma appears in only two of the five articles and nodular hyperplasia in four. In previous studies, the percentage of splenic nodular hyperplasia is 8.4% and 41% for Splanger and Kass, 1997 and Lee *et al.,* 2018, respectively. In the present study, the proportion of dogs with nodular hyperplasia was 10% of the total patients. Regarding hematoma, we should point out that the results of our twenty cases (15%) coincide with the articles by Splanger and Kass, 1997, (11.9%) and Cleveland and Casale, 2016, (15.2%).

In summary, we must emphasize that our data and those of these literature reviews must be considered when making the decision to operate or not.

5. CONCLUSIONS

1. According to our literature review, the percentage of benign lesions is higher than traditionally is considered. Our results were 70% for benign masses and 30% for malignant masses.

2. Clinical presentation is generally not associated to histopathologic nature, therefore, if lacking histopathologic diagnosis, no prognostic information can be deducted from clinical presentation. If no histologic or cytologic diagnosis can be obtained in emergency cases with splenic rupture, the presumptive diagnosis of HSA is not evidence based.

3. 70% of our patients affected of splenic masses and treated only by splenectomy presented at histopathologic study benign lesions, and splenectomy was curative in all of them.

4. The traditional assumption that 2/3 of splenic masses are malignant, and 2/3 of them are HSA is not sufficiently supported by recent literature, and the results of our case series study may be closer to the actual distribution.

5. If no histologic or cytologic diagnosis can be obtained in emergency cases with splenic rupture, the presumptive diagnosis of HSA is not evidence based.

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