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Article

# Discrepancies Between Preoperative Assessment and Surgical Reality in Canine Hepatic Masses: A Retrospective Study of 10 Cases with a Predominance of Right-Sided Lesions

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## Abstract

Primary hepatic masses in dogs represent a heterogeneous group of lesions with variable biological behavior and challenging preoperative characterization. The objective of this retrospective study was to describe the clinical presentation, diagnostic findings, surgical management, and outcome of dogs with primary hepatic masses treated surgically. Ten dogs with resectable hepatic lesions and no evidence of extrahepatic metastasis were included. Clinical records, imaging findings, histopathological diagnoses, treatment, and follow-up data were reviewed. Histopathological diagnoses included hepatocellular carcinoma (n=3), nodular hyperplasia (n=2), lobular hyperplasia (n=1), hepatocellular adenoma (n=1), undifferentiated sarcoma (n=1), osteosarcoma (n=1), and one case without definitive histological diagnosis. Tumor size ranged from 3.3 to 18 cm and was not associated with biological behavior. Preoperative cytology showed poor concordance with final histopathological diagnosis in all sampled cases. Abdominal ultrasound identified solitary lesions in all evaluated dogs, although surgery revealed previously undetected multifocal disease in two cases. Most lesions were located in the right hepatic lobes, differing from the predominance of left-sided lesions commonly reported in the literature. All dogs underwent surgical resection. Two perioperative deaths occurred secondary to postoperative renal failure. In the remaining dogs, surgery resulted in complete remission of clinical signs and prolonged survival, including dogs with malignant tumors. Four dogs remained alive and disease-free at the end of the follow-up period (>730 days). These findings highlight the limitations of preoperative diagnostic techniques for predicting the biological behavior and extent of canine hepatic masses. Surgical resection provided substantial

clinical benefit and prolonged survival in most cases, supporting its consideration whenever complete excision is technically feasible.

**Keywords:** cancer; dogs; oncology; hepatic tumors; prognosis

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## 1. Introduction

Primary hepatic tumors are uncommon in dogs, accounting for approximately 0.6% to 1.3% of all canine neoplasms[1–6]. According to their gross morphological presentation, these lesions are traditionally classified into three distinct categories: massive, nodular, or diffuse tumors[5]. Massive tumors are typically characterized by a solitary lesion confined to a single liver lobe, whereas nodular tumors present as multifocal lesions affecting several lobes, and diffuse tumors involve the liver parenchyma extensively[2,4]. This morphological classification is not merely descriptive but clinically fundamental, as tumor distribution strongly influences surgical resectability, metastatic behavior, and the overall long-term prognosis.

Canine primary hepatic tumors comprise a heterogeneous group of lesions with distinct cellular origins and biological behaviors. Tumors arising from hepatocytes are classified as hepatocellular adenomas or hepatocellular carcinomas (HCC), whereas those originating from the biliary epithelium include biliary adenomas and cholangiocarcinomas. Additional primary hepatic neoplasms, though less frequent, include sarcomas of mesenchymal origin and neuroendocrine carcinomas[7]. Among malignant primary liver tumors, HCC is considered the most frequently diagnosed entity in dogs, often presenting as the massive morphological type[7,8].

The biological behavior of hepatic tumors is highly variable and depends on both the histological subtype and the morphological pattern. Massive and well-differentiated lesions are generally associated with lower metastatic rates and more favorable outcomes compared with diffuse or highly aggressive tumors[2,7]. However, reported metastatic rates range widely from 37% to nearly 100%, reflecting the marked heterogeneity of these neoplasms[6]. In addition to the risk of metastatic spread, spontaneous rupture and secondary intra-abdominal hemorrhage represent critical causes of morbidity and mortality in dogs with hepatic neoplasia, particularly in cases of large hepatocellular carcinomas[9].

Surgical resection remains the treatment of choice for resectable primary hepatic masses and has been associated with significantly prolonged survival times compared with non-surgical management[2,10]. Nevertheless, the prognosis is influenced by multiple factors, including tumor morphology, histopathological diagnosis, the completeness of surgical margins, and the presence of metastatic disease[4]. Consequently, accurate preoperative characterization and staging of liver lesions play a major role in clinical decision-making and surgical planning.

Several studies have attempted to identify reliable predictors of malignancy in canine liver masses. Clinical and ultrasonographic features, such as thrombocytosis, a lesion size greater than 4.1 cm, and a heterogeneous echotexture, have been associated with malignant behavior[11]. However, imaging findings alone frequently lack the necessary specificity, and distinguishing benign from malignant lesions before surgery remains a formidable challenge for the clinician[12,13]. While ultrasonography remains the primary screening tool for hepatic masses in veterinary medicine, its limitations in accurately predicting malignancy and defining exact anatomical extent are well-documented[11,12].

In this context, the implementation of multi-phase contrast-enhanced computed tomography (CT) has emerged as a superior modality for characterizing complex vascular patterns and detecting small satellite nodules that may be overlooked during routine ultrasound examinations[13,17]. As noted by Fukushima et al. (2012), the use of arterial, portal, and delayed phases allows for a more precise characterization of tumor vascularity, which is essential for differentiating between hepatocellular carcinoma, typically showing hyperattenuation in the arterial phase, and other malignant lesions like cholangiocarcinoma or metastatic disease[17]. The discrepancy between

preoperative imaging and the actual surgical reality is a critical factor in surgical planning; the involvement of major vascular structures, such as the caudal vena cava or the portal vein, or the unexpected presence of multifocal disease, can significantly alter the surgical approach and the overall prognosis[3]. Understanding these discrepancies is essential for improving preoperative staging, optimizing surgical success, and ensuring transparent client communication regarding potential intraoperative complications and the likelihood of a curative resection.

Furthermore, the role of preoperative sampling, such as fine-needle aspiration (FNA) or needle-core biopsy, in the management of canine hepatic masses remains a subject of ongoing clinical debate[14–16]. While some authors advocate for ultrasound-guided biopsies to guide treatment decisions, others emphasize the inherent risks of hemorrhage and the high probability of obtaining non-diagnostic samples due to the marked intratumoral heterogeneity typical of large, voluminous masses[3,15]. In many clinical settings, the decision to proceed directly to surgical resection is based on the presence of a resectable mass and the known diagnostic limitations of minimally invasive techniques, as a definitive diagnosis usually requires a comprehensive histopathological examination[3,15].

Despite the increasing use of advanced imaging and cytological techniques, discrepancies between preoperative assessment and final histopathological diagnosis continue to complicate the management of canine hepatic masses. Moreover, information regarding the clinical behavior and surgical outcome of uncommon hepatic lesions, such as primary sarcomas, remains limited in the current literature.

The objective of this retrospective study was to describe the clinical presentation, imaging findings, histopathological diagnoses, surgical treatment, and outcome of ten dogs with primary hepatic masses managed surgically. Particular emphasis is placed on analyzing the diagnostic limitations of preoperative evaluation, the anatomical challenges of right-sided lesions, and the clinical benefits associated with aggressive surgical resection in a real-world clinical environment.

## 2. Materials and Methods

This retrospective study evaluated dogs diagnosed with primary hepatic masses and managed surgically at the Veterinary Oncology Service of GICOREC-IUSA, Universidad de Las Palmas de Gran Canaria (ULPGC, Gran Canaria, Spain), between January 2013 and December 2020. All procedures were performed according to Good Clinical Practice guidelines for animal clinical studies and approved by the Bioethics Committee of ULPGC (OEBA-ULPGC 33/2020R1). Informed owner consent was obtained in all cases.

Dogs were eligible for inclusion if they fulfilled the following criteria: (1) presence of one or more hepatic masses considered surgically resectable based on abdominal ultrasound and/or computed tomography (CT); (2) absence of detectable extrahepatic metastatic disease on thoracic radiographs, abdominal ultrasound, and/or whole-body CT; and (3) availability of clinical follow-up data. Dogs with diffuse non-resectable hepatic involvement or evidence of distant metastasis at diagnosis were excluded.

A total of 10 dogs met the inclusion criteria. Fine-needle aspiration (FNA) cytology was performed at the clinician's discretion and was not required for study inclusion because surgical decision-making was primarily based on imaging findings, clinical presentation, and resectability assessment.

Medical records were reviewed retrospectively. Data collected included signalment, clinical signs at presentation, hematological and biochemical findings, imaging characteristics, surgical findings, affected hepatic lobe, histopathological diagnosis, perioperative complications, adjuvant treatment, disease-free interval (DFI), and overall survival time (ST).

Abdominal ultrasound was used as the primary imaging modality in most cases, while CT was performed in selected patients for surgical planning and assessment of lesion extent. Surgical treatment consisted of liver lobectomy or partial hepatectomy depending on lesion location and intraoperative findings.

Histopathological evaluation was performed on surgically excised specimens in all dogs except one perioperative death in which definitive histological classification could not be obtained. Follow-up information was obtained from medical records and direct communication with owners or referring veterinarians whenever available. Survival time was defined as the interval between surgery and death or last follow-up, whereas disease-free interval was defined as the period between surgery and detection of recurrence or progression of disease.

### 3. Results

#### 3.1. Case Population

Ten dogs with surgically managed hepatic masses were included. The mean age at presentation was 10.4 years (range 7–13 years). Seven dogs were male and three were female, including one spayed female. Most dogs were purebred, representing eight different breeds, while one dog was mixed-breed. Detailed patient information, histopathological diagnosis, disease-free interval (DFI), survival time (ST), and adjuvant treatment are summarized in Table 1.

**Table 1.** Patient data, affected lobe, histopathological type, disease-free period, survival time, and treatment received in 10 dogs with liver tumors.

Pt	Age (y)	Breed	Sex	Affected lobe	Histological type	DFI	ST	Adjuvant therapy
1	7	Shih Tzu	F	LLL	Osteosarcoma	210	399	VAC
2	13	Golden Retriever	M	QL, RLL	Nodular hyperplasia, hepatoma	>730	>730	-
3	8	Chihuahua	M	RML	Hepatocellular carcinoma	>730	>730	-
4	10	Beagle	M	RML	Lobular hyperplasia	365	365	-
5	13	Yorkshire Terrier	F	RLL	Hepatocellular carcinoma	>730	>730	-
6	10	German Shepherd	M	RML	N/A	0	4	-
7	11	Mixed-breed	M	RML	Nodular hyperplasia	>730	>730	-
8	13	Briard	M	RML	Hepatocellular carcinoma	0	17	-
9	9	Bernese Mountain Dog	M	LLL	Undifferentiated sarcoma	0	180	-
10	10	Yorkshire Terrier	F	RML	Hepatocellular adenoma	150	150	-

**Abbreviations:** PT, patient; DFI, disease free period; ST, survival time; LLL, left lateral lobe; RLL, right lateral lobe; QL, quadrate lobe; RML, right medial lobe; RLL, right lateral lobe; VAC, vincristine, doxorubicin, and cyclophosphamide.

#### 3.2. Clinical Presentation

Clinical signs were non-specific and mainly included weight loss (8/10), hyporexia or anorexia (8/10), diarrhea (5/10), vomiting (1/10), and abdominal distension (1/10). Two dogs were diagnosed incidentally during imaging studies performed for unrelated reasons.

#### 3.3. Clinicopathological Findings

Biochemistry and hematology data were available on 8 dogs. Biochemistry abnormalities included increased alanine aminotransferase (ALT) in 6 dogs (mean 306.83 U/L, range 212–397; reference range 10–100) and increased alkaline phosphatase (ALP) in 4 dogs (mean 2369.25 U/L, range 305–4507, reference range 23–212). Hematologic abnormalities included decreased hematocrit in 5 dogs (mean 31.2%, range 28.6–33.6; reference range 37–55), thrombocytosis in 5 dogs (mean 746.8K/ $\mu$ L, range 632–959, reference range 175–500), neutrophilia in 3 dogs (mean 21.61K/ $\mu$ L, range 16.13–24.80; reference range 2–12), monocytosis in 3 dogs (mean 7, 34K  $\mu$ L, range 2.65–16.1, reference range 0.3–2) and eosinopenia in 3 dogs (mean 0.4%, range 0.1–0.7; reference range 2–10).

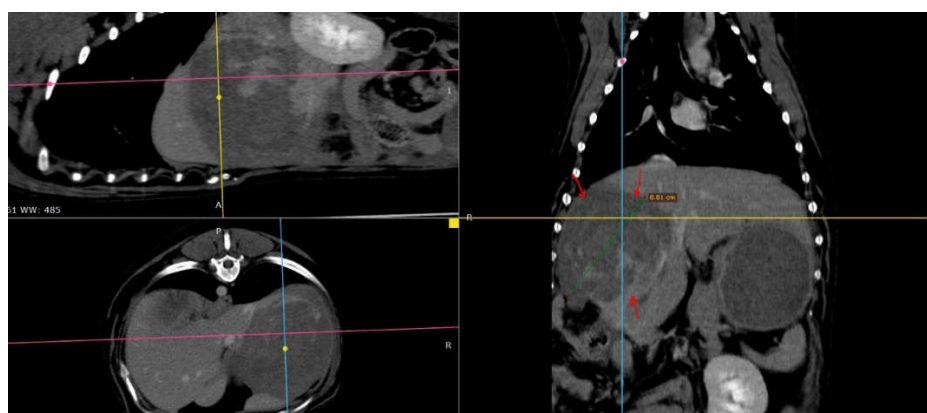
### 3.4. Cytological Evaluation

Preoperative fine-needle aspiration cytology was performed in four dogs. Cytological findings were discordant with the final histopathological diagnosis in three cases, while one sample was considered non-diagnostic because of marked blood contamination.

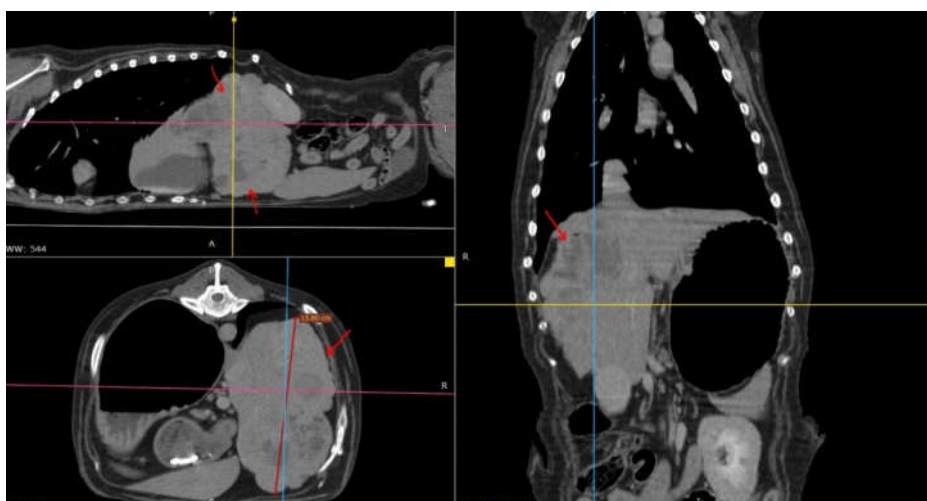
### 3.5. Diagnostic Imaging

Abdominal ultrasound was performed in eight dogs and identified a solitary hepatic mass in all cases. However, surgical exploration revealed additional lesions in two dogs, including one dog with multifocal nodules and another with two large masses affecting different hepatic lobes. Computed tomography (CT) was performed in two dogs and also identified solitary hepatic lesions. Thoracic radiographs showed no evidence of pulmonary metastatic disease in any patient.

Thoracic radiographs were performed in all patients, and none had evidence of metastatic disease.



**Figure 1.** Imaging tests of patient 4 showing the location and dimensions of a benign neoplasm; lobular hyperplasia.



**Figure 2.** Imaging tests of patient 8 showing the location and dimensions of a malignant neoplasm; hepatocellular carcinoma.

### 3.6. Surgical Findings

The mean maximal tumor diameter was 9.33 cm (range 3.3–18 cm) (Table 2). Single lesions were confirmed intraoperatively in eight dogs, whereas multifocal disease was identified in two. Most

lesions involved the right medial lobe (6/10), followed by the left lateral lobe (2/10) and right lateral lobe (1/10). One dog presented lesions affecting both the quadrate and right lateral lobes.

Complete liver lobectomy was performed in all surgically resectable lesions. Hilar resection techniques were used routinely, whereas an endo-stapler was required in one patient because of lesion location and vascular anatomy. In the dog with quadrate lobe involvement, resection additionally included the right medial lobe, gallbladder, and caudate lobe.

**Table 2.** Histological type, tumor size and dog weight.

PT	Histological type	Tumor size (cm)	Dog weight (kg)
1	Osteosarcoma	15	6
2	Nodular hyperplasia, hepatoma	15, 18	30.2
3	Hepatocellular carcinoma	8	5.5
4	Lobular hyperplasia	9	19.5
5	Hepatocellular carcinoma	3.3	6.04
6	N/A	9.49	45.8
7	Nodular hyperplasia	5.5	10
8	Hepatocellular carcinoma	16	39
9	Undifferentiated sarcoma	5	40
10	Hepatocellular adenoma	4.04	3.7

**Abbreviations:** N/A, not available.



**Figure 3.** Macroscopic images of patient 8 with a malignant neoplasm, hepatocellular carcinoma and patient 2 with benign neoplasms, nodular hyperplasia and hepatoma, respectively.

### 3.7. Histological Findings

Histopathological examination revealed three hepatocellular carcinomas, two nodular hyperplasias, one lobular hyperplasia, one hepatocellular adenoma, one undifferentiated sarcoma, and one osteosarcoma. One dog did not have a definitive histopathological diagnosis. The case finally classified as osteosarcoma had initially been diagnosed as undifferentiated sarcoma, but postmortem immunohistochemical evaluation performed for a separate study supported the diagnosis of osteosarcoma.

### 3.8. Treatment and Outcome

All dogs underwent surgical treatment. Adjuvant therapy was administered in one dog diagnosed with hepatic osteosarcoma. This dog received three cycles of doxorubicin (30 mg/m<sup>2</sup>) and vincristine (0.5 mg/m<sup>2</sup>), followed by masitinib (9 mg/kg once daily) and metronomic cyclophosphamide (15 mg/m<sup>2</sup>) for two months. Recurrence involving the liver and major omentum, consistent with abdominal sarcomatosis, was detected 210 days after surgery. Overall survival time in this dog was 399 days.

Two perioperative deaths occurred secondary to postoperative acute renal failure. Necropsy was performed in one case and revealed moderate-to-severe chronic interstitial nephritis, suggesting that pre-existing renal disease may have been exacerbated by perioperative hypotension.

Overall survival ranged from 4 to >730 days. Four dogs remained alive and disease-free at the end of the study period (>730 days), including two dogs with nodular hyperplasia and two with hepatocellular carcinoma. Dog 4, diagnosed with lobular hyperplasia, survived 365 days and remained disease-free until death from unrelated causes. Dog 10, diagnosed with hepatocellular adenoma, survived 150 days and remained disease-free until death from unrelated causes. In contrast, dogs diagnosed with undifferentiated sarcoma and osteosarcoma showed shorter survival times and disease progression.

**Table 3.** summarizes the differences found compared to other series.

Feature	Previous reports	Present study
<b>Most commonly affected lobes</b>	Predominantly left lobes	Predominantly right medial lobe
<b>Cytological diagnosis</b>	Moderate diagnostic accuracy reported	Poor concordance with histopathology
<b>Imaging findings</b>	Usually solitary lesions	Occult multifocal lesions detected intraoperative
<b>Tumor size</b>	May correlate with malignancy	No clear association observed
<b>Clinical presentation</b>	Variable, sometimes associated with malignancy	Similar clinical presentation regardless of histological type
<b>Surgical treatment</b>	Associated with prolonged survival	Clinical improvement and prolonged survival in most dogs

#### 4. Discussion

This retrospective study describes clinical presentation, diagnostic findings, surgical management, and outcome of dogs with surgically treated hepatic masses. Despite the heterogeneity of histopathological diagnoses included, most dogs experienced substantial clinical improvement and prolonged survival following surgical resection, supporting surgery as a valuable therapeutic option in selected patients with resectable hepatic lesions.

The signalment of the dogs included in this study was generally consistent with previous reports describing hepatic neoplasms as diseases affecting predominantly older dogs without a clear breed predisposition[2,5]. Similarly, clinical signs were mostly non-specific and included weight loss, hyporexia, diarrhea, and abdominal distension. Interestingly, clinical presentation was similar among dogs regardless of histopathological diagnosis, suggesting that benign and malignant hepatic masses may be clinically indistinguishable at presentation.

Clinicopathological abnormalities were variable and generally non-specific. Increased ALT and ALP activities represented the most frequent biochemical alterations, in agreement with previous studies[2,5]. However, two dogs with clinically significant hepatic lesions showed no biochemical abnormalities, indicating that normal liver enzyme activities do not exclude the presence of surgically relevant hepatic disease. Hematological alterations such as anemia, thrombocytosis, neutrophilia, and monocytosis were also identified, although no consistent association with specific histopathological diagnoses could be established because of the low number of cases.

One of the most relevant findings of this study was the poor concordance between preoperative cytology and final histopathological diagnosis. Cytological evaluation was discordant in three of the four sampled cases, while one sample was non-diagnostic because of blood contamination. Although previous studies have reported moderate diagnostic accuracy for hepatic cytology, our findings highlight important limitations of fine-needle aspiration (FNA) in canine hepatic masses. This marked discrepancy underscores a critical challenge in canine hepatic oncology; while FNA is a minimally invasive and cost-effective technique, its diagnostic utility is severely hampered by the intrinsic heterogeneity of hepatic masses. In voluminous tumors, such as those documented in this series (mean diameter of 9.33 cm), the coexistence of extensive areas of necrosis, hemorrhage, and reactive inflammatory or hyperplastic tissue surrounding the neoplastic core is common. This heterogeneity often leads to sampling errors where the harvested cells do not represent the predominant malignant population. Furthermore, the cytological differentiation between nodular hyperplasia, hepatocellular adenoma, and well-differentiated hepatocellular carcinoma is exceptionally complex. Our findings align with the observations of Roth (2001), who suggested that

tissue biopsy remains the gold standard because architectural patterns are essential for distinguishing between processes.

Complementary to these diagnostic challenges, the search for a reliable serum biomarker for hepatic neoplasia in canine medicine continues to be a persistent challenge. Alpha-fetoprotein (AFP) has been investigated as a potential diagnostic tool, similar to its widespread use in human oncology for the screening of hepatocellular carcinoma. However, as discussed by Lowseth et al. (1991), while elevated serum AFP levels are frequently associated with canine hepatocellular carcinoma, they lack the necessary specificity as they can also be present in dogs with non-neoplastic regenerative hepatic diseases, nodular hyperplasia, or other types of carcinomas. This lack of absolute specificity significantly limits the utility of AFP as a standalone diagnostic tool in clinical practice. Consequently, the absence of a definitive non-invasive biomarker further reinforces the necessity of surgical exploration and comprehensive histopathology to achieve a final diagnosis and guide therapeutic decisions in the cases presented in this series[18].

Moving from laboratory to imaging assessment, abdominal ultrasound successfully identified hepatic masses in all examined dogs; however, disease extent was underestimated in two cases in which additional lesions were detected only during surgery. Previous studies have shown that ultrasonography is useful for identifying liver lesions and determining their morphology, although its specificity for differentiating benign from malignant lesions remains limited[12,13]. Similarly, ultrasonographic appearance did not allow reliable discrimination between benign and malignant masses in our study. The presence of occult multifocal disease identified intraoperatively reinforces the importance of careful surgical exploration even in cases apparently presenting as solitary lesions on imaging studies.

Tumor size also failed to correlate with biological behavior in this case series. Large lesions were identified in both benign and malignant conditions, while some malignant tumors were comparatively small. Although previous studies have associated prognosis with tumor morphology, histological type, and stage[10], our findings suggest that lesion size alone may not accurately predict malignancy or clinical outcome.

An additional finding of interest was the predominance of lesions affecting the right hepatic lobes, particularly the right medial lobe. This observation contrasts with previous reports describing massive hepatic tumors more commonly affecting the left liver lobes[2,5]. The reason for this discrepancy remains unclear and may reflect the limited sample size, referral bias, or variability in tumor distribution patterns. Nevertheless, these findings highlight that surgically relevant hepatic masses may occur in any hepatic lobe and should not be considered uncommon in the right liver divisions. From a surgical perspective, this localization considerably increases the complexity of the procedure compared to the more commonly reported left-sided tumors. While the left lobes (lateral and medial) possess a longer, more accessible vascular pedicle that facilitates total lobectomy, the right lobes present a wider base of implantation and a close anatomical association with the caudal vena cava and the portal vein. The resection of masses in the right medial and quadrate lobes, as performed in Patient 2 and Patient 8, requires meticulous dissection of the hepatic hilum. In these cases, the risk of intraoperative hemorrhage is heightened due to the brevity of the hepatic veins draining directly into the vena cava. Additionally, the proximity of the gallbladder to these masses often necessitates adjuvant cholecystectomy to ensure clean margins or to facilitate vascular access, a maneuver required for one of our subjects to achieve complete excision. This technical difficulty did not translate into increased immediate intraoperative mortality in our series, suggesting that right-sided location should not be viewed as an exclusion criterion for surgery.

Two perioperative deaths occurred secondary to postoperative acute renal failure (ARF). While these complications were not directly attributable to the hepatic lesions, they highlight the systemic vulnerability of geriatric patients undergoing major hepatectomy. Although necropsy in one case revealed pre-existing chronic interstitial nephritis, it is likely that the physiological response to surgical trauma acted as a triggering factor. During the surgery of large hepatic masses, transient hypotensive episodes can occur due to blood loss or the compression of the caudal vena cava during

tumor manipulation. In patients with borderline renal reserve, even brief periods of renal hypoperfusion can trigger acute tubular necrosis. Moreover, the release of pro-inflammatory cytokines and oxidative stress associated with the manipulation of voluminous tumors may have deleterious systemic effects on renal microcirculation. These findings suggest that perioperative mortality does not consistently correlate with tumor size alone, but rather with the patient's physiological reserve and hemodynamic stability. Consequently, perioperative management must include not only an exhaustive evaluation of hepatic function but also strict monitoring of the glomerular filtration rate and mean arterial pressure.

Consistent with previous literature, dogs diagnosed with hepatocellular carcinoma and benign hyperplastic lesions generally experienced prolonged survival following surgical treatment[2,10]. In contrast, dogs affected by undifferentiated sarcoma and osteosarcoma showed more aggressive clinical behavior and shorter survival times. A particularly noteworthy finding in this series was the diagnosis of a primary hepatic osteosarcoma (PHO) in Patient 1, confirming the diagnosis of an exceedingly rare entity in veterinary medicine with only a few cases documented in the literature to date. Unlike its skeletal counterpart, primary extra-skeletal osteosarcoma in the liver is thought to arise from pluripotent mesenchymal stem cells that undergo malignant osteoblastic differentiation within the hepatic parenchyma[9]. The clinical challenge of PHO lies in its preoperative diagnosis, as imaging features often overlap with other mineralized primary sarcomas or complex carcinomas. In our study, the survival time of 399 days achieved by Patient 1 is remarkable when compared to the aggressive nature typically associated with extra-skeletal sarcomas in dogs, which often carry a guarded prognosis with rapid metastasis. This prolonged survival could be attributed to the multimodal therapeutic approach employed, combining aggressive surgical resection with adjuvant chemotherapy (VAC protocol) and the tyrosine kinase inhibitor masitinib. This outcome reinforces the importance of comprehensive histopathological and immunohistochemical evaluation to distinguish PHO from more common hepatocellular carcinomas, as the biological behavior and therapeutic sensitivity of these rare sarcomas may require specific adjuvant strategies to improve long-term outcomes. Nevertheless, surgical treatment provided noticeable clinical improvement in most dogs regardless of histopathological diagnosis, with rapid resolution of clinical signs observed during the early postoperative period.

## 5. Limitations

This study has several limitations inherent to its retrospective design, including the small sample size, heterogeneous histopathological diagnoses, incomplete preoperative diagnostic work-up in some dogs, and lack of standardized imaging protocols. In addition, survival analysis was limited by the low number of cases and absence of statistical comparisons between histological subtypes. Referral and surgical selection bias may also have influenced the observed outcomes, as only dogs considered surgically resectable were included.

Despite these limitations, this study reflects a real-world clinical population of dogs with surgically managed hepatic masses and highlights clinically relevant discrepancies between preoperative diagnostic assessment and final histopathological diagnosis.

**Author Contributions:** C.P-S: Resources, Project administration, Investigation, Supervision, Writing - original draft preparation, Writing - review and editing. S.C-R: Project administration, Investigation, Supervision, Writing - review and editing. A.J-A: Resources, Writing - review and editing. E.R-GB: Conceptualization, Resources, Methodology, Project administration, Funding acquisition. Investigation. B.C.: Writing - review and editing. F.R-E: Resources, Methodology, Project administration, Investigation, Writing - review and editing. All authors have read and agreed to the published version of the manuscript.

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