

Spontaneous lesions of the thyroid gland in goats (*Capra hircus*)

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ABSTRACT

The thyroid glands play an important role in the development of various tissues, thermoregulation, metabolic function and reproduction. Abattoir and necropsy-based studies provide an excellent opportunity for detecting diseases of both economic and public health importance. In the present study, thyroid glands from 150 goats were collected and the lesions were characterized. Correlations of gross and histopathological findings, gross and histomorphometry were carried out. The macroscopic findings recorded in the thyroid gland of abattoir and necropsy cases were thyroid gland with normal appearance (87.33%); paler than normal (3.33%); darker than normal (8.33%); brownish black discolouration (0.66%); gland with solitary nodule in the parenchyma (0.33%) and cyst(s) in the hilar region (6.33%). Out of 150 thyroid glands studied, it was observed that the histology of both lobes was not uniform. The microscopic findings recorded were: thyroid gland with normal histoarchitecture (3.66%), ultimobranchial cyst (28.33%), vacuolar degeneration (25.66%), follicular degeneration (13%), cystic degeneration (6%), mineralization of cyst (0.33%), congestion (27.66%), inter-follicular haemorrhages (2.66%) and intra-follicular haemorrhages (4.66%), focal atrophy (7.66%), hypertrophy of follicular epithelium (14.66%), follicular epithelial hyperplasia (24.33%), C-cell hyperplasia (25.33%), colloid goitre (4%), melanin pigmentation (4%), macrofollicles (19.33%), microfollicles (5.33%), focal fibrosis (17.33%), signet ring variant of follicular cell adenoma (2%), C-cell adenoma (0.66%) and capillary hemangioma (0.33%). Morphological examination including histopathology of endocrine glands is a sensitive parameter for the detection of compounds that adversely affect gland function. This information would be useful in interpreting and grading the severity of changes related to any specified treatment effect.

Key words: Goat, pathology, thyroid gland

INTRODUCTION

Alterations in the structure and function of the endocrine glands may be brought about by genetic factors, infectious agents, malnutrition and environmental factors. Similarly, the disorders affecting the endocrine organs either individually or collectively have a remarkable effect on the animal body as a whole. Among the endocrine glands, the thyroid is one which mediates most of the reproductive performances of domestic animals. The thyroid is the largest endocrine organ and is usually bilobed¹. Structurally, the thyroid gland consists of right and left lobes united by a narrow isthmus, which extends across the trachea anterior to second and third tracheal cartilages². The morphology and location of the thyroid gland varies with species. It consists of follicles containing colloid; follicular cells called thyrocytes trap iodine and synthesize thyroglobulin and parafollicular cells (C-cells) produce the hormone thyrocalcitonin³. Thyroid gland contains 70-80 % of the total body iodine and produces two main iodine containing hormones, T4 and T3⁴. The final assembly of the hormones (thyroxine, T4 and triiodothyronine, T3) occurs extracellularly in the colloid within the follicular lumen. Thyroglobulin is a high molecular weight glycoprotein synthesized in successive subunits on the ribosomes of the endoplasmic reticulum in follicular cells⁵. The pathological conditions of thyroid gland adversely affect production and productivity of livestock^{6,7}. Although hypothyroidism is reported to be the most common disorder affecting small ruminants, there are limited systematic studies carried out on the lesions affecting the thyroid gland in slaughtered animals, particularly in goats. The gross and histomorphometry of the thyroid gland of goats have been reported⁸. The present communication addresses

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the gross and histopathological features of spontaneous lesions recorded in the thyroid glands of goats that were either slaughtered at abattoirs or necropsied.

MATERIALS AND METHODS

The thyroid glands were collected from goats (n=145) at abattoirs and 5 from necropsy cases in Puducherry. The 145 crossbred goats were categorized according to their age and gender as: below 6 months (n=41, 28 M, 13 F), 6 months to 1 year (n=56, 32 M, 24 F) and above 1 year to

3 years (n=48, 30 M, 18 F) and 5 necropsied goats were categorized as: below 6 months (n=1, M), 6 months to 1 year (n=1, M) and above 1 year to 3 years (n=3, F). After ascertaining the age, sex and breed, the right and left lobes of the thyroid glands were carefully dissected out. A detailed gross examination of all the thyroid glands with respect to size, shape, colour and consistency was carried out. After making longitudinal incisions, the glands (right and left lobes) were fixed in 10% neutered buffered formalin (NBF) in separate containers. Representative tissues from each of the glands were processed by routine paraffin embedding technique and microtomy and 4-5 µm thick sections were stained by routine Haematoxylin and Eosin (H&E) staining procedure and Periodic acid schiffs (PAS) wherever necessary⁹. The microscopic changes of the thyroid gland were classified as described earlier⁵. All images were captured by using a trinocular microscope (Optika, Italy) fitted with Optika B5 camera.

RESULTS

The macroscopic features recorded in the thyroid gland of abattoir and necropsy cases were: (a) thyroid gland with normal features, 262/300 lobes, 87.33%); (b) paler than normal (10/300, 3.33%); (c) darker than normal (25/300, 8.33%); (d) brownish black discolouration (2/300, 0.66%), a lobe with solitary nodule (1/300, 0.33%); (e) cyst (s) in the hilar region (20/300, 6.33%).

The thyroid glands with normal histoarchitecture had characteristically, a thin capsule made of irregular connective tissue. The parenchyma comprised of thyroid follicles, parafollicular (C) cells, sparse interstitial loose connective tissue, and dense network of capillaries. Follicles were round to oval in shape and lined by a single layer of follicular epithelial cells that were either flattened or low columnar, depending on the degree of activity of the gland. Occasionally, follicular cells with abundant granular acidophilic cytoplasm (Hürthle cells) were noticed. In some of the cases, the thyroid gland appeared to be active. These cases were characterized by the presence of a row of small vacuoles located at the interface between follicular epithelium and the colloid and the phenomenon is referred to as scalloping (Fig.1). Ultimobranchial cysts were recorded in 85/290 lobes, 29.31% (27 in left lobe, 30 in right lobe and 14 bilaterally) in the abattoir cases.

Histopathological changes recorded in the thyroid glands were categorized as congenital anomalies, degenerative changes, vascular disturbances, growth disturbances, pigmentation, neoplasms and miscellaneous conditions. Degenerative changes in the thyroid lobes were recorded in both abattoir and necropsy cases. The various degenerative changes were categorized as vacuolar degeneration, follicular degeneration, cystic

degeneration (follicular cysts) and cystic mineralization. However, it is emphasized that, few degenerative changes were also seen concomitantly with various other thyroid lesions recorded.

Vacuolar degeneration was recorded in 72/290 lobes (24.82%) of the abattoir cases and 5/10 lobes (50%) of the necropsy cases. Amongst these 77 lobes, vacuolar degeneration occurred in 25 of the left lobes, 18 of the right lobes and bilaterally in 17 cases. Vacuolar degeneration was characterized by clear vacuoles, that were located either in a supra nuclear or infra nuclear position within the cytoplasm of the follicular epithelium (Fig.2). The degree of vacuolar degeneration varied from mild to severe. Follicular degeneration with desquamation was recorded in 37/290 lobes (12.75%) of the abattoir cases and in 2/10 (20%) of necropsy cases. Amongst these 39 cases, the feature was observed in 10 of the left lobes, 19 of the right lobes and bilaterally in 5 lobes characterized by partial to complete exfoliation of the follicular epithelial cells into follicular lumen. The severity of follicular degeneration varied from mild to severe. In severe cases, there was extensive desquamation with lack of colloid. Cystic degeneration of the follicles was recorded in 18/290 lobes (6.20%) of the abattoir cases, of which, 8 occurred in the left, 8 in the right and bilaterally in 1 case characterized by cystic dilatation of the degenerating follicles. These cysts were lined by flattened epithelial cells and contained degenerated follicular epithelial cells that gave a granular appearance (Fig.3). Mineralization was characterized by the formation of densely basophilic spherules or granules in the lumen of cysts. These appeared to represent the precipitation of minerals on the degenerated cellular debris (Fig.4). Mineralization was recorded in only one lobe of an abattoir case.

Vascular disturbances were recorded in 98/290 lobes (33.79%) of the abattoir cases and 7/10 lobes (70%) of the necropsy cases. The vascular disturbances recorded were congestion and haemorrhages. Grossly, congested thyroid glands appeared deep red in colour, normal in shape and consistency (Fig.5). Microscopically, congestion was multi-focal and varied from mild to severe degree. Haemorrhages were not grossly discernible. Microscopically, haemorrhages occurred in focal areas within the parenchyma and varied from mild to moderate degree. Based on the location, haemorrhages were categorized as either inter-follicular or intra-follicular (Fig.6).

The growth disturbances were categorized as focal atrophy, hypertrophy and hyperplasia. Focal areas of follicular atrophy were observed in 22/290 lobes (7.58%) of the abattoir cases and in 1/10 lobes (10%) of the necropsy cases. Amongst these 23 cases, focal follicular atrophy was noticed in 13 of the left lobes and 10 of the right lobes, with no bilateral involvement. Microscopically,

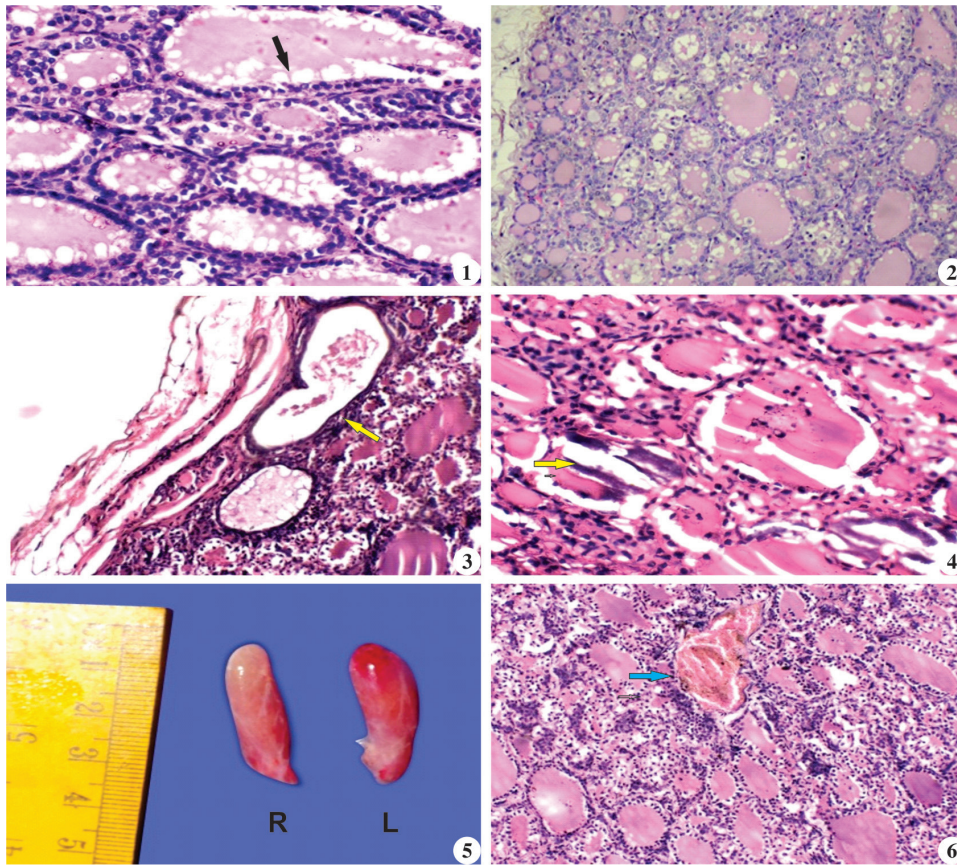


Fig. 1. Thyroid gland showing resorption vacuoles (arrow) at the interface between follicular epithelial cells and colloid [Scalloping]. H&E x200; **Fig.2.** Thyroid gland showing vacuolar degeneration of follicular epithelial cells. H&E x200; **Fig.3.** Thyroid gland showing cystic degeneration of the follicles, presence of granular material in the lumen (arrow).H&Ex100; **Fig.4.** Thyroid gland showing mineralization of follicular cyst(arrow). H&E x200; **Fig. 5.** Thyroid glands showing mild degree of congestion (L-leftlobe, R-rightlobe); **Fig.6.** Thyroid gland showing intra-follicular haemorrhage (arrow). H&E x200.

hyperplasia was recorded in 33/290 lobes (11.37%) of abattoir cases and 5/10 lobes (50%) of necropsy cases. Diffuse hyperplasia of intra-follicular epithelium was recorded in 4/290 lobes (1.37%) of the abattoir cases. Occasionally, an irregular papillary projection of hyperplastic epithelium was noticed extending into the lumen of cystic follicles. Both hyperplasia and hypertrophy of follicular epithelium were observed in 14/290 lobes (4.83%) of the abattoir cases. C-cell hyperplasia recorded in the present study was characterized by the presence of ovoid to round cells and had a distinct pale or light cytoplasm in the interstitium. The hyperplastic response of C-cells was either focal or diffuse and the proliferation response varied from mild to moderate degree. C-cell hyperplasia was recorded in 75/290 lobes (25.86%) of the abattoir cases and 1/10 lobes (10%) of the necropsy cases. The distribution of lesion was even in both the lobes. Colloid goitre was recorded in 11/290 lobes (3.79%) of the abattoir cases and 1/10 lobes (10%) of the necropsy cases. Colloid goitre occurred in 7 of the left lobes and

3 of the right lobes. Microscopically, the parenchyma comprised of large sized follicles, distended with pale pink-stained colloid, lined by low cuboidal to completely flattened single layer of epithelial cells (Fig. 10). Bilateral involvement was observed in only one case.

Neoplastic conditions of the thyroid gland were recorded in 9/290 lobes (3.10%) and all were from the abattoir cases. These were categorized as signet ring variant of follicular cell adenoma (6 cases), C-cell adenoma (2 cases) and capillary hemangioma (1 case). Miscellaneous conditions recorded were: (i) melanin pigmentation of the thyroid glands in 12/290 lobes (4.13%) of the abattoir cases. Melanin pigmentation was recorded in 5 left lobes, 3 right lobes and bilateral in two cases. Grossly, the affected thyroid lobes were dark brown in colour, had a firmer consistency (Fig.11). Microscopically, melanin deposition was noticed predominantly in the interstitium (Fig.12) and occasionally in the follicular epithelium. The distribution of the pigment varied from focal to diffuse. (ii) Macrofollicles, characterized by large

the follicles appeared smaller and collapsed and invariably devoid of colloid. There was an increase in the inter-follicular connective tissue separated and compressed the follicles (Fig.7). Hypertrophy of follicular epithelium (Fig.8), characterized by the transformation of cuboidal epithelial cells into tall columnar cells with concomitant reduction in colloid, was recorded in 43/290 lobes (14.82%) of the abattoir cases and in 1/10 lobes (10%) of the necropsied cases. The hypertrophied follicular epithelial cells were significantly larger compared to normal cases. Follicular epithelial hyperplasia (Fig.9) was recorded in 68/290 lobes (23.44%) of abattoir cases and 5/10 lobes (50%) of necropsied cases. Hyperplasia of follicular epithelium occurred either as focal, diffuse or sometimes cystic. Focal intra-follicular epithelial hyperplasia was recorded in 31/290 lobes (10.68%) of the abattoir cases. Minimal follicular epithelial

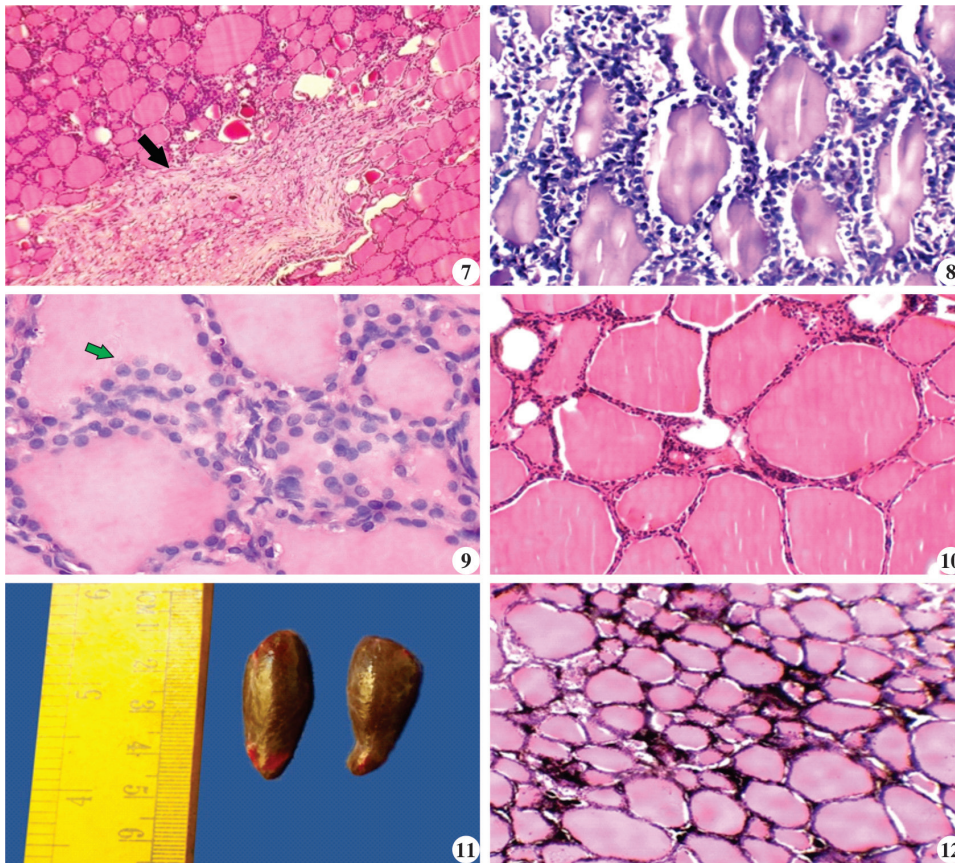


Fig.7. Thyroid gland showing focal follicular atrophy, follicular degeneration and fibrous tissue proliferation (arrow) in the interstitium. H&E $\times 100$; **Fig.8.** Thyroid gland showing moderate degree of hypertrophy of follicular epithelium. H&E $\times 200$; **Fig.9.** Thyroid gland showing focal hyperplasia of follicular epithelium (arrow). H&E $\times 400$; **Fig.10.** Thyroid gland showing moderately distended follicles lined by single layer of flattened epithelium. H&E $\times 200$; **Fig. 11.** Melanin pigmentation of the thyroid gland; **Fig.12.** Thyroid gland showing extensive deposition of melanin pigment in the interstitium. H&E $\times 200$.

DISCUSSION

Thyroid glands with normal histoarchitecture could be recorded only in 3.79% of the cases. Interestingly, only one case had normal histoarchitecture of both the lobes and in the rest of the cases normal histological features were observed either in the right lobe or in the left lobe. In an abattoir-based study on the thyroid gland of sheep at Puducherry¹⁰, normal histoarchitecture was recorded in 19/170 (11.17%) of the cases. In some of the cases recorded in the present study, the thyroid gland appeared to be active. These were characterized by either vacuolations at the periphery of the colloid in follicles (scalloping) or hypertrophy of the follicular epithelial cells. It has been reported that a row of small vacuoles that occur at the interface between follicular epithelium and the colloid is a feature of actively functioning glands and nomenclatured as resorption vacuoles. Functional polarity is apparent at the level of the follicle and the follicular cell. A single follicle may have flattened cells on one side and cuboidal or low columnar cells on the

follicles that were severely distended with completely flattened single layer of epithelial cells with abundant colloid were recorded in 53/290 lobes (18.27%) of the abattoir cases and 3/10 lobes (30%) of the necropsy cases. They were recorded in left lobes (29), right lobes (11) and bilaterally (8). Macrofollicles either occurred singly or in combination in focal areas within the thyroid parenchyma. (iii) Microfollicles, characterized by very small follicles lined by cuboidal epithelium with prominent nuclei and contained little or no colloid were recorded in 16/290 lobes (5.51%) of the abattoir cases, 6 in the left lobe, 4 in the right lobe and 3 bilaterally. (iv) Fibro-collagen tissue deposition was recorded in focal areas within the thyroid parenchyma in 49/290 lobes (16.89%) of the abattoir cases and in 3/10 lobes (30%) of the necropsy cases. Focal areas of fibrosis were recorded in 24 left lobes, 20 right lobes and 4 bilaterally.

other, the best expression of the functional activity of the thyroid gland¹¹. Histopathological changes recorded in the thyroid glands in the present study were categorized as congenital anomaly, degenerative changes, vascular disturbances, growth disturbances, pigmentation, neoplasms and miscellaneous conditions.

Ultimobranchial cysts, the only congenital anomaly recorded, were located predominantly at the hilar region either as single or multiple cysts in the parenchyma. A detailed report on ultimobranchial cysts of the thyroid gland of goats has been published¹². Degenerative changes in the thyroid lobes varied in severity from mild to severe which was in accordance an earlier study¹³. Vacuolar degeneration of the follicular epithelium of thyroid in sheep has been reported following experimental locoweed poisoning in sheep and Methylthiouracil (MTU) poisoning in cattle respectively^{14,15}. Spontaneous occurrence of vacuolar degeneration in the thyroid gland of slaughtered animals has been reported as: 18.6% in sheep and 0.4% in buffaloes, respectively^{4,10}. Vacuolar

degeneration of the thyroid follicular epithelium has been reported in *Ipomea carnea* toxicity in goats¹⁶. It has been postulated that Swainsonine, an indolizidine alkaloid in *Ipomea carnea*, promoted the cellular accumulation of non-metabolized oligosaccharides that lead to the inhibition of acid or lysosomal alpha mannosidase enzyme and resultant cellular vacuolation. Follicular degeneration has been attributed as a manifestation of aging process in cynomolgus monkeys¹⁷ and sheep¹⁰. Although degenerative changes were reported in apparently normal abattoir cases, experimental studies indicated that factors such as malnourishment, hypothyroidism and exposure to chemicals such as O-chlorobenzylidene malononitrile could induce degenerative changes in the thyroid gland^{18,19}. Spontaneous occurrence of cystic changes in the follicles has also been reported in sheep, buffaloes and rats^{4,10,19}.

Vascular changes (congestion and haemorrhages) observed in the present study have been reported on abattoir studies in sheep^{10,20} and experimentally induced hypothyroidism cases in goats²¹. Vascular disturbances recorded in abattoir cases could be attributed as agonal changes and those in necropsy cases, associated with generalized systemic involvement.

Growth disturbances recorded in the present study were focal atrophy, hypertrophy and hyperplasia. Atrophic changes of the thyroid gland have been reported in ruminants^{4,10,20,22} varied from 2.5% in cattle to 43.26% in sheep. Hypertrophic changes of the thyroid follicular epithelium following thiourea induced hypothyroidism in sheep have been reported²³.

Hyperplasia of follicular lining epithelial cells have been reported in experimentally induced hypothyroidism in goats (13, 21), sheep²⁴ and cattle¹⁵. Follicular epithelial hyperplasia was recorded after the experimental dosing with sulfonamides in rats, mouse and dog²⁵. C-cell hyperplasia in the present study (25.86%) in abattoir cases and 10% in necropsied cases was comparatively higher than that reported in cattle²⁶ and sheep¹⁰. Hyperplasia and hypertrophy of the follicular cells with concomitant reduction in thyroid hormones in blood due to the interference of iodination of tyrosine by thiourea was reported in experimental hypothyroidism in sheep²³. Inadequate iodine in the thyroid gland results in the synthesis of uniodinated inactive pre hormone instead of thyroxine, which stimulates the pituitary gland to secrete thyroid stimulating hormone (TSH). This commonly results in hyperplasia of the thyroid tissue and considerable enlargement of the gland leads to goitre²⁷. Colloid goitre cases recorded in the present study were in accordance with earlier reports in goats (2.4% to 10%)^{28,29} and in sheep (5.88%) (10). Colloid goitre is the most

frequent type of goitre reported in goat and sheep and has been proven to be either due to deficiency of iodine or the consumption of goitrogens^{7,30}.

Melanin pigmentation of the thyroid lobes was recorded in 4.13% of the abattoir cases. Accumulation of melanin-like pigments in the cytoplasm of follicular cells as a phenomenon of aging has been reported in man. This phenomenon becomes massive after the administration of drugs such as minocycline and when intense, it is appreciable grossly and referred to as melanosis thyroid or less pompously as black thyroid³¹. Details of the neoplasms of the thyroid gland recorded in the present study have already been published³².

The recording of macrofollicles and microfollicles were indicative of relatively inactive and as active follicles respectively in accordance with aging studies reported in man and animals³³.

Fibrosis of the thyroid gland of varying proportions (0.66% to 10%) has been reported in abattoir-based studies of cattle, goat, buffaloes, and sheep, respectively^{4,29,34,35}. In the present study, a relatively higher percentage (16.89%) of focal fibrosis of the thyroid gland was recorded. A recent report on the combined utility of ultrasonography with morphometric features of the thyroid and parathyroid gland of goats² would aid in detecting and monitoring focal lesions of the thyroid gland for clinical interventions.

CONCLUSION

Abattoir and necropsy-based study highlighted the importance of gross and microscopic examination of thyroid glands. Occult lesions that had no macroscopic alterations could be detected and characterized by microscopic studies. A large-scale study including the functional aspect of the thyroid glands would definitely help in elucidating the pathogenesis of thyroid abnormalities in goats.

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