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ADVANCED IMAGING AND SURGICAL INTERVENTION IN THE MANAGEMENT OF A CANINE ADRENAL PHEOCHROMOCYTOMA – A CASE REPORT

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Abstract

Pheochromocytomas are rare adrenal medullary tumours in dogs, often associated with severe systemic effects due to catecholamine secretion. This report details a six-year-old spayed mixed-breed dog presented for a corneal melting ulcer, where polyuria-polydipsia prompted further investigations. Biochemical tests showed low serum cortisol (1.5 µg/dL) and cTSH (<2.5 ng/dL), with no other abnormalities. Abdominal ultrasound revealed a left adrenal mass adherent to the kidney and caudal vena cava, further confirmed by CT to involve significant vascular structures. Surgical intervention included total nephrectomy, adrenal mass excision, and vena cava reconstruction. Despite the technically successful surgery, the patient succumbed to postoperative cardiovascular complications (severe arrhythmia and hypertensive crisis) within hours after surgery. Histopathology confirmed pheochromocytoma without renal infiltration. This case highlights the essential role of advanced imaging in diagnosis and surgical planning and underscores the perioperative risks of managing such aggressive tumours.

Key words*: abdominal ultrasound, adrenal neoplasm, adrenalectomy, computed tomography (CT), pheochromocytoma.*

INTRODUCTION

Pheochromocytoma is a rare neuroendocrine tumour that affects the adrenal gland in dogs, originating from the chromaffin cells of the adrenal medulla. This condition can have severe systemic implications due to excessive catecholamine secretion, leading to various clinical manifestations, including episodic hypertension, polyuria, polydipsia, tachycardia, weakness, and collapse (van den Berg & Galac, 2024).

The diagnosis of pheochromocytoma is challenging due to its nonspecific symptomatology and variable clinical presentation. Biochemical examination, including plasma metanephrine measurement, is a promising method but is not always available in veterinary practice (van den Berg & Galac, 2024). For this reason, imaging plays a crucial role in the diagnostic and treatment planning of these tumours.

Abdominal ultrasound is often used as an initial method for identifying adrenal masses. Although it provides useful information about the tumour's size and structure, it cannot accurately assess vascular invasion or metastases (Bargellini et al., 2016). The use of contrast-enhanced ultrasound (CEUS) has proven to be a promising tool in differentiating pheochromocytomas from other types of adrenal tumours due to its ability to highlight tumour perfusion (Nagumo et al., 2020).

Computed tomography (CT) is considered the method of choice for diagnosis and staging, offering superior details regarding tumour size, its relationship with adjacent structures, and the presence of vascular invasion (Gregori et al., 2015). A comparative study between CT and histopathological examination showed that computed tomography has high sensitivity in detecting vascular invasion and tumour extension (Davidson, 2022).

Surgical intervention remains the preferred approach for pheochromocytoma, with adrenalectomy representing the gold standard. However, due to the high risk of intraoperative

complications, such as severe haemorrhage and hemodynamic instability, adequate perioperative preparation is essential (Yoshida et al., 2016). Modern monitoring techniques and anaesthetic management, including the preoperative use of alpha-adrenergic blockers such as phenoxybenzamine or prazosin, are crucial for minimizing intraoperative hemodynamic fluctuations and improving postoperative prognosis (Yoshida et al., 2016; Hayes, 2022). However, some studies have shown that short-term outcomes may still be acceptable even in the absence of preoperative medical management, depending on individual case factors (Appelgrein et al., 2020).

For inoperable patients or those with high surgical risk, alternative therapies such as stereotactic radiotherapy have been investigated, although data on long-term efficacy remain limited (Linder et al., 2023).

This study aims to contribute to the specialized literature by presenting a case of canine pheochromocytoma diagnosed through advanced imaging and treated surgically, with a focus on perioperative challenges and prognostic implications.

MATERIALS AND METHODS

The patient was a spayed female mixed-breed, approximately six years old, adopted from a shelter four years prior to presentation. The initial reason for presentation was a comprehensive ophthalmologic examination, which led to a diagnosis of corneal melting ulcer and secondary uveitis in the right eye. During hospitalization, the dog was observed to have a polyuria-polydipsia syndrome, which prompted further investigation to identify the underlying cause.

Haematological and biochemical tests, including complete blood count, serum biochemistry panel, and hormonal assays, were conducted using IDEXX ProCyte Dx and Catalyst Dx analysers (IDEXX Laboratories, Westbrook, Maine, USA). Based on the results, advanced imaging was deemed necessary to investigate a suspected adrenal ethology.

An abdominal ultrasound was performed using an Esaote MyLab 7 ultrasound system (Esaote, Genova, Italy) equipped with an SC3123 convex transducer operating at a frequency range of 3-10 MHz. Based on this scan, an intra-abdominal mass was identified, prompting further imaging evaluation.

To achieve a more accurate assessment of the mass and to exclude the presence of pulmonary metastases, a contrast-enhanced computed tomography (CT) study of the thorax and abdomen was performed with the patient under sedation. The scan was carried out using a Philips Access 16-slice helical CT scanner (Philips, Suzhou, China), and included both pre-contrast and post-contrast phases. The contrast agent (Iohexol, Omnipaque 350 mg I/mL) was administered intravenously at a dose of 2 mL/kg. Image acquisition was performed with a slice thickness of 2.5 mm and a reconstruction increment of 1.25 mm. High-resolution multiplanar reconstructions were generated at 1 mm thickness with a 0.5 mm increment. Additional scan parameters included 180 mAs per slice, tube rotation time of 0.75 seconds, and a pitch of 1.0625. Multiplanar reconstructions were obtained using soft tissue, bone, and lung windows, providing detailed visualization of abdominal and thoracic structures, including vascular anatomy and potential metastatic sites.

Immediately after the completion of the CT scan (which indicated an invasive adrenal mass with vascular involvement), and while still under the same general anaesthesia, the patient was transferred directly to the operating room for surgical management.

A ventral midline laparotomy was performed with the patient in dorsal recumbency to access the abdominal cavity. Intraoperative exploration revealed a large adrenal mass firmly adherent to the cranial pole of the left kidney (Figure 1). Dissection was technically demanding due to the tumour's extensive involvement of the surrounding tissues, including the caudal vena cava.

Given the strong adhesion between the adrenal mass and the left kidney, an *en bloc* resection of the tumoural complex was performed, involving simultaneous removal of the affected adrenal gland and ipsilateral kidney. One of the most significant intraoperative challenges was the tumour's invasion into the wall of the caudal vena cava, which required partial venous resection and meticulous primary venorrhaphy to restore vascular continuity (Figure 2). Despite the complexity of the procedure, the mass was successfully excised in its entirety.

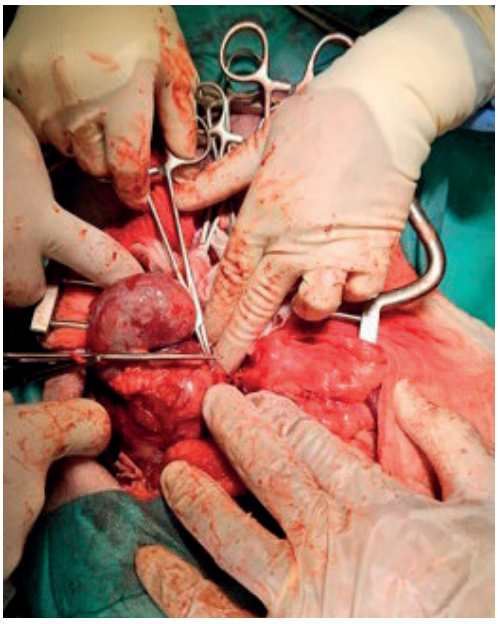

Figure 1. Intraoperative view - adrenal-kidney tumoural block being carefully dissected and isolated

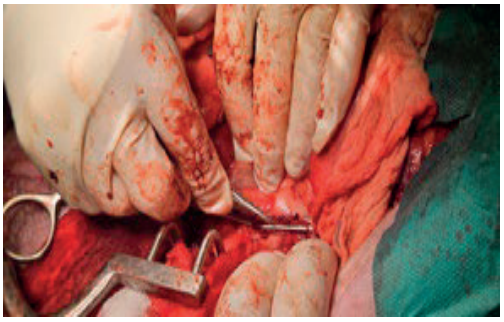

Figure 2. Intraoperative image showing the caudal vena cava (CVC) post-tumour resection.

The adrenal-kidney tumoural block was submitted for histopathological examination. Macroscopically, the mass appeared cavernous and friable, with alternating regions of necrosis and haemorrhage. Tissue sections were processed routinely and stained with Hematoxylin and Eosin (H & E) for microscopic evaluation. Histologically, the neoplasm consisted of a dense proliferation of polygonal cells.

In the immediate postoperative period, the patient received intensive postoperative monitoring. Initially, recovery from anaesthesia was uneventful, with stable vital parameters. However, approximately two hours after surgery, the patient developed acute gastrointestinal haemorrhage, manifested by bradycardia and severe bloody diarrhoea. Despite prompt initiation of intravenous fluid therapy for hemodynamic stabilization and intensive supportive care, the dog progressed to cardiopulmonary arrest and failed to respond to advanced resuscitation measures, ultimately resulting in death.

RESULTS AND DISCUSSIONS

The initial clinical presentation of the patient, a six-year-old spayed mixed-breed dog, was unrelated to adrenal pathology, with referral for ophthalmological examination and diagnosis of a corneal melting ulcer with secondary uveitis. However, the incidental observation of polyuria–polydipsia during hospitalization prompted further diagnostic work-up. Haematological and biochemical analyses revealed a low serum cortisol level (1.5 µg/dL) and decreased cTSH (<2.5 ng/dL), findings that raised suspicion of adrenal dysfunction and supported the need for advanced imaging.

Ultrasound examination identified at the cranial pole of the left kidney, a large and heterogeneous intra-abdominal mass measuring approximately 62.6 mm in diameter, poorly defined margins, and contained areas of reduced echogenicity suggestive of internal necrosis. The mass was also noted in close proximity to the caudal vena cava, suggesting potential vascular involvement (Figure 3).

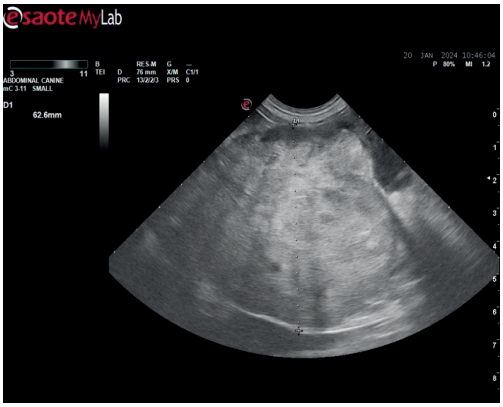

Figure 3. Ultrasound image showing a large, irregular and heterogeneous mass, appearing adherent to the cranial pole of the left kidney and in close contact to the caudal vena cava

These sonographic features are consistent with those described in the literature for adrenal pheochromocytomas, which are often large, heterogeneous, and capable of compressing or infiltrating surrounding structures (Bargellini et al., 2016; Nagumo et al., 2020).

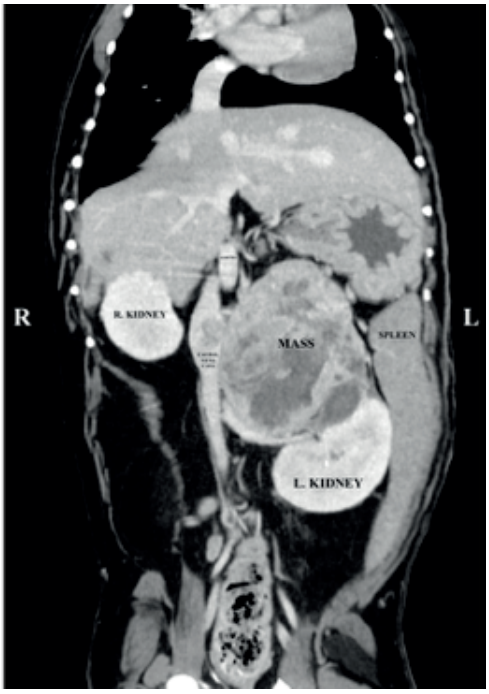

Figure 4. Post-contrast CT image in a dorsal oblique plane, reconstructed in a soft tissue window. The image highlights a large, heterogeneous adrenal mass measuring approximately 66.4 × 93.8 × 89.7 mm, located cranial to the left kidney and displacing it caudomedially

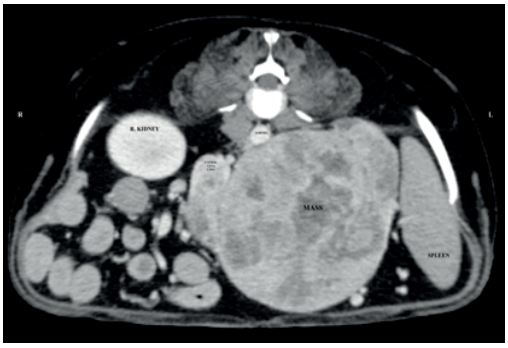

Figure 5. Post-contrast CT image in transverse plane at the level of the mid-abdomen, in a soft tissue window. The heterogeneous mass appears enlarged, with mixed attenuation consistent with necrotic and viable tumour regions

To further characterize the lesion and evaluate for potential metastases, a contrast-enhanced CT scan of the thorax and abdomen was performed. The tumour was identified as a large left adrenal mass measuring 66.4 × 93.8 × 89.7 mm, with hypoattenuating regions indicative of necrosis. It formed a contiguous mass with the left kidney, causing caudomedial displacement and encasement of the renal artery and vein. Notably, the tumour invaded the lumen of the caudal vena cava over a length of approximately 20 mm. These findings reinforced the diagnosis of an invasive adrenal neoplasm with a high potential for intraoperative complications. In comparison with literature reports, this case demonstrates imaging characteristics similar to those described by Gregori et al. (2015), where CT was shown to have high sensitivity in detecting vascular invasion. The use of multiplanar reconstructions further enhanced surgical planning, allowing precise visualization of the extent of vascular involvement (Figures 4 and 5), and such tools can be further enhanced by the use of 3D-printed anatomical models for surgical planning, as previously reported (Almeida et al., 2019).

Additional CT findings included left ventricular hypertrophy, bilateral renal calculi, and splenomegaly. While these may not be directly related to the adrenal pathology, they are important when assessing overall patient stability prior to surgery. In human and veterinary literature alike, the presence of caudal vena cava invasion is considered a poor prognostic indicator and significantly increases surgical risk (Mayhew et al., 2019).

Surgical excision was performed through *en bloc* resection of the adrenal mass and the ipsilateral kidney due to strong adhesion between the two structures. Intraoperatively, the tumour was found to infiltrate the wall of the caudal vena cava, necessitating partial resection and venorrhaphy. Despite the complexity of the procedure, complete tumour removal was achieved, with clean macroscopic margins.

Histopathological analysis confirmed the diagnosis of adrenal pheochromocytoma. Macroscopically, the mass was cavernous and friable, with extensive areas of haemorrhage and necrosis. Microscopically, the tumour consisted of polygonal neoplastic cells arranged in lobules and cords, separated by a fine fibrovascular

stroma. The cells exhibited mildly acidophilic cytoplasm, pleomorphic hyperchromatic nuclei, and occasional mitotic figures. Multifocal vascular thrombosis, necrosis, and neutrophilic infiltrates were observed. Capsular invasion by nests of neoplastic cells was noted in multiple areas, suggesting a high malignant potential. No evidence of neoplastic infiltration was found in the renal parenchyma, supporting the hypothesis of displacement rather than direct invasion (Figure 6).

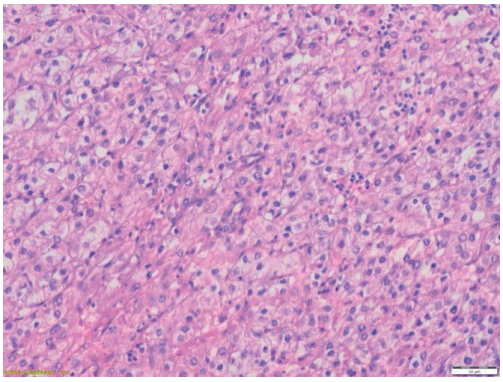

Figure 6. Histopathological image of the excised adrenal mass, stained with Haematoxylin and Eosin (H & E), at 20× magnification

These histological features are in agreement with those described in the literature for canine pheochromocytomas, which are characterized by a high degree of local invasiveness and metastatic potential (van den Berg & Galac, 2024; Zini et al., 2019). Capsular penetration, cellular pleomorphism, and vascular thrombosis are key features associated with poor prognosis. In the immediate postoperative period, the patient initially recovered without incident. However, within two hours of surgery, the dog developed acute gastrointestinal haemorrhage, bradycardia, and haemorrhagic diarrhoea. Despite intensive supportive care and intravenous fluid therapy aimed at hemodynamic stabilization, the patient deteriorated rapidly and progressed to cardiopulmonary arrest, ultimately unresponsive to resuscitation efforts. Such rapid postoperative decompensation is consistent with literature describing catecholamine surge and vascular instability following pheochromocytoma excision (Davidson, 2022). Removal of the tumour source may trigger abrupt hemodynamic collapse due to sudden catecholamine withdrawal.

This case illustrates the diagnostic and surgical challenges associated with canine pheochromocytomas. The use of advanced imaging modalities, particularly contrast-enhanced CT with high-resolution multiplanar reconstruction, proved essential for tumour characterization and preoperative planning. Histopathological findings confirmed the aggressive nature of the neoplasm, consistent with previously reported cases.

While adrenalectomy remains the gold standard treatment, the prognosis is strongly influenced by the extent of vascular invasion and perioperative stability. By contrast, dogs with small, non-invasive adrenal tumours generally have more favourable surgical outcomes and a reduced risk of complications (Cavalcanti et al., 2020).

In this case, adrenalectomy combined with total nephrectomy was technically feasible, but extensive invasion of the caudal vena cava posed a major challenge, requiring partial resection and difficult suturing of the vascular wall. The unfavourable postoperative evolution, with rapid deterioration and hemodynamic collapse, confirms the significant risks associated with these interventions - risks that are well-documented in the literature (Davidson, 2022).

Advancements in imaging diagnostics and perioperative therapy could improve long-term success rates. Recent reports have also explored the use of intraoperative Indocyanine Green (ICG) fluorescence imaging to aid in tumour localization and resection, offering promising outcomes (Yu & Lee, 2024). In some cases, stereotactic radiotherapy or palliative therapeutic approaches could serve as viable alternatives, but further studies are needed to evaluate the effectiveness of these methods (Linder et al., 2023). Laparoscopic adrenalectomy has also been successfully applied in selected cases with non-invasive adrenal tumours, providing favourable outcomes with reduced surgical trauma (Pitt et al., 2016). Additionally, favourable outcomes have been described even in bilateral adrenalectomies, provided that intensive perioperative management is applied (Oblak et al., 2016).

CONCLUSIONS

This case of invasive adrenal pheochromocytoma in a dog illustrates the diagnostic and surgical complexity of managing such rare but aggressive tumours.

A multimodal diagnostic approach - combining clinical evaluation, laboratory analysis, ultrasound, and CT - was essential for detecting adrenal involvement and vascular invasion.

While abdominal ultrasound can raise initial suspicion of adrenal involvement, contrast-enhanced CT with multiplanar reconstruction remains the diagnostic modality of choice, providing critical details for assessing tumour extent and vascular invasion, and guiding surgical planning.

Histopathological examination remains essential for the definitive diagnosis of pheochromocytoma, relying on cellu lar and architectural features such as capsular invasion, necrosis, and vascular thrombosis -hallmarks of malignancy that are critical for establishing prognosis and guiding further management.

En bloc adrenalectomy with nephrectomy and caval wall reconstruction was technically feasible but carried substantial perioperative risk due to the tumour's vascular involvement.

The patient's rapid postoperative deterioration emphasizes the importance of anticipating catecholamine-induced hemodynamic instability and ensuring intensive monitoring.

While adrenalectomy remains the only curative treatment, individualized perioperative strategies and proactive intraoperative management are critical in high-risk cases.

Each documented case of canine pheochromocytoma contributes to refining current diagnostic algorithms and surgical protocols, especially in the context of advanced imaging and perioperative care.

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