ENDOCRINE DISORDERS IN DOGS: EPIDEMIOLOGY, CLINICAL PRESENTATION, AND DIAGNOSTIC METHODS

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Abstract. This study evaluates the clinical, epidemiological, and diagnostic aspects of major endocrine disorders in dogs. The research focused on common endocrine disorders, breed predisposition, sex, neutering status, age, weight, symptom prevalence, and comorbidities. 46 canine patients meet the criteria and were included in the study. Diabetes mellitus (55%) and hyperadrenocorticism (22%) were the most common, with seasonal trends noted for diabetes in spring and hyperadrenocorticism in winter. Middle-aged or geriatric dogs showed higher incidences, and overweight dogs frequently had Cushing's syndrome. Small breeds like West Highland White Terriers (24%) and Bichons (16%) were commonly diabetic, while hyperadrenocorticism was seen in Bichons (30%), Dachshunds, and Poodles (20%). Comorbidities included pancreatitis (10.86%), hepatomegaly (10.86%), and biliary mucocele (15.21%). Diagnostic methods included glucose monitoring, glycemic curve analysis, and low-dose dexamethasone suppression tests, with imaging (ultrasound) confirming endocrine gland involvement in 50% of Cushing's cases. Major risk factors were breed, age, and neutering status, with higher incidences in geriatric (≥10 years) and intact small breed dogs, but no significant sex predisposition. Digestive symptoms and general health deterioration were common clinical signs, requiring biochemical and hematological evaluations for definitive diagnosis in 41% of cases.

Keywords: endocrine disorders, canine, diabetes mellitus, hyperadrenocorticism

Abbreviations
ACTH - Adrenocorticotropic Hormone
TSH - thyroid-stimulating hormone
T4 - Thyroxine

INTRODUCTION

Over time, research on various endocrine disorders has strengthened a branch of internal medicine with significant impact on canine health. Endocrinology encompasses a wide range of chronic and insidious disorders, often presenting with polymorphic symptoms. This can be observed in the clinical signs characteristic of canine hyperadrenocorticism or hypothyroidism, where multiple systems are frequently affected. The influence of endocrine glands on the body's homeostasis is thus readily apparent. Additionally, diabetes mellitus and Addison's disease are commonly encountered in veterinary practice. Advances in veterinary medicine and significant changes in the relationship between pet owners and their animals over the past two decades have led to an increase in the lifespan of dogs. Consequently, there has been a rise in the incidence of age-related diseases, including endocrine disorders.

The effects of these disorders can vary greatly; some conditions may be fatal without treatment, while others have a lesser impact on health.

Most endocrinopathies exhibit a chronic, insidious progression with slowly evolving clinical signs; however, the complications can be overwhelming. These disorders involve an interplay between the nervous, endocrine, and immune systems, which are considered a functional unit rather than distinct entities (Rijnberk and Kooistra, 2010). The immune system is responsive to endocrine signals via receptors on immune cells (Stelzer and Arck, 2016). Diabetes mellitus has an incidence of approximately 0.5%, making it one of the most common endocrinopathies in both dogs and cats (Hoenig, 2002). Glandular hypofunction is seen in primary hypothyroidism, a frequent pathology in dogs. Hypoadrenocorticism (Addison's disease) and hypoparathyroidism are more commonly reported in dogs and are rare in cats (Rijnberk et al., 2003).

Hyperadrenocorticism, or Cushing's disease, is commonly found in middle-aged or geriatric dogs and cats. Primary hyperparathyroidism, often caused by neoplasia affecting the parathyroid glands, is more frequently reported in geriatric dogs and rarely in cats. Nutritional secondary hyperparathyroidism primarily affects young animals fed an unbalanced diet based solely on meat or organs, leading to disturbances in the phospho-calcium balance and resulting in fibrous osteodystrophy (Tkalčić, 2010). Renal secondary hyperparathyroidism occurs due to chronic renal failure, initially caused by low calcitriol levels, with advanced stages characterized by hyperphosphatemia as a major contributing factor (Llach and Velasquez Forero, 2001). Hyperthyroidism is a common condition in elderly cats, whereas it is rarely observed in dogs (Peeters et al., 2002).

MATERIALS AND METHODS

The epidemiological data underpinning this study were obtained from the written and electronic records of the Internal Medicine Department, Faculty of Veterinary Medicine, Cluj-Napoca. Canine patients diagnosed with one or more endocrine disorders through specific tests (Diabetes Mellitus**:** Blood glucose measurement, Glycated hemoglobin (HbA1c) test, Fructosamine test, Urinalysis; Hyperadrenocorticism: Low-dose dexamethasone suppression test, ACTH stimulation test, Urine cortisol ratio, Abdominal ultrasound; Hypoadrenocorticism: ACTH stimulation test, Baseline cortisol measurement, Electrolyte panel, ECG; Hypothyroidism: Total T4 measurement, Free T4, TSH (thyroid-stimulating hormone) test; Hyperthyroidism: Total T4 measurement, Free T4 measurement) and symptomatology were identified. The collected data focused on age, sex, breed, weight, neutering status, seasonal trends, the timing of diagnosis, and the presence of comorbidities. Anamnestic data provided general information about the patient, symptom onset, concurrent diseases, and medications that could have contributed to or exacerbated endocrine disorders.

The objective clinical examination assessed the conformation, body condition, capillary refill time, hydration status via skin tenting, and evaluation of mucous membranes and palpable lymph nodes. Vital functions were assessed by measuring heart and respiratory rates, as well as body temperature.

RESULTS AND DISCUSSIONS

Between January 2019 and January 2022, the Medical Pathology and Semiology course at the Faculty of Veterinary Medicine in Cluj-Napoca evaluated 51 patients of canine and feline species, all of whom were diagnosed with one or more endocrine disorders based on clinical and paraclinical examinations. Of these, 10% (5 patients) were felines, and 90% (46 patients) were canines. This distribution suggests a potentially exponential interspecific variation in the likelihood of endocrine disorders (see Fig. 1). A study conducted by Álan Gomes Pöppl et al. in 2016 similarly reported a higher incidence of endocrine disorders in dogs compared to cats. Their research, involving 1,400 patients, found that 93.4% (1,308 patients) were dogs, while only 6.6% (92 patients) were cats.

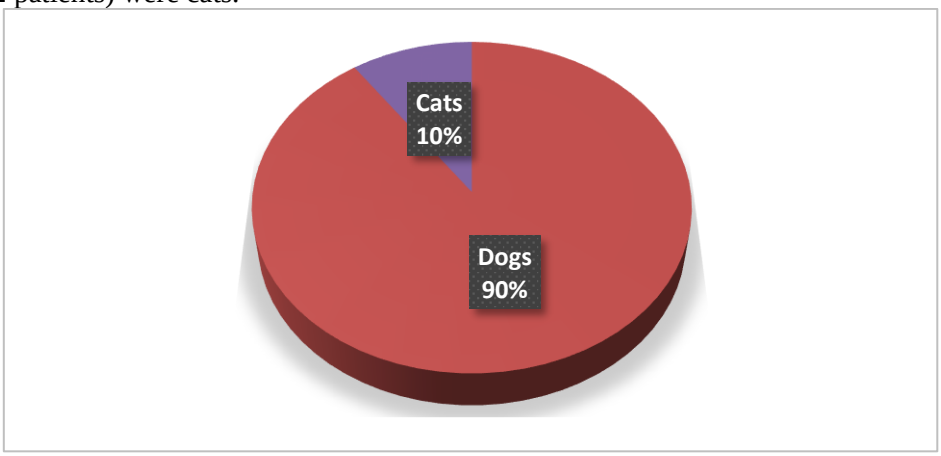

Fig.1. Incidence of Endocrine Disorders by Species

Among the 46 cases included in this study, age was identified as a major risk factor. Specifically, 59% (27 patients) were over 10 years old, 24% (11 patients) were between 7 and 9 years old, 13% (6 patients) were between 4 and 6 years old, and the smallest proportion, 4% (2 patients), were young animals aged between 1 and 3 years (see Fig. 2). Other studies have reported a higher incidence of endocrine disorders in patients under 10 years of age (Shauna L. Blois et al., 2011; Álan Gomes Pöppl et al., 2016).

Regarding body weight, it was not classified as a predisposing factor. It was observed that 47% of subjects (16 cases) had weights within the normal range for their breeds. However, 32% were overweight, with most weighing under 20 kilograms, which is significant considering they were small breed animals. Among the 46 cases included in this study, 12 patients lacked body weight information and were excluded from the statistical data presented in the figure below. Álan Gomes Pöppl et al. (2016) correlated obesity with the presence of endocrine comorbidities, a relationship not fully supported by the current study.

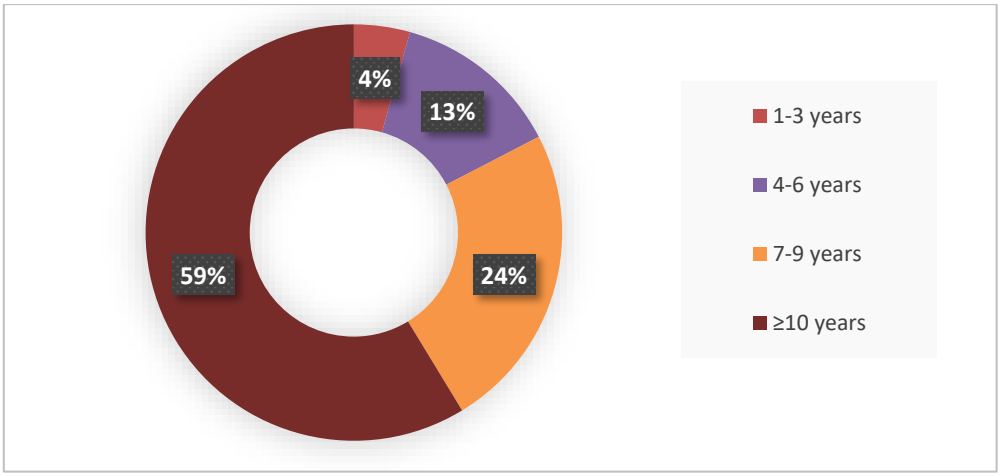

Fig. 2. Incidence of Endocrine Disorders by Age

Analysis of patient sex revealed that males are more predisposed to developing endocrine disorders than females. Additionally, intact patients are eight times more likely to develop an endocrine disorder compared to those that are neutered or spayed. Some studies have reported a higher incidence of endocrine disorders in females compared to males, while others have identified a greater predisposition for males (Eduard Feldman & Nelson R.W., 2004; Fall T. et al., 2007; Shauna L. Blois et al., 2011; Álan Gomes Pöppl et al., 2016).

Regarding the prevalence of endocrine disorders, the study revealed that 55% (25 cases) of the patients were diagnosed with diabetes mellitus, 22% (10 cases) with Cushing's syndrome, and 15% (7 cases) with hypothyroidism. Addison's disease was observed in 5% of patients, while hyperthyroidism and hyperparathyroidism each accounted for only 2% (see Fig. 3). Álan Gomes Pöppl et al. (2016) reported a higher incidence of hyperadrenocorticism (37%), followed by diabetes mellitus (22%) and hypothyroidism (11%). Similarly, Shauna L. Blois et al. (2011) also identified an increased incidence of hyperadrenocorticism in canine patients.

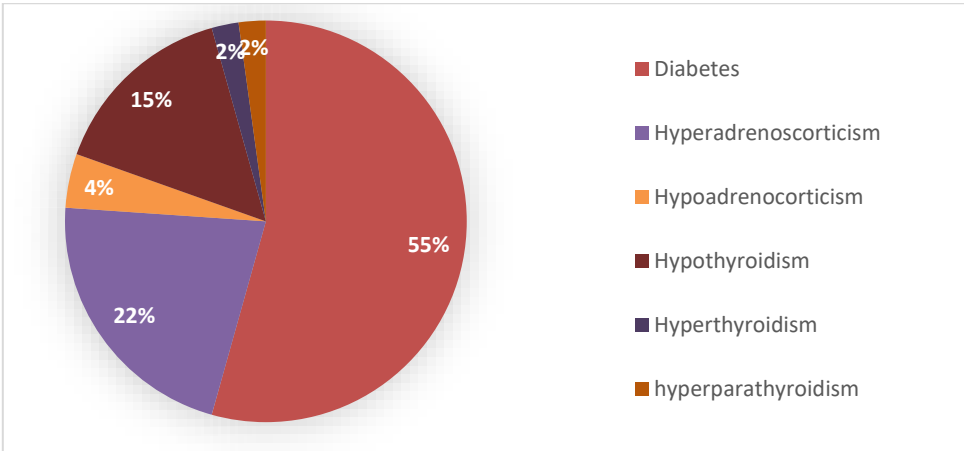

Fig. 3. Incidence of Endocrine Disorders

The majority of cases were recorded during the winter months (39%; 18 patients), while a similar proportion was observed in the spring and summer (22%; 10 patients each). A lower incidence was noted during the fall months (17%; 8 patients). Additionally, a seasonal variation in the prevalence of certain endocrinopathies was observed. Specifically, diabetes mellitus was more frequently diagnosed in the spring (8 cases) and winter (7 cases), while Cushing's syndrome (6 cases) was notably more prevalent during the winter months. The seasonality of hypothyroidism remains uncertain, as diagnoses occurred with equal frequency in both summer and winter months. In this regard, Davison et al. (2015) demonstrated a seasonal pattern in the occurrence of diabetes mellitus in canine patients, with a noted predisposition for winter months. Conversely, Martin et al. (2014) reported an increased incidence in both winter and spring, while Fall et al. (2004) identified a springtime predisposition for diagnosis.

Another identified predisposing factor for the development of various endocrine disorders in this study is breed. Among the 46 dogs diagnosed with an endocrine disorder, the breeds most predisposed to such conditions include the Bichon (17%), common breeds (17%), West Highland White Terrier (15%), Golden Retriever (9%), and Dachshund (7%). Breeds such as Poodle, Yorkshire Terrier, Husky, Labrador Retriever, and other terriers were represented with a prevalence of 4%. The least affected breeds, each representing 2%, include Boxer, German Shorthaired Pointer, Jack Russell Terrier, Pug, Rottweiler, and Miniature Schnauzer. A predisposition among certain breeds for developing specific endocrine disorders was also observed. This study, which focused on providing relevant statistics for only two of the more commonly encountered endocrine pathologies within the Medical Pathology and Semiology Department at the Faculty of Veterinary Medicine, Cluj-Napoca, presents the following findings. Diabetes mellitus was predominantly observed in West Highland White Terriers (24%), common breeds (20%), and Bichons (16%). Given that common breeds are more prevalent in Romania compared to other breeds, this may account for the higher incidence reported in this study. A lower prevalence was noted in Golden Retrievers, Huskies, and Labrador Retrievers (8%), while the least affected breeds (4%) included Jack Russell Terriers, Yorkshire Terriers, Rottweilers, and other terrier breeds (Fig. 6.10). Other studies have highlighted a higher predisposition for diabetes mellitus in Huskies, Samoyeds, Schnauzers, Labrador Retrievers, Dachshunds, and Jack Russell Terriers (Álan Gomes Pöppl et al., 2016; L. Guptill et al., 2003; F. Fracassi et al., 2004). Conversely, a study by Tove Fall et al. (2007) demonstrated a lower risk for German Shepherds, Boxers, and Golden Retrievers.

Among the 25 individuals diagnosed with diabetes mellitus, 15 were males (60%) and 10 were females (40%), indicating that there is no significant sex predisposition, with the condition affecting both males and females equally. Of these, 22 were intact (96%) and only one female was spayed (4%), suggesting that intact patients are at a higher risk for developing this endocrine disorder. Álan Gomes Pöppl et al. (2016) demonstrated that although it was previously believed that females were more predisposed, males also exhibit a similarly high risk. Additionally, a study by Guptill et al. (2003) highlighted an increased predisposition for diabetes mellitus in castrated individuals, particularly in the context of obesity. The age distribution of diabetes mellitus diagnoses, showing that affected patients are primarily middle-aged

and geriatric, ranging from 4 to 16 years of age. This observation is consistent with findings from other studies (Guptill et al., 2003; Davison et al., 2015; Fall et al., 2007; Mattin et al., 2014). Regarding the body weight of patients diagnosed with diabetes mellitus, it was found that weight does not serve as a predisposing factor, as more than half of the patients were of normal weight (11 cases). Data on body weight were unavailable for 5 individuals, who were thus excluded from the statistical analysis presented in the figure. Although Mattin et al. (2014) identified a link between diabetes mellitus and obesity, this study revealed that only 25% of the subjects exceeded optimal body weight, failing to support this hypothesis.

Hyperadrenocorticism was more frequently diagnosed in Bichons (30%). It was less commonly diagnosed in Poodles and Dachshunds (20%), while the least affected breeds (9%) included common breeds, various terrier breeds, and Golden Retrievers. O'Neil et al. (2016) observed a predisposition for hyperadrenocorticism in Bichons. Additionally, other studies have reported a higher incidence of this endocrine disorder in Dachshunds and other terrier breeds, as well as in Poodles, Chihuahuas, Beagles, Labrador Retrievers, Golden Retrievers, German Shepherds, and Australian Shepherds. However, these findings were not fully corroborated by the current study (Mark E. Peterson et al., 1982; Claudia E. Reusch and Edward C. Feldman, 1991; J.M. Hoffman et al., 2018).

A definitive diagnosis of Cushing's syndrome was established in 10 out of the 44 patients with various endocrine disorders. Among these, 5 were females (50%) and 5 were males (50%), suggesting no significant sex predisposition. Nevertheless, several epidemiological studies have highlighted a higher prevalence in females, likely associated with the influence of sex hormones on corticotropic cells. Conversely, other studies have not corroborated this finding (Farica D. Wood et al., 2007; Claudia E. Reusch and Edward C. Feldman, 1991; M.F. Gallelli et al., 2010; D.G. O'Neill et al., 2016). In this study, it was observed that 8 of the patients were intact (80%) while only 2 were spayed females (20%), indicating a higher prevalence among intact individuals. Gaia Carotenuto et al. (2019) reported an increased risk of hyperadrenocorticism, particularly in spayed females. Age distribution of patients diagnosed with hyperadrenocorticism, showed a predominance in middle-aged to geriatric patients, particularly those aged 8 to 13 years, with the highest incidence observed in 13-year-old patients. This observation is consistent with findings from Reusch and Feldman (1991) and Carotenuto et al. (2019). Analysis of body weight revealed that half of the individuals were overweight, with the majority weighing under 20 kilograms, thus exceeding the typical weight limits for their respective breeds. This finding is consistent with the study conducted by D.G. O'Neill et al. (2016).

Among the 46 patients diagnosed with a primary endocrine disorder, 5 individuals (11%) were found to have a secondary endocrine disorder. The most frequently observed secondary condition was hyperadrenocorticism secondary to diabetes mellitus (9%), followed by hypothyroidism secondary to hyperadrenocorticism (2%). Shauna L. Blois et al. (2011) identified diabetes mellitus and hyperadrenocorticism as the most common combination of endocrine disorders, followed by hypothyroidism and hyperadrenocorticism. Hoening (2002) noted a frequent correlation between diabetes mellitus and hyperadrenocorticism, a finding also supported by Tove Fall et al. (2007), who observed an increased incidence of diabetes mellitus in patients with hyperadrenocorticism. This suggests that elevated

cortisol levels may increase plasma glucose concentration, thereby inducing insulin resistance in cells.

Regarding the symptoms frequently observed in the 46 patients included in this study, the predominant signs were digestive symptoms such as vomiting or diarrhea, polyuria and polydipsia, and alterations in general condition characterized by apathy, lethargy, anorexia, inappetence, and progressive weight loss. At the time of presentation, 23% of the patients (10 cases) were asymptomatic, while 18% (8 cases) exhibited only clinical signs of polyuria and polydipsia. Gastrointestinal symptoms, with or without polyuria and polydipsia, were present in 20% of the individuals (9 cases). Among these, 8 patients displayed symptoms of vomiting and diarrhea, and one patient had both gastrointestinal symptoms and polyuria and polydipsia. Symptoms suggesting a deterioration in general condition were observed in 14% of patients (6 cases), with 4 of these also presenting polyuria and polydipsia. Dermatological signs such as alopecia or hyperkeratosis were noted in 7% of the individuals (3 cases), with one of these patients also exhibiting polyuria and polydipsia. Neurological signs, including epileptiform seizures, altered mental status, and even coma, were identified in 9% of the patients (4 cases). Additionally, 9% of patients presented signs affecting other systems, such as coughing, exercise intolerance, stranguria, and abdominal enlargement.

Among the patients identified with one or more endocrine disorders, 16 (36%) did not present any concurrent conditions, while 64% exhibited either a single system involvement or multiple system impairments. Notably, involvement of two or more systems was observed in 52% of the cases with concurrent conditions (15 patients), followed by gastrointestinal system involvement (6 cases). Neoplasms (3 cases) and genitourinary system disorders (3 cases) were less commonly observed, each affecting 10% of the patients.

Among the 25 patients diagnosed with diabetes mellitus, the majority exhibited signs associated with polyuria and polydipsia (24%). It was noted that patients with gastrointestinal symptoms (4 cases) did not show polyuria and polydipsia. In contrast, those demonstrating symptoms of general deterioration also presented with polyuria and polydipsia (4 cases). Neurological signs, including comatose states or epileptiform seizures, were observed in only 8% of the individuals (2 cases). Carmel T. Mooney and Mark E. Peterson (2012) reported that the most common clinical signs in diabetic dogs are polyuria, polydipsia, weight loss, and lethargy. Additionally, Megan J. Morgan et al. (2008) found that neurological signs are rarely encountered in dogs compared to cats.

In the context of diabetes mellitus, it was observed that concurrent diseases do not represent a predisposing factor for the onset or complication of this condition. The most commonly affected system is the digestive system (3 cases), with most patients showing involvement of two or more systems. Among the most frequently reported complications in the literature are acute pancreatitis and urinary tract infections, which can present with anorexia and vomiting (Edward C. Feldman et al., 2015; L.J. Davison, 2015; Stacy Beam et al., 1999). Cataracts have been identified as one of the most common complications in dogs, and they are irreversible (Edward C. Feldman et al., 2015). Additionally, a study by M. Mattin et al. (2014) highlighted that pancreatitis was observed in two-thirds of the patients diagnosed with diabetes mellitus.

Most patients diagnosed with hyperadrenocorticism did not exhibit clinical signs at the time of consultation. Among the most frequent clinical signs facilitating a definitive diagnosis were polyuria and polydipsia (3 cases). Abdominal enlargement was observed in only one individual. Mark E. Peterson (1984) reported a prevalence of 80-85% for polyuria and polydipsia in dogs with hyperadrenocorticism. Jacquie Rand et al. (2013) identified an incidence of 50-90% for polyphagia in dogs with this endocrine disorder. Other clinical signs frequently cited in the literature for Cushing's syndrome include abdominal distension, lethargy, fatigue, exercise intolerance, and dermatological manifestations (Jacquie Rand et al., 2013; Carmel T. Mooney and Mark E. Peterson, 2012).

Analysis of frequent comorbidities revealed that Cushing's syndrome is predominantly accompanied by a concurrent condition. This study demonstrated a frequent involvement of the digestive system (3 cases), accounting for 30%. Less commonly, neoplasms or genitourinary tract disorders were observed as predisposing factors (20%). Additionally, hyperadrenocorticism was often associated with involvement of two or more systems in the development or exacerbation of this endocrine disorder. J.M. Hoffman et al. (2018) identified the following conditions as primary comorbidities in dogs with hyperadrenocorticism: urinary tract infections, urolithiasis, hypertension, biliary mucoceles, and thromboembolism.

Among the 46 canine patients diagnosed with one or more endocrine disorders, 13% (6 cases) sought consultation specifically for one of the concurrent conditions discussed previously while also noting a previously diagnosed endocrine pathology from another clinic in their medical history. Of the remaining 87% of patients whose owners requested specialized consultation, a higher frequency (41%) involved biochemical analyses, which in some cases included a hormonal panel (21 cases). This was followed by a combined approach of biochemical and hematological investigations in 37% of the cases (15 cases). Ultrasound contributed to a definitive diagnosis in only 5 patients. Main hematological and biochemical abnormalities encountered among patients with endocrine disorders are summarized in Fig. 4.

Hematological Changes	Biochemical Changes
Eosinopenia	Elevated PAL (Phosphatase Alkaline)
Thrombocytosis/Thrombocytopenia	Elevated GGT (Gamma-Glutamyl Transferase)
Lymphocytosis/Lymphopenia	Elevated ALAT (Alanine Aminotransferase)
Neutrophilia/Neutropenia	Elevated ASAT (Aspartate Aminotransferase)
Monocytosis/Monopenia	Elevated BUN (Blood Urea Nitrogen)
Anemia	Elevated Creatinine
	Elevated α-Amylase
	Elevated Lipase

Fig. 4. Paraclinical changes

Regarding the diagnosis of diabetes mellitus, it was observed that more than half of the diagnosed patients (14 cases) underwent both hematological and

biochemical evaluations, including endocrine tests. Paraclinical investigations revealed that 44% of patients showed elevated alkaline phosphatase (ALP), 36% had increased gamma-glutamyl transferase (GGT), and 28% exhibited anemia, neutrophilia, or elevated alanine aminotransferase (ALAT). One patient demonstrated the presence of toxic neutrophils upon blood smear examination. Megan J. Morgan et al. (2008) documented a mild thrombocytosis in their paraclinical investigations, with biochemical changes including hypocalcemia, hyperkalemia, hypoalbuminemia, hypercholesterolemia, and elevated alkaline phosphatase. Edward C. Feldman et al. (2015) frequently observed elevated ALP and ASAT, with anemia and toxic neutrophils in the hematological assessment, findings consistent with those observed in this study. Rebecka Hess et al. (2000) reported increases in ALP, ASAT, and ALAT, while GGT levels were within normal limits for most individuals.

Endocrine analyses focused on glucose monitoring, either as a standalone parameter or in conjunction with fructosamine measurements, and included glucose curve testing. It was observed that, most frequently, the diagnosis of diabetes mellitus relied on glucose evaluation alone (62%, 15 cases), followed by glucose curve testing in 23% of patients (6 cases). Only 4 patients diagnosed with diabetes mellitus underwent fructosamine measurement. Of these, 3 exhibited elevated levels of both glucose and fructosamine, while 1 patient showed an increase in glucose levels without an associated increase in fructosamine. L. J. Davison et al. (2015) monitored diabetic patients using glucose, fructosamine, and glycosylated hemoglobin measurements.

In facilitating diagnosis, a urinalysis using test strips was employed in 4 diabetic patients (16%). This assessment revealed glucosuria, proteinuria, hematuria, and ketonuria. Numerous studies have identified glucosuria, proteinuria, and ketonuria as key urinary biochemical abnormalities in individuals diagnosed with diabetes mellitus (Megan J. Morgan et al., 2008; F. Fracassi et al., 2004; Rebecka Hess et al., 2000; Edward C. Feldman et al., 2015).

Hyperadrenocorticism was diagnosed in half of the patients (5 cases) using ultrasound in conjunction with biochemical analysis. Additionally, 4 of these patients underwent low-dose dexamethasone suppression testing, while 3 individuals were evaluated through a combination of hematology and biochemistry. Although many studies have utilized the ACTH stimulation test as the primary diagnostic method, Feldman et al. (1996) and Behrend et al. (2013) consider the low-dose dexamethasone suppression test to be particularly useful for diagnosing hyperadrenocorticism. Analysis of paraclinical investigation results indicated that 50% of patients exhibited elevated alkaline phosphatase or alanine aminotransferase levels; 30% showed neutrophilia or thrombocytosis; and 20% demonstrated lymphopenia or lymphocytosis, thrombocytosis, eosinopenia, monocytosis, as well as increased levels of gamma-glutamyltransferase, urea, or creatinine. Two studies have highlighted thrombocytosis, lymphopenia, eosinopenia, and elevated ASAT, ALAT, and GGT as principal paraclinical changes, which were also observed in this study (D. G. O'Neill et al., 2016; Mark E. Peterson, 1984). A study conducted in Japan identified thrombosis as a complication associated with hyperadrenocorticism in a canine patient (Takairo Teshima et al., 2008).

Ultrasonographic examination revealed involvement of only one adrenal gland in most cases, with no specific predilection for the left or right adrenal gland. However, in one patient, both adrenal glands were enlarged, exceeding 2.2 cm in size. Common

pathologies identified included cystic degeneration, focal mineralization, hypertrophy, and neoplastic changes. According to Peterson (1984), 10-15% of dogs diagnosed with hyperadrenocorticism exhibit unilateral adrenal neoplasms. Behrend et al. (2013) highlighted the necessity of correlating imaging findings with hormonal assays to achieve a definitive diagnosis. In one case, computed tomography revealed a pituitary macroadenoma, while another case was attributed to iatrogenic hyperadrenocorticism due to prolonged prednisone administration. Additionally, ultrasonography identified concurrent conditions such as pancreatitis (10.86%), hepatomegaly (10.86%), and biliary mucoceles (15.21%).

Hypothyroidism diagnosis was based on the measurement of thyroid hormones (T4, fT4) and thyroid-stimulating hormone (TSH). The data indicated that, in most cases (3 cases), the diagnosis was established through the measurement of T4, fT4, and TSH. In some cases, diagnosis was facilitated by measuring only T4 in conjunction with TSH or by evaluating T4 as a solitary parameter. Rand et al. (2013) suggested that assessing TSH improves the diagnostic accuracy for fT4 and T4.

The presumptive diagnosis of Addison's disease was based on the Na:K ratio, which was approximately 24:1, and the presence of hyponatremia, hyperkalemia, hypochloremia, and hypoglycemic episodes. Following treatment with Fludrocortisone, stabilization of the patient was observed, which supported the diagnosis. It is noteworthy that the ACTH stimulation test could not be performed due to its unavailability in Romania, necessitating a therapeutic diagnostic approach. The principal paraclinical changes observed in this study, which are consistent with the literature, include a Na:K ratio below 27:1, with or without hyponatremia, hyperkalemia, hypochloremia, and hypoglycemia (Nelson et al., 2020).

CONCLUSIONS

Endocrine disorders predominantly affect geriatric patients, typically those aged 10 years or older, who are generally normoweight. The analysis did not reveal a significant predisposition based on sex, though it was observed that intact patients are more susceptible to these conditions. Among the endocrine disorders identified, diabetes mellitus and hyperadrenocorticism were the most common. A seasonal pattern was noted, with these conditions being more frequently diagnosed during the winter months. A notable predisposition was found in certain breeds, particularly small breeds such as Bichons and Westies, as well as mixed-breed dogs. These breeds appeared more frequently in the cases studied. Diabetes mellitus was most commonly diagnosed in the spring, with a higher prevalence observed in intact males. This condition primarily affected middle-aged or geriatric dogs who were normoweight. A breed-specific predisposition was evident, with small breeds like Westies and Bichons being particularly affected. For hyperadrenocorticism, no clear sex predisposition was identified. However, a seasonal pattern was observed, with the condition being more common in the winter months. The disorder predominantly affected middle-aged or geriatric patients, who were often overweight. The breeds most frequently affected by hyperadrenocorticism were Bichons, Dachshunds (Teckels), and Poodles. The symptomatology of these endocrine disorders commonly included gastrointestinal symptoms such as vomiting and diarrhea, as well as polyuria and polydipsia. Additionally, signs indicating a general deterioration in health, such as apathy,

lethargy, inappetence, anorexia, and progressive weight loss, were frequently observed. Comorbid conditions often involved the involvement of two or more systems, indicating a complex interplay of health issues in affected patients.

In conclusion, the diagnosis of endocrine disorders was established by correlating biochemical and endocrine data in 41% of patients. The majority of individuals exhibited elevated alkaline phosphatase (44%) and gamma-glutamyl transferase (36%). Diabetes mellitus diagnosis was predominantly based on glucose monitoring and glucose tolerance tests. Ultrasonographic examination revealed adrenal gland abnormalities in 50% of patients with hyperadrenocorticism. Canine hypothyroidism was primarily diagnosed through the measurement of thyroid hormones (T4, fT4) along with TSH.

REFERENCES

1. Beam Stacy, Maria Correa, M.G. Davidson, 1999, A retrospective-cohort study on the development of cataracts in dogs with diabetes mellitus: 200 cases, Veterinary Ophtalmology, 2:169 – 172
2. Behrend Ellen, H.S. Kooistra, R. Nelson, C.E. Reusch, J.C. Scott-Moncrieff, 2013, Diagnosis of Spontaneous Canine Hyperadrenocorticism: 2012 ACVIM Consensus Statement (Small Animal), J Vet Intern Med, 27:1292 – 1304
3. Blois Shauna, Erica Dickie, S. A. Kruth, Dana G. Allen, 2011, Multiple endocrine diseases in dogs: 35 cases (1996–2009), JAVMA, Vol 238, No. 12, pp. 1616 – 1620
4. Carotenuto Gaia, Eleonora Malerba, Costanza Dolfini, Francesca Brugnoli, P. Giannuzzi, G. Semprini, P. Tosolini, F. Fracassi, 2019, Cushing's syndrome—an epidemiological study based on a canine population of 21,281 dogs, Open Veterinary Journal, Vol. 9(1): 27 – 32
5. Davison Jennifer, M. E. Herrtage, B. Catchpole, 2015, Study of 253 dogs in the United Kingdom with diabetes mellitus, Veterinary Record 156, pp. 467 – 471 .
6. Fall Tove, Helene Hansson Hamlin, Ake Hedhammar, Olle Kampe, Agneta Egenvall, 2007, Diabetes Mellitus in a Population of 180,000 Insured Dogs: Incidence, Survival, and Breed Distribution, J Vet Intern Med, 21:1209 – 1216
7. Fall Tove, Helene Hansson Hamlin, Ake Hedhammar, Olle Kampe, Agneta Egenvall, 2007, Diabetes Mellitus in a Population of 180,000 Insured Dogs: Incidence, Survival, and Breed Distribution, J Vet Intern Med, 21:1209 – 1216
8. Feldman Edward C. , R. W. Nelson, M. S. Feldman, 1996, Use of low- and highdose dexamethasone tests for distinguishing pituitary-dependent from adrenal tumor hyperadrenocorticism in dogs, Journal of the American Veterinary Medical Association, 209: 772 – 775
9. Fracassi Federico, L. Zagnoli, D. Rosenberg, T. Furlanello, M. Caldin, 2014, Spontaneous acromegaly: A retrospective case control study in German shepherd dogs, The Veterinary Journal, Italia, 202:69 – 75
10. Gallelli María Florencia, M.F. Cabrera Blatter, V. Castillo, 2010, A comparative study by age and gender of the pituitary adenoma and ACTH and a-MSH secretion in dogs with pituitary-dependent hyperadrenocorticism, Research in Veterinary Science, 88:33 – 40
11. Guptill Lynn, L. Glickman, N. Glickman, 2003, Time Trends and Risk Factors for Diabetes Mellitus in Dogs: Analysis of Veterinary Medical Data Base Records (1970–1999), The Veterinary Journal, 165:240 – 247
12. Hess Rebecka S., H.M. Saunders, T.J. Van Winkle, Cynthia Ward, 2000, Concurrent disorders in dogs with diabetes mellitus: 221 cases (1993–1998), JAVMA, Vol 217, No. 8, pp. 1166 – 1172

13. Hoenig Margarethe, 2002, Comparative aspects of diabetes mellitus in dogs and cats, Molecular and Cellular Endocrinology, 197:221 – 229.
14. Hoffman Joel Manuel, B. N. Lourenço, D. E. L. Promislow, K. E. Creevy, 2018, Canine hyperadrenocorticism associations with signalment, selected comorbidities and mortality within North American veterinary teaching hospitals, Journal of Small Animal Practice, USA, pp. 1 – 9
15. Llach Francisco, F. Velasquez Forero, 2001, Secondary hyperparathyroidism in chronic renal failure: Pathogenic and clinical aspects, American Journal of Kidney Diseases, Vol. 38, No. 5, pp 20 – 33.
16. Mattin Madeleine, D. O'Neill, D. Church, P. D. McGreevy, P. C. Thomson, D. Brodbelt, 2014, An epidemiological study of diabetes mellitus in dogs attending first opinion practice in the UK, Veterinary Record.
17. Mattin Madeleine, D. O'Neill, D. Church, P. D. McGreevy, P. C. Thomson, D. Brodbelt, 2014, An epidemiological study of diabetes mellitus in dogs attending first opinion practice in the UK, Veterinary Record
18. Mooney Carmel T., M. E. Peterson, 2012, BSAVA Manual of Canine and Feline Endocrinology 4th edition, British Small Animal Veterinary Association, Anglia
19. Morgan Megan, C.H. Vite, Anant Radhakrishnan, Rebecka S. Hess, 2008, Clinical peripheral neuropathy associated with diabetes mellitus in 3 dogs, The Canadian veterinary journal, vol. 49, pp. 583 – 586
20. Nelson Richard W., C. Guillermo Couto, 2020, Small Internal Medicine 6th edition, Elsevier, Missouri
21. O'Neill Dan, C. Scudder, J. M. Faire, D. B. Church, P. D. McGreevy, P. C. Thomson, D. C. Brodbelt, 2016, Epidemiology of hyperadrenocorticism among 210,824 dogs attending primary-care veterinary practices in the UK from 2009 to 2014, Journal of Small Animal Practice, pp. 1 – 8
22. Peterson Mark E., 1984, Hyperadrenocorticism, Veterinary Clinics of North America: Small Animal Practice, Vol. 14, No. 4, pp. 731 – 746
23. Peterson Mark E., N. Altszuler, 1981, Suppression of growth hormone secretion in spontaneous canine hyperadrenocorticism and its reversal after treatment, Am J Vet Res, 42:1881 – 1883
24. Peterson Mark E., P.P. Kintzer, P.H. Kass, 1996, Pretreatment clinical and laboratory findings in dogs with hypoadrenocorticism: 225 cases (1979-1993), JAVMA, Vol. 208, No. 1: 85 – 91
25. Peterson Mark E., S.R. Gilbertson, W.D. Drucker, 1982, Plasma cortisol response to exogenous ACTH in 22 dogs with hyperadrenocorticism caused by adrenocortical neoplasia, JAVMA, Vol. 180, No. 5: 542 – 544
26. Pöppl Álan Gomes, Isadora Comparsi Coelho, Camila Alves da Silveira, M. B. Moresco, G. L. Carvalho, 2016, Frequency of Endocrinopathies and Characteristics of Affected Dogs and Cats in Southern Brazil, Acta Scientiae Veterinariae, Brazilia, pp. 1 – 8
27. Rand Jacquie, Ellen N. Behrend, Danièlle Gunn-Moore, Michelle L. Campbell-Ward, 2013, Clinical Endocrinology of Companion Animals, John Wiley & Sons, Inc., USA
28. Reusch Claudia E., E.C. Feldman, 1991, Canine Hyperadrenocorticism Due to Adrenocortical Neoplasia Pretreatment Evaluation of 41 Dogs, Journal of Veterinary Internal Medicine, 5:3 – 10
29. Rijnberk Ad, H.S. Kooistra, J.A. Mol, 2003, Endocrine diseases in dogs and cats: similarities and differences with endocrine diseases in humans, Growth Hormone & IGF Research, Olanda, pp. S158 – S162
30. Rijnberk Ad, Hans S. Kooistra, 2010, Clinical Endocrinology of Dogs and Cats, Schlütersche, Germania
31. Stelzer Ina Annelies, Petra Clara Arck, 2016, Immunity and the Endocrine System, Encyclopedia of Immunobiology, pp. 73 – 85

32. Teshima Takahiro, Y.Hara, T.Taoda, H.Koyama, K.Takahashi, Y.Nezu, Y.Harada, T.Yogo, K.Nishida, R.Y. Osamura, A.Teramoto, M.Tagawa, 2008, Cushing's Disease Complicated with Thrombosis in a Dog, J. Vet. Med. Sci., 70(5): 487–491
33. Tkalcic Suzana, 2010, Endocrine Disorders of Animals: A few good lessons, Acta Clin Croat, Pomona, CA, USA, pg. 222
34. Wood Farica D., Rachel E. Pollard, Megan R. Uerling, E. C. Feldman, 2007, Diagnostic imaging findings and endocrine test results in dogs with pituitary-dependent hyperadrenocorticism that did or did not have neurologic abnormalities: 157 cases (1989–2005), JAVMA, Vol. 231, No. 7, pp. 1081 – 1085