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Hemato-biochemical and thyroid profile alterations in dogs with hypothyroidism associated neuromuscular disorders

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Abstract

The present study investigated the clinical signs, hematological and biochemical parameters, and thyroid hormone levels in dogs with hypothyroidism associated neuromuscular disorders. A total of 28 dogs were examined, comprising 7 clinically healthy dogs (Group I) and 21 hypothyroid dogs exhibiting neuromuscular symptoms (Group II). Serum levels of Total Triiodothyronine (TT₃), Total Thyroxine (TT₄), and free Thyroxine (fT₄) were measured using Radio Immuno Assay, while Thyroid Stimulating Hormone (TSH) levels were assessed with a canine-specific ELISA kit. Neuromuscular abnormalities observed in hypothyroid dogs included nystagmus (4.76%), seizures (9.52%), proprioceptive ataxia (14.29%), head tilt (14.29%), paraparesis (14.29%), facial asymmetry (23.81%), megaesophagus-related regurgitation (23.81%), and tetraparesis (28.57%). The affected dogs showed normocytic normochromic anemia and elevated serum cholesterol levels compared to healthy controls. Significant differences ($p \leq 0.01$) were noted in TT₄, fT₄, and TSH concentrations between the groups, whereas TT₃ levels did not differ significantly ($p > 0.05$).

Keywords: Canine hypothyroidism, neuromuscular disorders, thyroid hormones, hematological parameters, biochemical parameters

Introduction

Hypothyroidism is the most common hormonal disorder in dogs, with a global prevalence of 0.20% (Dixon, 2001) [11] and 0.80% (Catherine *et al.*, 2005) [8] and reported rates in India of 0.206% in Mumbai, 0.40% in Hisar, and 0.174% in Punjab (Pawar, 2009; Gulzar *et al.*, 2014; Kour *et al.*, 2020) [32, 17, 25]. The nervous and endocrine systems jointly regulate body functions, with the former acting quickly through electrical signals and the latter through slower, long-lasting hormonal effects (Vala *et al.*, 2013) [37]. Thyroxine plays a key role in ATP production by enhancing mitochondrial function and ATPase activity, which supports the Na⁺/K⁺ pump critical for axonal transport. In hypothyroidism, reduced ATP and ATPase activity impair this transport, potentially leading to axonal degeneration and peripheral neuropathy (Jaggy *et al.*, 1994) [19]. As a result, hypothyroidism can affect the cranial and peripheral nerves as well as the central nervous system, causing signs such as facial nerve paralysis, megaesophagus, vestibular disease, generalized weakness, proprioceptive deficits, and lower motor neuron dysfunction that may progress to paraparesis or tetraparesis (Lathan, 2012; Ettinger *et al.*, 2000) [28, 12]. In India, Radio Immunoassay (RIA) has been widely used for hormone measurement in veterinary clinical settings (Dadke *et al.*, 2018; Roopali *et al.*, 2020; Galdhar *et al.*, 2021; Jayabhaye *et al.*, 2021; Galdhar *et al.*, 2022; Salutgi *et al.*, 2023; Kawade *et al.*, 2025) [9, 34, 15, 20, 16, 35, 23]. At Mumbai Veterinary College, the Department of Veterinary Clinical Medicine and Veterinary Nuclear Medicine, along with the radioisotope laboratory, has successfully established reference ranges for canine thyroid hormones, including TT₃, TT₄, and fT₄, using RIA.

The study focuses on the hemato-biochemical and thyroid profile alterations in Dogs with hypothyroidism associated neuromuscular disorders.

Materials and Methods

Statutory approval: The study commenced following approval from the Institutional Ethics Committee for Veterinary Clinical Research (IEC-VCR) and the Institutional Biosafety Committee (IBSC) at Mumbai Veterinary College, MAFSU, Mumbai, India.

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Selection of hypothyroid dogs

A total of 28 dogs were included, comprising 7 apparently healthy dogs (Group I) and 21 dogs with suspected hypothyroidism and neuromuscular disorders (Group II). Group II included dogs of various breeds (10 males and 11 females) with a mean age of 6.83 ± 0.68 years and average body weight of 21.26 ± 2.42 kg. These cases were ethically enrolled at the clinical facility of Mumbai Veterinary College for thyroid evaluation.

Hormonal analysis

Blood samples were collected from the cephalic or saphenous veins, and serum was stored at -20°C for hormonal testing. TT_3 , TT_4 , and fT_4 were measured using commercial human RIA kits (Immunotech, Czech Republic), while canine-specific TSH was assessed using an ELISA kit (Wuhan Fine Biotech Co., Ltd). Hormonal assays were conducted at the Radio Isotope Laboratory, Mumbai Veterinary College, following the manufacturers' protocols. Each sample was tested in duplicate, and quality control checks ensured assay reliability through control sample evaluation and recovery rates.

Diagnosis

Hypothyroidism was diagnosed based on abnormal thyroid hormone levels and clinical improvement following thyroxine supplementation.

Statistical analysis

Data were analyzed using mean and standard error calculations as per Snedecor and Cochran (2004), with additional nonparametric methods applied for result validation.

Results and discussion

The neurological signs recorded in the present study were nystagmus ($n=1/21$, 4.76%), seizures ($n=2/21$, 9.52%), proprioceptive ataxia ($n=3/21$, 14.29%), head tilt ($n=3/21$, 14.29%), paraparesis ($n=3/21$, 14.29%), facial asymmetry ($n=5/21$, 23.81%), regurgitation associated with megaesophagus ($n=5/21$, 23.81%), and tetraparesis ($n=6/21$, 28.57%). Comparable neurological manifestations have been documented in previous studies by Bichsel *et al.* (1988) [4], Jaggy *et al.* (1994) [19], Panciera (1994) [31], and Fracassi and Tamborini (2011) [14].

The mean levels of TT_3 , TT_4 , fT_4 , and TSH in healthy dogs were 1.08 ± 0.14 nmol/L, 20.12 ± 1.40 nmol/L, 14.77 ± 0.83 pmol/L, and 0.25 ± 0.04 ng/mL, respectively. In hypothyroid dogs with neuromuscular disorders, the corresponding mean values were 0.89 ± 0.04 nmol/L for TT_3 , 9.45 ± 0.94 nmol/L for TT_4 , 7.72 ± 0.37 pmol/L for fT_4 , and 1.59 ± 0.20 ng/mL for TSH. In the hypothyroid dogs associated with neuromuscular disorders, the mean concentrations of TT_3 , TT_4 , and fT_4 were below the reference ranges established by Galdhar *et al.* (2022) [16] for healthy dogs (Table 1). A highly significant ($p \leq 0.01$) difference was observed in serum total thyroxine and free thyroxine levels between the groups, while a non-significant difference was found in TT_3 concentrations. Similar findings were reported by Higgins *et al.* (2006) [18] and Alone *et al.* (2025) [1]. The lack of a significant difference in TT_3 levels between healthy and hypothyroid dogs supports the observations of Kantrowitz *et al.* (2001) [22], who queried about the sensitivity and accuracy of TT_3 for diagnosing

hypothyroidism. The average TSH level in the hypothyroid group exceeded the reference ranges established for healthy dogs by Kemppainen and Behrend (2001) [24], Gulzar *et al.* (2014) [17], Kaur *et al.* (2021) [26], and Boretti *et al.* (2022) [7]. A significant difference ($p \leq 0.01$) was observed between the healthy and hypothyroid groups, with hypothyroid dogs showing elevated TSH concentrations. These findings are consistent with those reported by Bonagura and Twedt (2009) [6], Pawar (2009) [32], and Fernandez and Seth (2016) [13], who also noted significantly increased TSH levels in hypothyroid cases.

The Mean $\pm$ SE values for hemoglobin, total erythrocyte count, and packed cell volume in healthy dogs in this study were 14.77 ± 0.90 (gm%), 6.55 ± 0.40 ($\times 10^6/\mu\text{l}$), and 43.23 ± 2.63 (%), respectively. In contrast, the mean values for these parameters in hypothyroid dogs were 11.11 ± 0.58 (gm%), 4.80 ± 0.25 ($\times 10^6/\mu\text{l}$), and 32.29 ± 1.71 (%) (Table 1). The study found highly significant ($p \leq 0.01$) differences in hemoglobin, total erythrocyte count, and packed cell volume between healthy dogs (Group I) and those with hypothyroidism-associated neuromuscular disorders (Group II). The Mean $\pm$ SE values for mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration were within the normal reference range. However, the values for hemoglobin and packed cell volume were below the reference range, indicating normocytic, normochromic anemia in the hypothyroid dogs of Group II. These findings are consistent with those of Jaggy *et al.* (1994) [19], Kumar *et al.* (2007) [27], Blois (2008) [5], Fracassi and Tamborini (2011) [14], Romão *et al.* (2012) [33], Kour *et al.* (2021) [26], and de Oliveira (2022) [7].

Earlier studies by Mooney (2011) [29], Bertalan *et al.* (2013) [3], and Kour *et al.* (2020) [25] have reported that thyroid hormones stimulate erythropoiesis by promoting the rapid proliferation of immature erythroid progenitors and enhancing erythropoietin (EPO) production through the activation of erythropoietin gene expression. Conversely, Kumar *et al.* (2007) [27] suggested that bone marrow suppression could be a potential cause of anemia in hypothyroid dogs.

The study reported non-significant ($p \leq 0.05$) alterations in the leucocyte and platelet counts.

The lipid profile, including serum cholesterol, showed significant ($p \leq 0.05$) alterations in healthy and hypothyroid groups. The study reported Mean $\pm$ SE values of 154.71 ± 17.95 (mg/dl) in healthy dogs and 219.14 ± 13.76 (mg/dl) in hypothyroid dogs (Table 1). This finding is consistent with the work of Kumar *et al.* (2007) [27], Vitale and Olby (2007) [38], Blois *et al.* (2008) [5], Pawar (2009) [32], Fracassi and Tamborini (2011) [14], Romão *et al.* (2012) [33], de Oliveira (2022) [7], Alone (2024) [2], and Naveen (2024) [2]. The results of the present study also align with Kahn *et al.* (2006) [21], who reported that hypothyroid cases often exhibit cholesterol levels at the upper end of the normal range. These researchers emphasized the role of thyroxine in lipid synthesis, mobilization, and degradation through its effects on hepatic and lipoprotein lipase, as well as its action on hepatic low-density lipoprotein (LDL) receptors. They attributed the observed hypercholesterolemia in hypothyroid dogs to the reduced thyroxine levels associated with the condition.

The study reported non-significant ($p \leq 0.05$) alterations in liver function test, kidney function tests and serum electrolytes between the groups.

Table 1: Comparative analysis Hemato-Biochemical and Thyroid profile in healthy (n=7) and hypothyroid (n=21) dogs.

Sr. No.	Parameter	Healthy Mean $\pm$ SE	Hypothyroid Mean $\pm$ SE	t Value
1	Hb (gm%)	14.77 $\pm$ 0.90	11.11 $\pm$ 0.58	3.24**
2	TEC($\times 10^6/\mu$ l)	6.55 $\pm$ 0.40	4.80 $\pm$ 0.25	3.50**
3	PCV (%)	43.23 $\pm$ 2.63	32.29 $\pm$ 1.71	3.28**
4	Sr. Cholesterol (mg/dl)	154.71 $\pm$ 17.95	219.14 $\pm$ 13.76	2.46*
5	TT ₃ (nmol/L)	1.08 $\pm$ 0.14	0.89 $\pm$ 0.04	1.89
6	TT ₄ (nmol/L)	20.12 $\pm$ 1.40	9.45 $\pm$ 0.94	5.86**
7	fT ₄ (pmol/L)	14.77 $\pm$ 0.83	7.72 $\pm$ 0.37	8.92**
8	TSH (ng/mL)	0.25 $\pm$ 0.04	1.59 $\pm$ 0.20	6.60**
*= $p \leq 0.05$ (Table t= 2.05) and **= $p \leq 0.01$ (Table t= 2.77)				

Conclusion

Dogs with hypothyroidism showed significant ($p \leq 0.05$) changes in hematological and biochemical parameters, including normocytic normochromic anemia and elevated cholesterol levels. Additionally, they had significantly lower ($p \leq 0.01$) serum total and free thyroxine concentrations, while their thyroid-stimulating hormone levels were significantly ($p \leq 0.01$) elevated.

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Conflict of interest

The authors declare that there is no conflict of interest.

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