JAVMA

AVMA

Pathology in Practice

In collaboration with the American College of Veterinary Pathologists

Swollen neck in 3 lambs

History

Three lambs from different mothers, aged between 2 and 3 days, were referred to the diagnostic laboratory for postmortem examination. The animals were found dead on the premises in the early morning, and it is suspected that they died during the night. These cases were presented at a semi-extensive meat production farm with around 800 Lacaune-breed ewes in the Spanish Pyrenees mountains. The ewes are housed during lactation, which lasts about 40 days. During this time, they are fed hay and commercial concentrate. For the rest of the time, the animals graze on native pastures. During the mating season, they receive mineral supplementation. The animals were fed turnips during the mating season and early gestation. Although the number of affected animals remains unknown, there was a significant outbreak in which animals were born alive but weak and died within hours of parturition.

Clinical and Gross Findings

The 3 animals had the same gross findings, but with different severity **(Figure 1)**, and the carcasses were well preserved, so there was not much time between death and submission to the diagnostic laboratory. The gross findings included poor body condition and extensive edema in the subcutaneous tissue of the neck, and both thyroid glands were markedly enlarged, diffusely dark red, and firm **(Figure 2)**. No significant gross abnormalities were detected in the rest of the carcass.

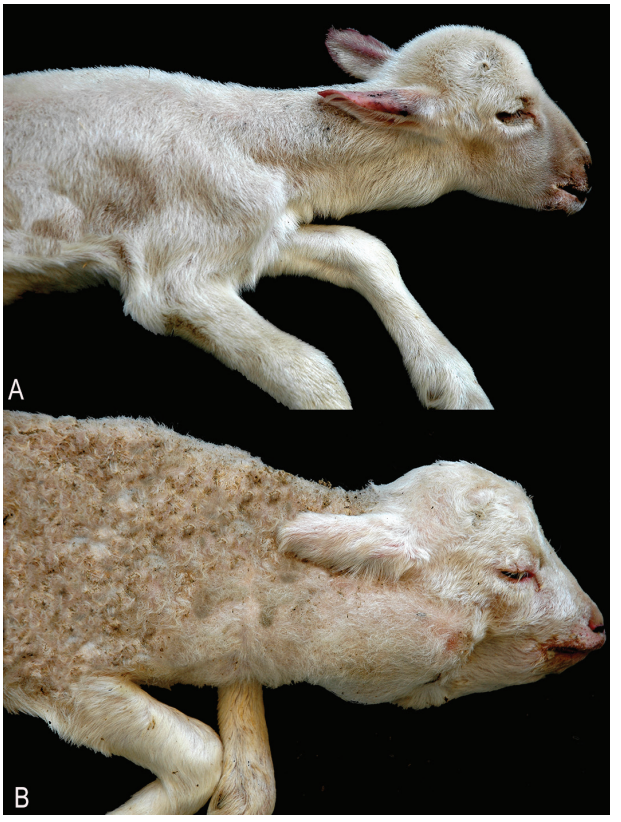

Figure 1—Two Lacaune lambs, between 2 and 3 days old, showing 2 extremes regarding the severity of gross findings. Lambs exhibited increased size in the ventral cervical region; this area was edematous and firm. One animal showed less increase in this area (A), while another displayed a more severe increase (B).

Formulate differential diagnoses, then continue reading.

Histopathological Findings

Thyroid glands samples were collected and preserved in neutral-buffered 10% formalin for 24 hours. They were then routinely processed and stained with H&E.

The thyroid gland exhibited diffusely enlarged follicles bordered by 1 or 2 layers of cylindrical follicular cells forming papillary projections, some supported by a fibrovascular stalk. The cells present abundant, poorly defined, pale, clumpy cytoplasm

Raul A. Resendiz-Pozos, DVM, MS, DACVP[1]*; Calasanz Jiménez Gracia, DVM[2]; Delia Lacasta, DVM, PhD, DECSRHM[3]; Marcelo de las Heras, DVM, PhD, DECVP[3]

[1]California Animal Health and Food Safety Laboratory, School of Veterinary Medicine, University of California-Davis, Tulare, CA
[2]Veterinarios Asesores en Clínica y Sanidad Animal, Zaragoza, Spain
[3]Department of Animal Pathology, Faculty of Veterinary Medicine, University of Zaragoza, Zaragoza, Spain

*Corresponding author: Dr. Resendiz (raresendizp@ucdavis.edu)

Received March 10, 2025
Accepted April 2, 2025
Published online April 18, 2025

doi.org/10.2460/javma.25.03.0150

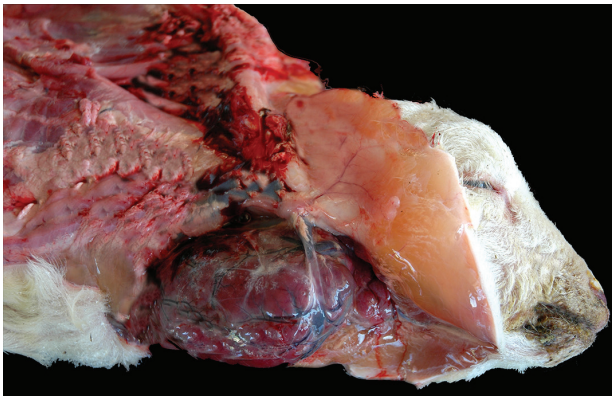

Figure 2—Animal B described in Figure 1. Within the subcutaneous tissue of the neck, there is abundant myxedema and a severe increase in the size of the thyroid, which is highly vascularized and red.

and a small nucleus. Variable amounts of pale eosinophilic colloid can be seen within the follicles. Numerous newly formed blood vessels, markedly distended with erythrocytes, are visible in the interstitium **(Figure 3)**. No histological findings of a neoplasia or infectious agent were found in the evaluated tissues.

Morphologic Diagnosis and Case Summary

The morphologic diagnosis on the 3 lambs was diffuse, severe, chronic hyperplasia and hypertrophy of the thyroid gland—findings that occur in hyperplastic goiter.

Case summary: congenital hyperplastic goiter in 3 lambs associated with the consumption of turnips during gestation.

Comments

The treatment following diagnosis involved prophylactic iodine supplementation with iodized salt blocks for the dams and removing turnips as a food supplement. These vegetables had been consumed ad libitum by the dams for over a month during gestation. In this herd, there had been isolated cases of goiter in previous years, suggesting that the iodine levels in the grazing area were not high enough, thus limiting availability for the animals and making them more sensitive to goitrogenic substances, or *goitrogens*.

Goiter can occur in all animals, including mammals, birds, fishes, and reptiles. Morphologically, there are 2 types of hyperplastic goiter: multinodular, which typically occurs in older animals, mainly cats, and diffuse goiter, which is usually compensatory and induced by thyroid-stimulating hormone (TSH) by the pituitary gland in response to hypothyroidism.[1] Diffuse goiter causes are iodine deficiencies, goitrogens, iodine excess, and hereditary defects in thyroid hormone biosynthesis.

As mentioned above, 1 cause of hyperplastic goiter is iodine deficiency, which is a component of the thyroid hormones triiodothyronine (T3) and thyroxine (T4). Although this can occur in animals of any age, it is rare in adults; deficiencies of this mineral tend to occur

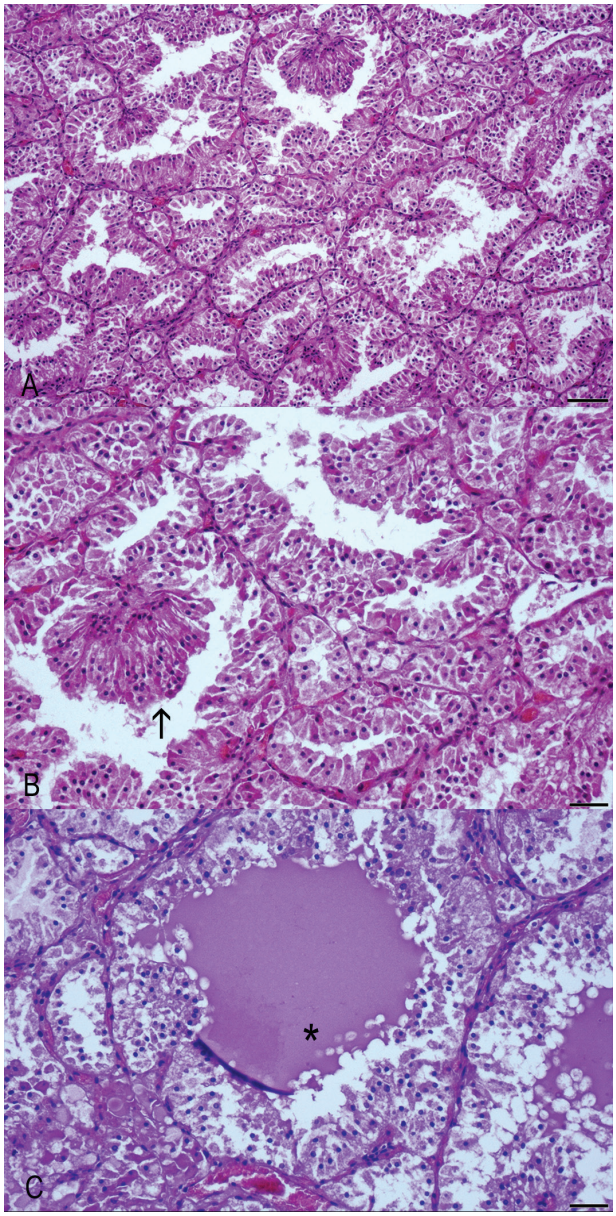

Figure 3—Photomicrograph of a section of thyroid gland from the lamb described in Figure 2. A—Microscopically, the follicles are increased in size, with slightly eosinophilic colloid at the lumen. 10X magnification; H&E stain; bar = 100 µm. B—The follicle's lumen is reduced due to hyperplasia and hypertrophy of the follicular cells that issue papillary projections to the lumen (arrow). 20X magnification; H&E stain; bar = 100 µm. C—The epithelial cells are prismatic, with abundant light eosinophilic cytoplasm, and the colloid appears light eosinophilic with endocytic vacuoles at the periphery (asterisk). 40X magnification; H&E stain; bar = 100 µm.

more frequently during the fetal and neonatal stages, when thyroid hormone requirements are higher.[1] Females are generally more predisposed than males because they have higher iodine requirements.[1]

In certain geographic regions, such as the Pacific Northwest and the Great Lakes region of the US, goiter tends to occur frequently, particularly in horses, calves, small ruminants, and pigs that graze

in these areas where iodine availability in the soil is low. The increase in grass growth and winter season contributes to the loss of iodine from the soil[2]; this, combined with a lack of iodine supplementation, predisposes these animals to develop goiter.[1]

Other causes include goitrogens, compounds found in plants, drugs, and other medical substances that can induce this disease.[1] Low levels of iodine are believed to heighten the thyroid's sensitivity to goitrogens. Cruciferous plants (genus *Brassica*) contain glucosinolates, which are converted in the intestine to glucose and compounds like isothiocyanate by the enzyme myrosinase, found either in the plant or the intestinal lumen. Thiocyanates, goitrin, and other ions compete with iodine for uptake by the thyroid follicular cells.[1]

Some vegetables and seeds that contain goitrogens include soybeans, cabbage, flaxseed, kale, turnips, and broccoli; however, goitrogens are typically destroyed during cooking.[3] Drugs like pentobarbital, rifampicin, and other medical compounds also act as goitrogens, as they promote the degradation of T3 and T4 hormones. Other substances that reduce iodine availability include lithium, nitrates (found in young grasses), rubidium, arsenic, fluoride, and potassium.[3]

Paradoxically, an excess of iodine decreases the response of follicular cells to TSH, reduces the absorption of iodine from the blood, blocks the release of thyroid hormones by interfering with the fusion of colloid droplets and lysosomal bodies, and halts the proteolysis of thyroglobulin colloid, inhibiting the oxidation and release of T3 and T4.[1] Iodine is concentrated in milk, so animals such as foals from mares fed with seaweed and kelp as iodine supplementation are exposed to high concentrations of this mineral and can develop goiter.[1] The thyroid gland of young animals is more exposed due to high concentrations of iodine in the blood, the placenta, and later through the mammary gland. Additionally, it is essential to consider that iodine supplementation in adult animals should be well-balanced; there have been reports of goiter in adult bovines due to excessive iodine supplementation[4].

Defects in thyroid hormone synthesis result in familial dyshormonogenetic goiter, even with adequate iodine intake. This autosomal recessive defect occurs in sheep and goats but is rare in calves, dogs, and cats. The defect lies in thyroglobulin synthesis or in the enzyme thyroid peroxidase or dual oxidase 2, which produces the H_2O_2 needed by thyroid peroxidase. Mutations in peroxidase lead to ineffective iodine oxidation and organification.[1] The findings at postmortem and histological examination are similar in all the aforementioned causes.

Despite the TSH response, fetuses and neonates develop extrathyroidal lesions such as myxedema, decreased hair or wool, thickened skin, and slow growth. They may be stillborn or weak or may succumb to environmental challenges.[1,4]

Hypertrophy and hyperplasia of the follicular cells enhance the ability to extract the low levels of iodine from the blood. This, combined with dietary corrections and the decrease in thyroid hormone requirements with increasing age, allows the hyperplastic thyroid gland to produce sufficient circulating T3 and T4 to generate negative feedback in the hypothalamus and pituitary, effectively stopping the production of TSH. With low TSH, the hyperplastic thyroid involutes and transforms into a colloid goiter.

As mentioned above, fetal thyroids are more susceptible to the effects of iodine deficiency or overdose. Animals born from iodine-deficient females are more likely to develop severe thyroid enlargement and signs of hypothyroidism.[1,2]

In conclusion, it is essential to consider that metabolic demands increase during winter, gestation, and lactation stages, leading to a higher requirement for thyroid hormones. This increase, coupled with grazing in rainy, sandy, and alpine regions where iodine is depleted from the soil—along with the intake of goitrogen-containing plants, as in the current situation—can affect the offspring.

Goiter is a well-established metabolic disease that affects a variety of species. The present report highlights the importance of a diet that is well-balanced, that is based on the nutritional demands of the animal, and that avoids antinutritional factors. The gross and histological findings in goiter are well established; this fact, combined with an extensive clinical history, is essential to identifying the trigger factor. To diagnose the cause of goiter, inadequate iodine availability, consumption of goitrogens, and congenital genetic issues must be excluded. Some diagnostic laboratories routinely assess the body's thyroid weight ratio, where glands weighing more than 0.8 g/kg indicate iodine deficiency. This assessment provides a practical approach to evaluating the risk of iodine deficiency in herds.[5]

Keywords: goiter, lamb, sheep, goitrogens, iodine

Acknowledgments

The authors thank Rosario Puyó and Santiago Becerra for their inestimable technical assistance.

Disclosures

The authors used Grammarly to review the text for grammar.

Funding

The authors have nothing to disclose.

ORCID

Raul A. Resendiz-Pozos https://orcid.org/0009-0004-8517-9288

Marcelo de las Heras https://orcid.org/0000-0003-3792-287X

Delia Lacasta https://orcid.org/0000-0002-7822-6646

References

1. Miller MA. Endocrine system. In: Zachary JF, ed. *Pathologic Basis of Veterinary Disease.* 7th ed. Elsevier; 2021:767–805.
2. Campbell AJD, Croser EL, Milne ME, Hodge PJ, Webb Ware JK. An outbreak of severe iodine-deficiency goitre in a sheep flock in north-east Victoria. *Aust Vet J*. 2012;90(6):235–239.
3. Kahn CM, Line S. Endocrine system. In: *The Merck Veterinary Manual.* 10th ed. Merck; 2010:492–534.
4. Ong CB, Herdt TH, Fitzgerald SD. Hyperplastic goiter in two adult dairy cows. *J Vet Diagn Invest*. 2014;26(6):810–814.
5. Knowles SO, Grace ND. A practical approach to managing the risks of iodine deficiency in flocks using thyroid - weight: birthweight ratios of lambs. *N Z Vet J*. 2007;55(6):314–318.