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Nagella Naveen

PhD Scholar, Division of
medicine, ICAR-IVRI,
Izatnagar, Bareilly, Uttar
Pradesh, India

Nalluri Lakshmi Rani

Professor and Head, Department
of Veterinary Medicine, NTR
College of Veterinary Science,
Gannavaram, Sri Venkateswara
Veterinary University, Andhra
Pradesh, India

Yalavarthi Chaitanya

Assistant Professor, Department
of Veterinary Medicine, NTR
College of Veterinary Science,
Gannavaram, Sri Venkateswara
Veterinary University, Andhra
Pradesh, India

Chennamaraju Pavan Kumar

Assistant Professor, Department
of Veterinary Medicine, NTR
College of Veterinary Science,
Gannavaram, Sri Venkateswara
Veterinary University, Andhra
Pradesh, India

Corresponding Author:

Nalluri Lakshmi Rani

Professor and Head, Department
of Veterinary Medicine, NTR
College of Veterinary Science,
Gannavaram, Sri Venkateswara
Veterinary University, Andhra
Pradesh, India

Hypothyroidism associated insulin resistant diabetes mellitus in a dog: A case report

**Nagella Naveen, Nalluri Lakshmi Rani, Yalavarthi Chaitanya and
Chennamaraju Pavan Kumar**

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Abstract

Hypothyroidism and diabetes mellitus are two common endocrine disorders in dogs, but their co-occurrence is relatively rare and poses significant diagnostic and therapeutic challenges. A three-year-old female Indian Spitz, weighing 17kg, was presented with the history of polyuria, polydipsia, weight gain, lethargy, seborrhoea with recurrent skin infections, rough brittle hair coat and exercise intolerance. On clinical examination accelerated heart rate was observed. Haemato-biochemical analysis revealed hyperglycemia both pre-prandially and post-prandially, while thyroid profile indicated hypothyroidism with reduced total T4 and free T4 levels. Based on the diagnostic investigation case was diagnosed as hypothyroidism associated insulin-resistant diabetes mellitus. The dog was managed with a combination of hormone replacement therapy, insulin therapy, supportive medications, and dietary modifications. This report highlights the significance of considering concurrent endocrine disorders in canine patients with poor glycemic control, emphasizing the need for early diagnosis and integrated management to improve clinical outcomes.

Keywords: Dog, Diabetes mellitus, Endocrine disorder, Hypothyroidism, Insulin resistance

Introduction

Hypothyroidism and diabetes mellitus are among the most frequently reported endocrine disorders in dogs, each causing significant metabolic disturbances. Hypothyroidism is the most frequently encountered clinical endocrinopathy in dogs, resulting from decreased production of thyroid hormones, namely thyroxine (T4) and triiodothyronine (T3) (Jaiswal *et al.*, 2018; Bugbee *et al.*, 2023) ^[10, 2]. The thyroid gland plays a vital role in metabolic regulation by synthesizing T4 and T3 under the influence of thyrotropin (TSH) secreted from the pituitary gland, which is in turn regulated by thyrotropin-releasing hormone (TRH) from the hypothalamus. Dysfunction within the hypothalamic-pituitary-thyroid (HPT) axis can result in inadequate thyroid hormone production and subsequent hypothyroidism (Gulzar *et al.*, 2014) ^[9]. Clinical signs of hypothyroidism are often vague and non-specific, as thyroxine deficiency affects multiple organ systems throughout the body. Diagnosing hypothyroidism in dogs can be challenging, as its clinical signs often overlap with those of other diseases (Kour *et al.*, 2021) ^[11]. Dogs with low total and free T4 concentrations, along with compatible clinical or biochemical findings, are considered hypothyroid. Typically, total T4 below 1 µg/dL and free T4 below 0.8 ng/dL are used as diagnostic thresholds (Nelson and Couto, 2020; Bugbee *et al.*, 2023) ^[14, 2]. Synthetic thyroid hormone replacement, primarily sodium levothyroxine, is the treatment of choice for canine hypothyroidism. The recommended dose is 0.02 mg/kg body weight orally once daily (Ettinger *et al.*, 2017) ^[7].

Diabetes mellitus (DM) is a metabolic syndrome characterized by persistent hyperglycemia resulting from impaired insulin secretion by pancreatic β-cells, reduced tissue sensitivity to insulin, or a combination of both (Davison, 2003) ^[3]. In dogs, β-cell loss is often rapid and progressive, commonly attributed to immune-mediated destruction, vacuolar degeneration, or chronic pancreatitis (Behrand *et al.*, 2018) ^[1]. According to the World Health Organization (WHO), DM is a metabolic disorder of multiple aetiologies characterised by persistent

hyperglycaemia with disturbances of carbohydrate, fat, and protein metabolism, resulting from a defect in insulin secretion, insulin action, or both (Oliveira *et al.*, 2024) [16]. In dogs, the definition of diabetes mellitus is less clearly established compared to humans. According to the Agreeing Language in Veterinary Endocrinology (ALIVE) consensus (endorsement 105/110), canine diabetes mellitus is diagnosed in dogs with random blood glucose ≥ 11.1 mmol/L (≥ 200 mg/dL) and classic clinical signs or hyperglycemic crisis. If clinical signs are unclear, diagnosis should be confirmed by repeat blood glucose measurement or alternative markers such as elevated glycated proteins or glucosuria. Dogs with fasting glucose 7–11.1 mmol/L (126–200 mg/dL) are distinguished from stress hyperglycemia by persistent fasting hyperglycemia >24 h or elevated glycated proteins. Various insulin formulations are employed in the long-term management of canine diabetes mellitus. These insulins primarily serve as basal agents, maintaining a steady background level of the hormone throughout the day. This approach helps prevent severe hyperglycaemia and reduces the risk of hypoglycaemic episodes.

Although hypothyroidism and diabetes mellitus can occur independently, their coexistence in dogs presents a significant therapeutic challenge due to the complex interplay between thyroid hormones and glucose metabolism. Thyroid hormone deficiency may exacerbate insulin resistance, impair cellular glucose uptake, and reduce overall insulin sensitivity, often contributing to persistent hyperglycemia despite appropriate insulin therapy (Gierach *et al.*, 2014) [6]. Additionally, overlapping clinical signs of these endocrine disorders can complicate diagnosis, and failure to identify concurrent hypothyroidism may lead to suboptimal treatment outcomes. This case report describes an Indian Spitz bitch diagnosed with hypothyroidism-associated insulin-resistant diabetes

mellitus, highlighting the critical need for comprehensive endocrine evaluation in canine patients with poorly controlled diabetes. Early detection and management of both disorders can improve clinical response, enhance glycemic control, and reduce the risk of long-term complications.

Case description

A three-year-old female Indian Spitz, weighing 17 kg, was presented to the Veterinary Clinical Complex, NTR College of Veterinary Science, Gannavaram, with a history of polyuria, polydipsia, weight gain, lethargy, seborrhoea, recurrent skin infections, constipation, rough brittle hair coat, and exercise intolerance. On clinical examination, slightly pallor mucous membranes and an accelerated heart rate were observed. Radiographic evaluation revealed marked distension of the gastrointestinal tract with gas and faecal material, confirming constipation (Figure 1). Electrocardiography (Lead II) demonstrated a regular sinus rhythm with shortened R-R intervals, consistent with sinus tachycardia (Figure 4a). Echocardiographic examination further revealed mild pleural and pericardial effusion (Figure 2). Haemato-biochemical analysis revealed mild non-regenerative anemia, persistent hyperglycemia both pre-prandially and post-prandially, while thyroid profile indicated hypothyroidism with reduced total T4 and free T4 levels (Table 1). Based on the diagnostic investigation, the case was diagnosed as hypothyroidism associated insulin-resistant diabetes mellitus complicated with constipation and sinus tachycardia. This report highlights the significance of considering concurrent endocrine disorders in canine patients with poor glycemic control, emphasizing the need for early diagnosis and integrated management to improve clinical outcomes.



Fig 1: Lateral abdominal view showing distended gut with gas and feces (arrow)

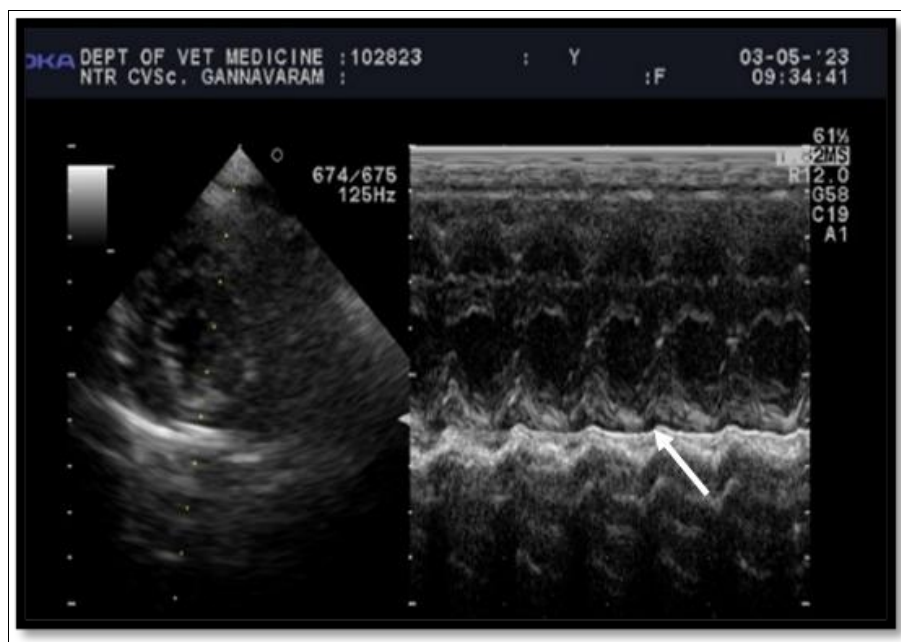


Fig 2: Pericardial & pleural effusion (2D); normal ventricular motion (M-mode)

Table 1: Haemato-biochemical profile

Parameter	0 th day	15 th day	30 th day	60 th day
Hb (gm/dl)	10.8	11.2	13.2	16.8
PCV (%)	32.6	34.5	38.72	47.86
TEC ($\times 10^6/\text{mm}^3$)	4.71	4.95	5.10	5.45
TLC ($\times 10^3/\text{mm}^3$)	13.62	12.97	9.78	10.34
Neutrophils (%)	70	67	68	72
Lymphocytes (%)	26	27	32	27
Monocytes (%)	4	6	0	1
Platelets ($/\text{mm}^3$)	2,91,000	2,92,000	2,57,000	3,13,000
ALT (IU/L)	87.39	65.31	56.14	44.3
AST (IU/L)	76.70	66.78	55.32	48.9
ALP (IU/L)	117	78	63	65.3
Creatinine (mg/dL)	0.87	1.1	1.0	1.2
Glucose (mg/dL) (Pre-prandial)	425	360	146	135
Glucose (mg/dL) (Post prandial)	520	438	172	164
Total T4 ($\mu\text{g/dL}$)	0.7	1.0	2.4	3.5
Free T4 (ng/dL)	0.15	0.19	0.6	0.99
Cholesterol (mg/dL)	196	182.3	177.8	153.34
Triglycerides (mg/dL)	115	102.4	94.73	78.60

Findings/treatment and outcome

The dog was managed with a combination of hormone replacement therapy, insulin therapy, supportive medications, and dietary modifications. Levothyroxine supplementation was initiated at 20 $\mu\text{g/kg}$ body weight once daily orally to correct hypothyroidism. To manage the mild pleural and pericardial effusion, furosemide at 3 mg/kg body weight twice daily orally was prescribed as a diuretic.

For glycemic regulation, Mixtard® (a combination of regular and intermediate-acting insulin) was initially administered at a starting dose of 0.5 IU/kg body weight subcutaneously twice daily. The dose was gradually titrated up to 1 IU/kg over a 15-day treatment period in an attempt to achieve optimal glycemic control and minimize fluctuations in blood glucose levels. Despite careful dose adjustments and close monitoring, adequate long-term stabilization of blood glucose could not be achieved with Mixtard®, and persistent hyperglycemia was noted. Consequently, the insulin therapy was transitioned to Glargine (a long-acting insulin analog) at a dose of 0.5 IU/kg body weight subcutaneously once daily. This change resulted

in more consistent and prolonged glycemic control, leading to improved clinical outcomes, reduced risk of hypoglycemic episodes, and overall better management of the diabetic condition.

Dermatological issues were managed using a combination of supportive and topical therapies, including a multivitamin syrup supplemented with omega-3 and omega-6 fatty acids at 5 ml orally twice daily, topical medicated oils and regular bathing with medicated shampoo. In addition, the owner was advised to provide a strict diabetic diet, incorporating brown rice and other suitable components, to support glycemic control. After 60 days of consistent therapy, the dog showed marked clinical improvement, with resolution of dermatological lesions, improved energy levels and stabilization of blood glucose. The case ultimately culminated in a smooth and uneventful recovery, demonstrating the effectiveness of a multimodal therapeutic approach in managing concurrent endocrine and dermatological disorders in dogs.



Fig 3: Clinical improvement of the dog on Day 0, Day 30 and Day 60 of treatment

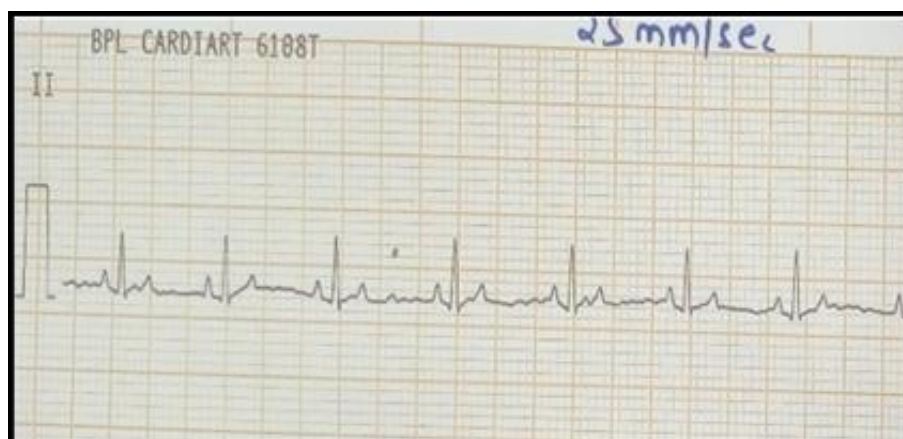


Fig 4a: 0th day

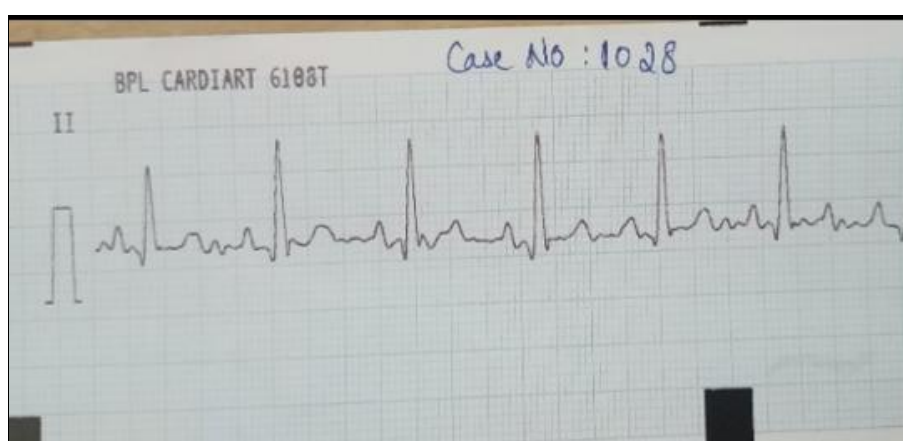


Fig 4b: 60th day

Fig 4: ECG showed improvement in voltage of QRS complexes

Discussion

Concurrent hypothyroidism and diabetes mellitus in dogs is uncommon but clinically significant, as the coexistence of both endocrinopathies complicates diagnosis and long-term management. Hypothyroidism contributes to insulin resistance through altered glucose metabolism, dyslipidemia and reduced insulin sensitivity, thereby complicating glycemic regulation in diabetic dogs (De Oliveira and Ritter, 2025) ^[4]. The clinical signs observed in the present case correlate with the findings of Lokes-Krupka *et al.* (2020) ^[12], who also reported similar manifestations in hypothyroid dogs. In the present case, the dog showed constipation, which aligns with the findings of Gori *et al.* (2023) ^[8], who reported gastrointestinal signs in about 45 per cent of hypothyroid dogs. This highlights the role of hypothyroidism in altering gut motility. Ojeda *et al.* (2015) ^[5] reported pericardial effusion in a hypothyroid dog; similarly, in the present case, mild pleural and pericardial effusion with sinus tachycardia were noted, suggestive of hypothyroidism-related ECG changes that could be reversible with hormone therapy. The markedly elevated pre-prandial and post-prandial glucose

concentrations confirm the diagnosis of diabetes mellitus in this case. The dog showed a total T4 concentration of 0.7 µg/dL and a free T4 concentration of 0.15 ng/dL, both markedly below the reference cut-offs (<1 µg/dL and <0.8 ng/dL, respectively) as per Nelson and Couto (2020) ^[14], thereby confirming the diagnosis of hypothyroidism concurrent with diabetes mellitus.

In this case, correction of dyslipidemia was noted, with cholesterol and triglycerides declining after thyroid hormone replacement. This aligns with Mitrevska *et al.* (2023) ^[13], who reported that hypothyroid dogs develop hyperlipidemia from impaired lipid metabolism, predisposing to insulin resistance and atherosclerosis. In this case, glycemic control was suboptimal with Mixtard®, prompting a switch to Glargine, which provides a more stable and prolonged insulin action. The change underscores the importance of individualized insulin therapy in managing diabetic dogs with concurrent hypothyroidism.

Haemato-biochemical analysis demonstrated a progressive normalization of liver enzymes (ALT, AST, ALP), glucose levels and lipid profile over the course of therapy, indicating

improved metabolic control. Hematological improvement, including increases in hemoglobin and packed cell volume, further reflects the correction of the metabolic derangements associated with hypothyroidism and diabetes mellitus. These findings are in agreement with Kour *et al.* (2021) [11], who suggested that anaemia in hypothyroid dogs may result from reduced plasma erythropoietin, impaired responsiveness of erythroid progenitors to erythropoietin, or a direct effect of thyroid hormone on early haematopoietic and pluripotent stem cells. The integrated management strategy, including levothyroxine supplementation, insulin therapy adjustment, supportive care for dermatological manifestations, and dietary modifications with a strict diabetic diet, led to marked clinical improvement over 60 days, as demonstrated in Figures 4a–c. This emphasizes the necessity of addressing concurrent endocrine disorders in canine patients to achieve optimal glycemic control and overall clinical recovery.

The clinical outcome in this case underscores the importance of screening for hypothyroidism in diabetic dogs, particularly those exhibiting poor or unstable glycemic control. Correction of the underlying thyroid deficiency not only improved insulin sensitivity but also facilitated more consistent long-term stabilization of blood glucose levels. These observations align with earlier reports indicating that diabetes associated with hypothyroidism often necessitates a multimodal therapeutic approach, in which both endocrine disorders are addressed concurrently to achieve optimal clinical outcomes (Behrend *et al.*, 2018; Bugbee *et al.*, 2023) [1, 3]. Timely identification and management of thyroid dysfunction can therefore play a crucial role in enhancing the efficacy of insulin therapy and overall disease management in affected dogs.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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