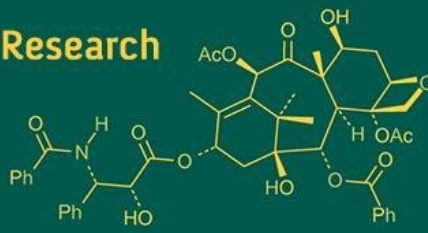
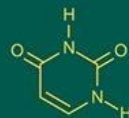


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(1): 958-963
www.biochemjournal.com
Received: 09-11-2025
Accepted: 12-12-2025

Bendangla Changkija
Assistant Professor, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Inzamamul Haque Laskar
MVSc Scholar, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Dolly Thakur
MVSc Scholar, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Harshit Singh
MVSc Scholar, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Ditul Barman
Assistant Professor, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Deepa Lahkar
Assistant Professor, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Utpal Barman
Assistant Professor, Veterinary
Clinical Complex, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Mousumi Hazorika
Assistant Professor, Veterinary
Clinical Complex, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Arabinda Phukan
Professor, Department of Veterinary
Medicine, College of Veterinary
Science, Assam Agricultural
University, Khanapara, Guwahati,
Assam, India

Corresponding Author:
Bendangla Changkija
Assistant Professor, Department of
Veterinary Medicine, College of
Veterinary Science, Assam
Agricultural University, Khanapara,
Guwahati, Assam, India

Therapeutic management of hypothyroidism with concurrent babesiosis in a non-descript dog

Bendangla Changkija, Inzamamul Haque Laskar, Dolly Thakur, Harshit Singh, Ditul Barman, Deepa Lahkar, Utpal Barman, Mousumi Hazorika and Arabinda Phukan

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i11.7162>

Abstract

A non-descript dog aged 4 years old was presented to the Veterinary Clinical Complex, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam with the history of fever for the past 3 days, black coloured soft stool, dark yellow urine, loss of hair on the back of the body, lethargy, itching, chronic obesity and irregular treatment with thyroxine. On clinical examination, temperature was found to be 104.6°F, congested visible mucous membrane, severe alopecia on the back particularly in the tail and neck region and hyperpigmentation, dry hair coat, presence of ticks, and lethargic. The body weight of the dog was 35.6 kilograms. Detailed haemato-biochemical examination revealed low haemoglobin, TEC, total thyroxine (TT4) and blood urea nitrogen. Peripheral blood smear examination was positive *Babesia gibsoni*. Based on clinical and haemato-biochemical examinations, and microscopy, the dog was diagnosed to be suffering from primary hypothyroidism with concurrent with babesia infection. The therapeutic approach adopted in this case (a) babesia infection was treated using Diminazine aceturate, metronidazole, doxycycline, clindamycin and other supportive drugs (b) primary hypothyroidism was managed using Thyroxine sodium. Supportives like iron supplements, antiemetics, acid blockers, essential fatty acids (Omega 3 Omega 6), Vitamin A supplement and B-complexes were given for approximately one month. Noticeable clinical improvement was seen along with improved haemato-biochemical parameters by day 30 post treatment and blood smear was negative for babesia organism and T₄ level increased to 1.3 mcg/dl. Thyroxine sodium @ 250 mcg, orally once daily was advised to be continued lifelong with regular evaluation at 3 months interval. This work reports the successful management of hypothyroidism and babesiosis.

Keywords: Hypothyroidism, T₄, *Babesia gibsoni*, Diminazine aceturate, Thyroxine sodium

Introduction

Hypothyroidism is one of the most common endocrine diseases in dogs, caused by a decrease in the production of thyroxine (T₄) and triiodothyronine (T₃) by the thyroid gland (Strey *et al.*, 2021) [62] with an estimated prevalence of 0.174% to 0.23% (Panciera, 1994; Kour *et al.*, 2020 and O'Neill *et al.*, 2022) [49, 32, 48]. Hypothyroidism in dogs is commonly reported in middle-aged animals, between 4 and 10 years old, castrated and of both sexes (Strey *et al.*, 2021 and O'Neill *et al.*, 2022) [62, 48]. A recent study revealed that the most common breeds diagnosed with hypothyroidism were Tibetan Terriers, Standard Doberman Pinschers and Boxers (O'Neill *et al.*, 2022) [48]. The condition is often manifested as weight gain, lethargy, hair loss, intolerance to the cold and a tragic facial expression thereby reducing the quality of life of affected dogs (Bugbee, *et al.* 2023 and Fleeman and Barret 2023) [10, 12]. Measurement of serum total thyroxine (TT4) concentration is most commonly performed for clinical diagnosis and management of the condition is often a lifelong, daily oral thyroid hormone replacement (Suranti *et al.*, 2008; Bugbee, *et al.* 2023) [63, 10]. Canine babesiosis is a common vector-borne disease caused by intraerythrocytic protozoan parasite of the genus *Babesia* (Irwin 2009) [29]. The disease is endemic to the Indian subcontinent with varying prevalence across different regions depending on vector population, climate and dog demographics. The disease is clinically manifested by anorexia, dehydration, high body temperature, dullness/depression, diarrhoea/constipation, pale mucosa, hepatomegaly, vomiting/nausea, splenomegaly, distended abdomen/ascites, yellow coloured urine, emaciation/weight loss, and ocular discharge (Irwin 2009) [29].

The diagnosis of babesiosis is based on cytological evidence of *Babesia* organism in freshly prepared blood smears. The recommended therapeutic drugs for babesiosis are diminazine aceturate and imidocarb dipropionate. This report describes a case of successful management of hypothyroidism with concurrent babesiosis in a nondescript dog.

Case Presentation

A 4 years old nondescript dog was presented to the Veterinary Clinical Complex, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam with the history of fever for the past 3 days, black coloured soft stool, dark yellow urine, loss of hair on the back of the body, lethargy, chronic obesity (previous record of body weight up to 39 kg) and irregular treatment with thyroxine sodium. On physical examination, temperature was found to be 104.6°F, congested visible mucous membrane, with severe alopecia on the back region and hyperpigmentation (Fig. A), dry hair coat, presence of ticks (++), and lethargy. The body weight of the dog was 35.6 kilograms.

Approximately 5 ml of whole blood was collected from the affected dog on the day of presentation by using 22-gauge needle attached to a 5 ml syringe through saphenous venipuncture. A fraction of whole blood was transferred into K₃-EDTA vacutainer and was subjected to haematological analysis. Haematological parameters viz., haemoglobin (g/dl), Packed cell volume (%), Total leucocyte count ($\times 10^3/\mu\text{l}$), Total erythrocyte count ($\times 10^6/\mu\text{l}$), Thrombocyte count ($\times 10^6/\mu\text{l}$) was estimated on zero-day, day 30 and day 60 after treatment by using Automated Hematology Analyzer (MELET SCHLOESING Laboratoires, FLS257). Serum samples were used for determination of TT4 ($\mu\text{g/dl}$) by using fully automated Chemistry Analyzer (IDEXX's the Catalyst One™ Chemistry Analyzer) based on dry-slide technology. Biochemical analyses of the blood samples were completed on the day of collection. Serum TT4 was estimated on day zero (before treatment with Thyroxine), day 30, day 60 and day 180 after initiating treatment with Thyroxine. Peripheral blood smears (ear tip) were obtained and subjected to Giemsa staining technique and microscopy for detection of the haemoprotozoan parasite. Detailed haemato-biochemical examination revealed low haemoglobin, TEC, and total thyroxine (TT4) (Table 1). Blood smear was positive for *Babesia gibsoni* (Fig. D).

Treatment

Based on clinical and haemato-biochemical examination, and microscopy, the dog was diagnosed to be suffering from hypothyroidism (serum TT4 0.5 mcg/dl), with *Babesia gibsoni* infection. A two-way therapeutic approach was adopted in this case, first was to treat the babesia infection using Diminazine aceturate, doxycycline, clindamycin, metronidazole and other supportive drugs and second was to manage the hypothyroid condition by hormone replacement. Following standard guidelines, specific therapy for babesiosis was initiated with two doses of Diminazine aceturate @ 3.5 mg/kg body weight, deep intramuscular injections, 48 hrs apart, with metronidazole @ 15 mg/kg body weight orally for 3 weeks, doxycycline @ 5 mg/kg body weight orally for 3 weeks and clindamycin @ 25 mg/kg body weight orally for 3 weeks. Supportive therapy like iron supplements, antiemetics, acid blockers, essential

fatty acids (Omega 3 and Omega 6), Vitamin A supplement and B-complexes were given for approximately one month. Noticeable clinical improvement was seen along with improved haemato-biochemical parameters by day 30 post treatment. Microscopic examination for babesia organism was found to be negative 30 days after initiation of treatment.

The second therapeutic approach was to stabilize and maintain the thyroid hormone imbalance by hormone replacement and monitoring to provide a comfortable life for the dog. Thyroid hormone replacement was initiated by administering Thyroxine sodium @ 250 mcg, orally once daily before food in the morning and a commercial obesity diet was advised. Serum TT4 concentration increased to 1.3 mcg/dl after one month (30 days) of thyroxine treatment. It was still below the normal level, so the owner was advised to continue thyroxine at the same concentration for another one month. Serum TT4 concentration increased to 4.0 mcg/dl after another month (Total 60 days) of thyroxine treatment. Thyroxine treatment was advised to be continued at the same dose rate till the next monitoring of TT4 levels. Serum TT4 was measured after 180 days of continuous thyroxine and it measured 3.9 mcg/dl. The owner was advised to keep the dog under lifelong thyroid medication with regular evaluation at every 3 months interval. Following intensive anti-haemoprotozoan and thyroid replacement therapy, the dog showed a slow and progressive recovery with improvement in the overall health status, regrowth of hair on its back (Fig. B), reduced pigmentation and improvement in its vitality. A complete regrowth of hair on its back and improved body coat condition was observed in 180 days (Fig. C) following treatment. However, the dog failed to lose its body weight (still 37 kg) after 180 days of treatment, which still left some reservation for the clinicians looking after the dog about the standard therapeutic modalities followed for management of hypothyroidism in dogs and its weight management.

Discussion

In hypothyroid dogs, distinct dermatological peculiarities like including bilaterally symmetric, nonpruritic alopecia over the trunk or areas of wear and tear, dull and lusterless hair coat, scaling, seborrhoea, hyperpigmentation, absence of itching and recurrent infections (pyoderma or otitis externa) are often manifested (Panciera 1994; Dixon *et al.*, 1999; Srikala and Kumar, 2014; Haritha *et al.*, 2017; Mohanambal *et al.* 2023) [49, 18, 61, 27, 43]. Hypothyroidism accounted for 32.90 per cent of total dermatopathies (Costa *et al.*, 2016) [13] and has been reported as the most common endocrinopathies (0.2-0.8 %) in dogs (Ferguson, 2007; De Bellis, 2011 and Mooney 2011) [22, 17, 44]. In the present case, severe alopecia on the back region (truncal alopecia) and hyperpigmentation and dry hair coat was observed which was similar to the dermatological changes as reported by Haritha *et al.*, (2017) [27] who recorded a decreased value of T₃ and T₄ and increased value of TSH in a five years old Labrador dog with alopecia associated with hypothyroidism. Ramesh *et al.*, (2018) [55] also reported the presence of skin lesions like bilateral alopecia and hyperpigmentation with pruritus in a 7 years old female Labrador dog with hypothyroidism.

Thyroid hormones play a crucial role in ensuring the normal function of the skin and approximately 60% to 80% of hypothyroid dogs exhibit dermatological problems. The lack

of thyroid hormones leads to decreased fibroblast activity and altered collagen metabolism, causing delayed wound healing and potential excessive fibrous tissue deposition after trauma (Credille *et al.*, 2001) [13], whereas lack of thyroid hormone impairs cell development in the epidermis and alters sebaceous gland secretion which could either lead to dry or oily seborrhoea (Nelson and Couto, 2020) [46].

Thyroid hormone directly influences the mechanism of proteoglycan synthesis in the skin by stimulation of fibroblasts. In addition, they play a role in epidermal differentiation by their effect on keratinocytes, also it is essential in hair formation and sebum production (Doshi *et al.*, 2008) [19]. Dermatological signs appear later, when T₄ secretion is severely affected as was seen in the current case where the T₄ levels dropped to 0.5 mcg/dl. Hair loss is usually the first symptom perceived by owners, it occurs bilaterally and symmetrically in dorsal region of the neck, ventral and lateral of the thorax, abdomen and tail while head and extremities are usually spared (Scott-Moncrieff, 2007) [60]. Very common characteristic change is the "rat's tail" which is alopecia located in the tail (Scott *et al.*, 2001) [59].

Hyperpigmentation is often observed in dogs with hypothyroidism, but its mechanism is still unknown (Scott-Moncrieff, 2007; Scarampella, 2011) [60, 57]. Hyperpigmentation usually begins in areas with alopecia. This alteration, also affects inguinal region and medial sides of the limbs. In dogs with endocrine dermatopathy, hyperpigmented areas may also present hyperkeratosis when they are related to pruritus and chronic inflammation of the skin (Scott *et al.*, 2001 and Scott-Moncrieff, 2007) [59, 60].

Lethargy and weight gain/obesity are also common manifestation seen in hypothyroid dogs (Panciera 1994; Dixon *et al.*, 1999; Mohanambal *et al.*, 2023) [49, 18, 43]. Obesity is observed in more than 40% of dogs with hypothyroidism in several studies (Kaelin *et al.*, 1986; Panciera, 1994; Dixon *et al.*, 1999; Feldman and Nelson 2004) [32, 49, 18, 21]. Obesity, however, is a common nutritionally related problem in dogs and many dogs with obesity are not hypothyroid. It is estimated that in the general population, between 21-30% of dogs seen in practice are obese (Laflamme *et al.*, 1994) [35]. The effect of obesity on canine thyroid function is frequently cited in the literature (Peterson and Ferguson 1989; Scott-Moncrieff and Guptill-Yoran 2000) [52, 58]. Canine obesity is a common medical disorder and a recognized risk factor for obesity-related metabolic dysfunction. It can seriously influence various physiological functions the body, thereby limiting the longevity of the animals (Pereira-Neto *et al.*, 2018) [51].

Canine hypothyroidism is diagnosed based on history and clinical findings that are suggestive of the disease along with supporting laboratory findings and responsive hormonal therapy (Ferguson, 1994) [22]. Approximately 80% of the secreted thyroid hormone is T₄ and 20% is T₃. A failing thyroid gland preferentially makes T₃, so in developing hypothyroidism, T₄ is expected to decrease earlier than T₃. Serum T₄ levels are considered more useful in the diagnosis of hypothyroidism than are triiodothyronine (T₃) level (Nelson *et al.*, 1991) [46]. In the present case only T₄ was estimated (0.50 mcg/dl) which confirmed the hypothyroidism, similar to that reported by Daminet and Paradis (2000) [14]. Estimation of free thyroxine (fT₄) was reported to be better assessment for hypothyroidism evaluation in dogs since it was less commonly affected by

drugs and concurrent illness (Celeska and Atanaskova, 2020 and Bennaïm *et al.*, 2022) [11, 5].

In the current case, the dog was diagnosed to be suffering from concurrent babesia infection as confirmed by clinical signs, serum biochemistry and microscopic detection of babesia organism in blood smear. A confirmation of canine babesiosis is often based on history (particularly the presence of ticks on the body) and clinical signs along with the identification of Babesia organism within infected erythrocytes, positive serologic results, and molecular detection of amplified nucleic acid extracted from blood or tissues (Bhattacharjee and Sarmah 2013; Laha *et al.*, 2013; Kushwaha *et al.*, 2018 and Panda *et al.*, 2021) [7, 36, 34, 50].

A number of drugs have been used in the management of canine babesiosis, including antiprotozoal agent like diminazene aceturate/diaceturate, imidocarb dipropionate, atovaquone (Farwell *et al.*, 1982; Fowler *et al.*, 1972; Baggish and Hill, 2002) [20, 25, 4], and antibiotics like azithromycin, clindamycin, doxycycline and metronidazole (Birkenheuer *et al.*, 2004; Wulansari *et al.*, 2003; Vercammen *et al.*, 1996; and Almendros *et al.*, 2020) [6, 68, 66, 2]. However, no single drug has been reported to successfully eliminated *B. gibsoni* from infected dogs (Vercammen *et al.*, 1996; Wulansari *et al.*, 2003; Vial and Gorenflot 2006; and Lin and Huang 2010) [66, 68, 67, 38]. In the present case, we have also selected a combination of three drugs i.e., metronidazole, clindamycin and doxycycline with a standard dosing of diminazene aceturate to manage the babesia infection. Diminazene aceturate is an antiprotozoal agent widely used to treat babesiosis in (Lee *et al.*, 2009; Hwang *et al.*, 2010) [37, 28]. The exact mechanism of action is still poorly understood but it appears to interfere with aerobic glycolysis and synthesis of deoxyribonucleic acid in the parasite (Matsuo *et al.*, 2008; Plumb, 2011) [40, 53]. However, treatment with diminazene often fails to eliminate the parasite from the affected dog and high incidences of relapses or recurrences are often observed even after a temporary improvement is obtained by the administration of diminazene (Adachi *et al.*, 1993; Boozer and Douglass, 2003; and Suzuki *et al.*, 2007) [1, 9, 65]. Moreover, diminazene in dogs have a narrow margin of safety and often induces many adverse effects like tachycardia and CNS signs such as ataxia, nystagmus, and opisthotonos, haemorrhages in the cerebellum, hepatotoxicity and necrosis at the site of injection (Wulansari *et al.*, 2003; Macintire and Boozer, 2003; Miller *et al.*, 2005; Han *et al.*, 2014; Sykes and Papich, 2014; and da Silva *et al.*, 2024) [68, 39, 41, 26, 64, 16]. Because of the above-mentioned reasons, in the present case, we have used a combination of metronidazole, clindamycin and doxycycline (MCD) as an additional treatment protocol for *B. gibsoni* infection and could eliminate the babesia organism as the blood smear examination was found to be negative after a month and the dog did not show any signs of relapse or recurrence even after 180 days of treatment. This combined MCD therapeutic protocol was first reported in 2007 by Suzuki *et al.* [65] where they could successfully eliminate *B. gibsoni* from peripheral blood in 3 out of 4 dogs. Since then, many reports have been documented on the successful management of babesiosis caused by *B. gibsoni* in dogs (Nandini *et al.*, 2016; An *et al.*, 2019; PonnuSwamy *et al.*, 2019; Almendros *et al.*, 2020; Milosevic *et al.*, 2024) [45, 3, 54, 2, 42].

Hypothyroidism, in the present case was managed using oral levothyroxine hormone replacement as per standard dosing with treatment monitoring at 4 weeks interval for two consecutive months. To keep the obesity in control, a dietary limitation of calorie intake and gradual addition of commercially available obesity diet was advised. An increase in physical activity was noticed within two weeks after initiation of treatment, but significant improvement in skin condition required more than four weeks treatment, however negligible weight loss was observed even after 6 months of therapy and the dog remained obese with a body weight of 37kg. Levothyroxine has been extensively used as the standard treatment for hypothyroidism in humans as well as canines. Treatment with levothyroxine sodium, a synthetic form of the thyroid hormone (T_4), plays a crucial role in maintaining normal thyroid hormone levels in the body (Jaiswal *et al.*, 2018) [30]. When taken orally, it is effective, has a prolonged serum half-life that allows for once-daily dosing, and typically leads to the resolution of hypothyroidism symptoms in most patients (Jonklaas *et al.*, 2014) [31]. Clinical improvement was mostly observed after 6-8 months from the levothyroxine administration (Das *et al.*, 2021 and Ryad *et al.*, 2020) [15, 56].



Fig. A: A non-descript 4 years old male dog showing severe alopecia and hyperpigmentation on the back.



Fig. B: Photograph showing regrowth of hair and reduction in hyperpigmentation following treatment (60 days)



Fig. C: Photograph showing complete regrowth of hair and improved body coat condition following treatment (180 days)



Fig. D: Microphotograph of peripheral blood smear showing *Babesia gibsoni* (arrow)

Table 1: Haemato-biochemical observations before and after treatment

Parameters	Before treatment	After treatment		
	Zero day	30 days	60 days	180 days
Hb (gm%)	6.90	9.80	10.65	10.55
PCV (%)	24.50	30.50	30.80	29.50
TEC ($\times 10^6/\mu\text{l}$)	3.29	5.02	5.16	5.12
TLC ($\times 10^3/\mu\text{l}$)	6.40	6.55	6.50	6.50
Thrombocyte ($\times 10^6/\mu\text{l}$)	170.00	230.00	225.00	230.00
Serum TT4 (mcg/dl)	0.50	1.30	4.00	3.90

References

- Adachi K, Ueno C, Makimura S. Immunosuppression in dogs naturally infected with *Babesia gibsoni*. J Vet Med Sci. 1993;55:503-505. doi:10.1292/jvms.55.503.
- Almendros A, Burchell R, Wierenga J. An alternative combination therapy with metronidazole, clindamycin and doxycycline for *Babesia gibsoni* in dogs in Hong Kong. J Vet Med Sci. 2020;82(9):1334-1340. doi:10.1292/jvms.20-0209.
- An HM, Song JH, An SJ, Yu DH, Han D, Kim YJ, *et al.* Clindamycin-doxycycline-metronidazole combination therapy in a refractory canine babesiosis case. J Biomed Transl Res. 2019;20(3):71-74. doi:10.12729/jbtr.2019.20.3.071.
- Baggish AL, Hill DR. Antiparasitic agent atovaquone. Antimicrob Agents Chemother. 2002;46(5):1163-1173. doi:10.1128/AAC.46.5.1163-1173.2002.

5. Bennaïm M, Shiel RE, Evans H, Mooney CT. Free thyroxine measurement by analogue immunoassay and equilibrium dialysis in dogs with non-thyroidal illness. *Res Vet Sci*. 2022;147:37-43.
6. Birkenheuer AJ, Levy MG, Breitschwerdt EB. Efficacy of combined atovaquone and azithromycin for therapy of chronic *Babesia gibsoni* infections in dogs. *J Vet Intern Med*. 2004;18:494-498.
7. Bhattacharjee K, Sarmah PC. Prevalence of haemoparasites in pet, working and stray dogs of Assam and North-East India: a hospital based study. *Vet World*. 2013;6(11):874-878.
8. Birkenheuer AJ, Levy MG, Savary KC, Gager RB, Breitschwerdt EB. *Babesia gibsoni* infections in dogs from North Carolina. *J Am Anim Hosp Assoc*. 1999;35:125-128. doi:10.5326/15473317-35-2-125.
9. Boozer AL, Douglass KM. Canine babesiosis. *Vet Clin North Am Small Anim Pract*. 2003;33:885-904. doi:10.1016/S0195-5616(03)00039-1.
10. Bugbee A, Rucinsky R, Cazabon S, Kvitko-White H, Lathan P, Nichelason A, *et al*. AAHA selected endocrinopathies of dogs and cats guidelines. *J Am Anim Hosp Assoc*. 2023;59(3):113-135.
11. Celeska I, Atanaskova PE. International Congress on Advances of Veterinary Sciences and Techniques (ICAVST). Sarajevo; 2020. p. 1-2.
12. Costa GM, Araujo SL, Júnior FA, Araujo DV, Evangelista JS. Dermatological manifestations associated with canine hypothyroidism: a review. *Rev Bras Hig Sanid Anim*. 2016;10(4):781-797. doi:10.5935/1981-2965.20160064.
13. Credille KM, Slater MR, Moriello KA, Nachreiner RF, Tucker KA, Dunstan RW. The effects of thyroid hormones on the skin of beagle dogs. *J Vet Intern Med*. 2001;15(6):539-546. doi:10.1892/0891-6640(2001)015<0539>.
14. Daminet S, Paradis M. Evaluation of thyroid function in dogs suffering from flank alopecia. *Can Vet J*. 2000;41:699-703.
15. Das G, Deka P, Dutta KJ. Clinical management of hypothyroidism associated dermatological signs in a Labrador: a case report. *Indian J Vet Sci Biotechnol*. 2021;17:91-92.
16. da Silva NT, Nascimento AEJ, Soto-Blanco B, de Souza LR, Oliveira AR. Diminazene aceturate poisoning in a dog treated for visceral leishmaniasis. *Braz J Vet Pathol*. 2024;17(3):207-212. doi:10.24070/bjvp.1983-0246.v17i3p207-212.
17. De Bellis F. Endocrinopathies in dogs: how to recognise and treat cases. *Vet Times*. 2011;1-11.
18. Dixon RM, Reid SW, Mooney CT. Epidemiological, clinical, haematological and biochemical characteristics of canine hypothyroidism. *Vet Rec*. 1999;145(17):481-487.
19. Doshi DN, Blyumin ML, Kimball AB. Cutaneous manifestations of thyroid disease. *Clin Dermatol*. 2008;26:283-287.
20. Farwell GE, LeGrand EK, Cobb CC. Clinical observations on *Babesia gibsoni* and *Babesia canis* infections in dogs. *J Am Vet Med Assoc*. 1982;180:507-511.
21. Feldman EC, Nelson RW. Hypothyroidism. In: *Canine and Feline Endocrinology and Reproduction*. Missouri: Saunders; 2004. p.86-150.
22. Ferguson DC. Update on diagnosis of canine hypothyroidism. *Vet Clin North Am Small Anim Pract*. 1994;24(3):515-539. doi:10.1016/S0195-5616(94)50057-3.
23. Ferguson DC. Testing for hypothyroidism in dogs. *Vet Clin North Am Small Anim Pract*. 2007;37(4):647-649.
24. Fleeman L, Barret R. Cushing's syndrome and other causes of insulin resistance in dogs. *Vet Clin North Am Small Anim Pract*. 2023;53(3):711-730.
25. Fowler JL, Ruff MD, Fernau RC, Furusho Y. *Babesia gibsoni*: chemotherapy in dogs. *Am J Vet Res*. 1972;33:1109-1114.
26. Han D, Yoon WK, Hyun C. Cerebellar encephalopathy from diminazene aceturate toxicity in a dog. *Korean J Vet Res*. 2014;54(3):193-196. doi:10.14405/kjvr.2014.54.3.193.
27. Haritha GS, Saritha G, Nalini Kumari K. Malasseziosis associated with hypothyroidism in a dog. *Dairy Vet Sci J*. 2017;2(2):1-2.
28. Hwang SJ, Yamasaki M, Nakamura K, Sasaki N, Murakami M, Wickramasekara Rajapakshage BK, *et al*. Development and characterization of a strain of *Babesia gibsoni* resistant to diminazene aceturate *in vitro*. *J Vet Med Sci*. 2010;72(6):765-771. doi:10.1292/jvms.09-0535.
29. Irwin PJ. Canine babesiosis: from molecular taxonomy to control. *Parasite Vectors*. 2009;2(Suppl 1):S4. doi:10.1186/1756-3305-2-S1-S4.
30. Jaiswal M, Tiwari A, Gupta D, Pavan Kumar M, Singh B, Maravi P, *et al*. Recent approaches in diagnosis and management of canine hypothyroidism. *Pharma Innov J*. 2018;7:90-94.
31. Jonklaas J, Bianco AC, Bauer AJ, Burman KD, Cappola AR, Celi FS, *et al*. Guidelines for the treatment of hypothyroidism. *Thyroid*. 2014;24:1670-1751.
32. Kaelin S, Watson AD, Church DB. Hypothyroidism in the dog: a retrospective study. *J Small Anim Pract*. 1986;27:533-539.
33. Kour H, Chhabra S, Randhawa CS. Prevalence of hypothyroidism in dogs. *Pharma Innov J*. 2020;9(11S):70-72.
34. Kushwaha N, Mondal D, Singh KP, Mahapatra RR. Comparative evaluation of diagnostic tests for *Babesia gibsoni* in dogs. *Indian J Anim Res*. 2018;52(11):1642-1648. doi:10.18805/ijar.B-3413.
35. Laflamme DP, Kuhlman G, Lawler DF, Kealy RD, Schmidt DA. Obesity management in dogs. *Vet Clin Nutr*. 1994;1:59-65.
36. Laha R, Bhattacharjee K, Sarmah PC. *Babesia* infection in pet dogs from Assam detected by PCR. *J Parasit Dis*. 2013;38(4):389-393.
37. Lee MJ, Yu DH, Yoon JS, Li YH, Lee JH, Chae JS, *et al*. Epidemiologic surveys of *Babesia gibsoni* in South Korea. *Vector Borne Zoonotic Dis*. 2009;9:681-686.
38. Lin MY, Huang HP. Use of doxycycline-enrofloxacin-metronidazole combination to treat canine babesiosis. *Acta Vet Scand*. 2010;52:27.
39. Macintire DK, Boozer AL. Canine babesiosis. *Vet Clin North Am Small Anim Pract*. 2003;33:885-904.
40. Matsuu A, Yamasaki M, Xuan X, Ikadai H, Hikasa Y. Growth inhibitory activities of drugs against *Babesia gibsoni*. *Vet Parasitol*. 2008;157:1-8. doi:10.1016/j.vetpar.2008.07.023.

41. Miller DM, Swan GE, Lobetti RG, Jacobson LS. Pharmacokinetics of diminazene aceturate in dogs. J S Afr Vet Assoc. 2005;76:146-150.
42. Milošević S, Božović Ilić A, Magaš V, Sukara R, Tomanović S, Radaković M, *et al.* *Babesia gibsoni* mono-infection in two dogs from Serbia. Pak Vet J. 2024;44(4):1315-1321. doi:10.29261/pakvetj/2024.286.
43. Mohanambal K, Satish Kumar K, Nagaraj P, Lakshman M, Usha Rani M, Ravi Kumar Y. Clinical study on canine hypothyroidism. Int J Vet Sci Anim Husb. 2023;8(5):350-353.
44. Mooney CT. Canine hypothyroidism: aetiology and diagnosis. N Z Vet J. 2013;59(3):105-114.
45. Nandini MK, Vishwakarma P, Kamran A. New therapeutic protocol for canine babesiosis. J Dairy Vet Anim Res. 2016;3(3):112-113.
46. Nelson RW, Ihle SL, Feldman EC, Bottoms GD. Serum free thyroxine concentration in dogs. J Am Vet Med Assoc. 1991;198(8):1401-1407.
47. Nelson RW, Couto CG. Disorders of thyroid gland. In: Small Animal Internal Medicine. 6th ed. Elsevier; 2020. p.767-805.
48. O'Neill DG, Khoo JSP, Brodbelt DC, *et al.* Risk factors for hypothyroidism in dogs in the UK. Canine Med Genet. 2022;9:11. doi:10.1186/s40575-022-00123-8.
49. Panciera DL. Hypothyroidism in dogs: 66 cases. J Am Vet Med Assoc. 1994;204:761-767.
50. Panda C, Dehuri M, Panda MR, Sahoo LK, Mohanty B. Molecular detection of canine babesiosis. Ind J Vet Sci Biotechnol. 2021;17(3):70.
51. Pereira-Neto GB, Brunetto MA, Oba PM, Champion T, Villaverde C, Vendramini TH, *et al.* Weight loss improves respiratory parameters in obese dogs. J Anim Physiol Anim Nutr. 2018;102(6):1743-1748.
52. Peterson ME, Ferguson D. Thyroid diseases. In: Textbook of Veterinary Internal Medicine. 3rd ed. Philadelphia: WB Saunders; 1989. p. 1632-1675.
53. Plumb DC. Plumb's veterinary drug handbook. 7th ed. New York: Pharma Vet Inc.; 2011. p. 1191-1195.
54. Ponnu Swamy KK, Mohanapriya T, Enbavelan PA, Sundararajan RC, Saravanan S, Ramprabhu R. Triple therapy in canine babesiosis. Int J Curr Microbiol Appl Sci. 2019;8:12. doi:10.20546/ijcmas.2019.812.124.
55. Ramesh S, Sokkalingam R, Subapriya S, Soundararajan C, Muthukrishnan S. Hypothyroidism in a dog. Int J Curr Microbiol Appl Sci. 2018;7(12):3686-3689. doi:10.20546/ijcmas.2018.712.417.
56. Ryad N, Ramadan E, Salem N, Saleh I. Adult-onset hypothyroidism in dogs. Vet Med J. 2020;66:10-18.
57. Scarampella F. Endocrine alopecia in dogs. Vet Focus. 2011;21(1):40-46.
58. Scott-Moncrieff CR, Guptill-Yoran L. Hypothyroidism. In: Textbook of Veterinary Internal Medicine. 5th ed. Philadelphia: WB Saunders; 2000. p. 1419-1429.
59. Scott DW, Miller DH, Griffin CE. Small animal dermatology. 6th ed. Philadelphia: Saunders; 2001.
60. Scott-Moncrieff JC. Clinical signs of hypothyroidism in dogs and cats. Vet Clin North Am Small Anim Pract. 2007;37:709-722.
61. Srikala D, Kumar KS. Hypothyroidism associated disorders in dogs. Anim Sci Rep. 2014;8(1):31-40.
62. Strey S, Mischke R, Rieder J. Hypothyroidism in dogs: an overview. Prax Ausg K Kleintiere Heimtiere. 2021;49(3):195-205.
63. Suranti A, Gilardoni L, Rama LM, Echevarría M, Marcondes M. Hypothyroid associated polyneuropathy in dogs. Braz J Vet Res Anim Sci. 2008;45:284-288.
64. Sykes JE, Papich MG. Antiprotozoal drugs. In: Canine and Feline Infectious Diseases. Saunders; 2014. p.97-104.
65. Suzuki K, Wakabayashi H, Takahashi M, Fukushima K, Yabuki A, Endo Y. Treatment strategy in *Babesia gibsoni* infection. J Vet Med Sci. 2007;69:563-568.
66. Vercammen F, De Deken R, Maes L. Prophylactic treatment of canine babesiosis with doxycycline. Vet Parasitol. 1996;66:251-255. doi:10.1016/S0304-4017(96)01016-3.
67. Vial HJ, Gorenflot A. Chemotherapy against babesiosis. Vet Parasitol. 2006;138:147-160.
68. Wulansari R, Wijaya A, Ano H, Horii Y, Nasu T, Yamane S, *et al.* Clindamycin in treatment of *Babesia gibsoni* infections. J Am Anim Hosp Assoc. 2003;39:558-562.