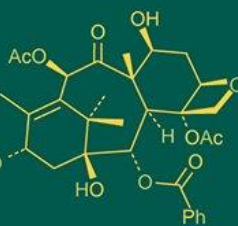
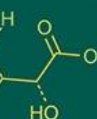
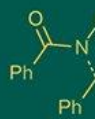


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Prevalence and pathomorphology of canine non-epithelial tumours with particular emphasis on tumours of reproductive tract

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Abstract

The present study, conducted at the Department of Veterinary Pathology, Veterinary College, Shivamogga, investigated the prevalence and pathology of canine non-epithelial tumours. Over a study period of five years, 268 canine tumour cases were documented, representing a prevalence of 3.09%, with reproductive tract tumours being most frequent (47.76%), predominantly in non-descript, middle-aged to older dogs, with higher incidence in females. Haematological alterations included anaemia, leukocytosis with neutrophilia, and monocytosis, while biochemical values remained within normal limits. Grossly, tumours varied by type: small reddish nodules in mast cell tumours, friable multilobular cauliflower-like lesions in transmissible venereal tumours, large irregular ulcerated fibrosarcomas, and firm lobulated reproductive tract masses such as seminomas, Sertoli cell tumours, leiomyomas, and hemangiosarcomas. Cytology supported gross features but required histopathological confirmation. Histopathology identified transmissible venereal tumour as the most common non-epithelial neoplasm, followed by mast cell tumour and leiomyoma. Masson's Trichrome staining differentiated smooth muscle from stromal tissue.

Keywords: Canine non epithelial tumors, leiomyoma, histopathology, Masson's Trichrome

Introduction

Cancer is a major health concern affecting both humans and animals, with growing importance in companion animal medicine, particularly in dogs. In recent years, canine neoplastic diseases have gained attention due to their increasing incidence, clinical significance, and value as comparative models for human cancers. Similar to human oncology, canine tumours exhibit a wide range of biological behaviours, from benign to highly malignant forms. Advances in veterinary healthcare, improved nutrition, and better living conditions have extended the lifespan of dogs, leading to a higher frequency of cancer diagnoses. Consequently, the study of canine cancer has become a key area in veterinary oncopatology and comparative medicine.

Canine cancer represents a leading cause of morbidity and mortality, posing significant challenges for veterinarians and pet owners alike. Beyond clinical relevance, dogs share close environmental exposure and biological similarities with humans, making them valuable spontaneous models in comparative oncology. Research in canine cancers not only enhances veterinary clinical practice but also contributes to understanding tumour biology, progression, and therapeutic strategies in human medicine.

Canine tumours are broadly classified into epithelial and non-epithelial types. While epithelial tumours such as mammary and cutaneous neoplasms are well documented, non-epithelial tumours remain comparatively underexplored. These include mesenchymal tumours of connective tissue origin, round cell tumours, and other discrete cell neoplasms such as transmissible venereal tumours, mast cell tumours, fibrosarcomas, hemangiosarcomas, and smooth muscle tumours (SMTs). Arising from connective, vascular, or hematopoietic tissues, these tumours display diverse pathological features. However, compared to epithelial neoplasms, systematic studies on their incidence, distribution, and

biological behaviour are limited, leaving notable gaps in veterinary oncology research.

Reproductive tract tumours in dogs are relatively rare, accounting for only a small proportion of overall neoplastic conditions. Among these, smooth muscle tumours form an important but understudied subset. SMTs can arise in any organ containing smooth muscle, including the gastrointestinal tract, vascular system, and reproductive organs. In human medicine, reproductive SMTs—particularly uterine leiomyomas (fibroids)—are among the most common benign tumours in women and are extensively studied due to their clinical impact. In contrast, canine reproductive SMTs are infrequently reported. Excluding mammary tumours, vulvar and vaginal neoplasms constitute only about 2.4-3.0% of all canine tumours, while uterine SMTs are even rarer, accounting for approximately 0.3-0.4%.

Although individual cases of leiomyomas and leiomyosarcomas in dogs have been described, comprehensive data on their incidence, pathology, and clinical significance remain scarce. This highlights a clear gap in veterinary oncological knowledge, particularly when compared to the well-established understanding of similar tumours in human medicine. Studying the occurrence and behaviour of canine SMTs is therefore important for improving diagnosis and clinical management, as well as for advancing comparative pathology.

In this context, the present study aims to systematically analyse the occurrence of canine smooth muscle tumours among non-epithelial neoplasms, with particular emphasis on the reproductive tract. The study focuses on their incidence, gross and microscopic characteristics, and molecular features. By addressing this underexplored area, the research seeks to enhance understanding of these tumours and contribute to bridging existing knowledge gaps. Ultimately, such investigations reinforce the role of canine oncology as a valuable link between veterinary and human medical research.

Despite numerous studies on canine tumors, limited data are available from Shivamogga, Karnataka, where the pet population has increased substantially since the establishment of the Veterinary College in 2007. Therefore, the present study was undertaken to record the prevalence of non-epithelial tumors, evaluate their clinical and pathomorphological features, and characterize canine smooth muscle tumours of reproductive tract using histochemical and molecular techniques in and around Shivamogga, Karnataka.

Materials & Methods

Prevalence Studies

Prevalence data were obtained from clinical case records, biopsy, and necropsy reports maintained at the Veterinary Clinical Complex and the Department of Veterinary Pathology, Veterinary College, Shivamogga. Tumor cases recorded over a five-year period (2019-2024) were reviewed, with special emphasis on smooth muscle tumours of reproductive tract. Data regarding age, breed, sex, and tumor type were collected and analyzed to assess susceptibility patterns among different demographic groups.

Case Studies (Prospective Study of tumors)

The study area comprised Shivamogga and surrounding regions, and active case collection was carried out from July 2024 to June 2025. Tumor samples were obtained from dogs

presented to the Department of Veterinary Surgery and Radiology, Veterinary College, Shivamogga; the Veterinary Polyclinic, Department of AH&VS, Shivamogga; and selected private veterinary clinics. Detailed history and signalment were recorded in each case and blood and serum samples were collected for hematological and biochemical evaluation. Following surgical excision, gross pathological features were documented, and tumor tissues were collected for histopathological and histochemistry analyses. Tissue set was prepared and fixed in 10% neutral buffered formalin for histopathology.

Hemato-biochemical Analysis

The complete hemogram of all the tumor cases was estimated using a fully automated veterinary hematology analyzer (Exigo®, Sweden) and the serum biochemical parameters such as alanine aminotransferase and creatinine were estimated using a Meryl® Compact biochemical analyzer.

Gross Pathology, Cytopathology and histopathology

Excised tumor tissues were examined immediately after surgery for size, shape, color, consistency, surface characteristics, and presence of necrosis, hemorrhage, or ulceration. Morphometric measurements were taken using Vernier calipers, and representative photographs were recorded for documentation.

Pre-operative cytological samples were collected by fine needle aspiration cytology (FNAC) while in post-operative cases, impression smears were prepared from freshly excised tumor tissues, air-dried, fixed in methanol, and stained using Giemsa stain as per standard protocols (Valenciano and Cowell, 2014) [30]. Microscopic evaluation was carried out to assess cellular morphology and malignancy features.

Formalin-fixed tissues were processed using routine paraffin embedding technique. Sections of 5-6 µm thickness were stained with hematoxylin and eosin (H&E) for histopathological evaluation along with special stains like Masson's Trichrome for reproductive tract tumours (Mason 1929; Luna, 1968) [20, 18].

Results

Occurrence of Canine Tumors

The retrospective analysis of records from the Veterinary Clinical Complex, Veterinary College, Shivamogga revealed that out of 8,671 canine cases presented during 2020-2024, 268 cases (3.09%) were diagnosed with tumors. Among these, 121 cases (45.14%) were from reproductive tract of both sexes, indicating their predominance among canine neoplasms.

Breed-wise analysis showed the highest tumor incidence in non-descript dogs (30.22%), followed by Labrador Retrievers (18.6%), Golden Retrievers (13.05%), and Pomeranians (10.8%) (Table 1). Reproductive tract tumours were most frequently recorded in non-descript (39.6%), followed by labradors (19%) and Golden Retrievers (13.22%), suggesting higher predisposition in small to medium-sized breeds (Table 2).

Age-wise distribution indicated maximum tumor occurrence in dogs aged 8-12 years (52.98%), followed by 4-8 years (30.97%), confirming increased tumour risk with advancing age (Table 3). Reproductive tract tumors were most common in the 4-8 years (55.37%) and 8-12years (30.57%) age groups (Table 4). Sex-wise analysis revealed higher

tumour incidence in females (67.6%), (Table 5).

Prospective Study (July 2024-June 2025)

During the prospective study period, 67 tumor cases were recorded, of which 25 (37.31%) were epithelial tumors and 42 (62.69%) were non-epithelial (Table 6). Among non-epithelial tumors, 23 (54.76%) cases were TVT, 6(14.28%) cases were mast cell tumour, 2(4.76%) cases were cutaneous lymphoma, 1(2.38%) case of cutaneous histiocytoma and 1(2.38%) case of fibrosarcoma these constituting as round cell tumours. The cases of reproductive tract non epithelial tumours were 4(9.52%) vaginal leiomyoma, 2(4.76%) sertoli cell tumour, 1(2.38%) ovarian haemangiosarcoma, 1(2.38%) testicular seminoma and 1(2.38%) case of vaginal leiomyosarcoma. (Table 7).

Non-epithelial tumours were most common in Non-Descript (33.33%), followed by Labradors (19.04%) Pomeranian (9.52%) and Golden Reteriever (9.52%) (Table 8). The majority of non-epithelial tumors occurred in dogs aged 4-8 years (57.14%) and 9-12 years (23.80%) (Table 9). Females accounted for 57.14% of non-epithelial tumors and male 42.80% (Table 10).

Hematological and Biochemical Findings

Dogs affected with non-epithelial tumours comprising round cell tumours, reproductive tract tumours and smooth muscle tumours exhibited mild anemia, evidenced by reduced hemoglobin and RBC values. Leukocytosis was consistently observed, suggesting inflammatory or neoplastic stress. Other parameters, including PCV, platelet count, differential leukocyte counts, creatinine, and SGPT, remained within reference limits. (Table 11)

Gross Findings

Grossly, vaginal leiomyoma tumours were of varying sizes (1-12 cm) and appeared as firm, nodular to oval, circumscribed mass with encapsulation. Testicular seminoma appeared firm, smooth, lobulated round to oval in shape with size 9-10cm. Sertoli cell tumour appeared lobulated and pale white to tan in color with a solid homogenous appearance with surface exhibiting multinodular pattern. Mast cell tumours appeared small, rounded to spherical well circumscribed with slight irregular external surface. Ovarian hemangiosarcoma appears as large, irregularly ovoid, and lobulated mass with smooth external surface covered by thin glistening serosa surface. TVT mass protruding from the external genitalia (penis) of the male dog is irregular, lobulated, and cauliflower-like in appearance, with reddish-pink coloration. Multiple nodular projections are evident, some showing ulceration and haemorrhage.

Gross morphology of fibrosarcoma appeared firm, with a variably smooth but uneven external texture, irregular, and moderately circumscribed mass with distinct area of ulceration, penetrating through the skin and exposing underlying tissues.

Cytopathology Findings

Cytology of mast cell tumour showed numerous discrete, round to oval cells with abundant, pale to moderately basophilic cytoplasm containing distinct purple granules that were metachromatic granules. Cytological evaluation of TVT showed round to oval cells characterized by distinct cytoplasmic margins with high nuclear-to-cytoplasmic ratio, and basophilic cytoplasm containing clear vacuoles.

Cytology of testicular seminoma revealed round to polygonal cells arranged in sheets or clusters, often with indistinct cytoplasmic borders with cells having abundant pale cytoplasm, large round nuclei with pleomorphism.

Histopathology

Histopathology of vaginal leiomyosarcoma revealed a wavy arrangement of spindle cells with cylindrical nuclei, organized in sheets and whorls pattern. Mitotic figures, with more cellular and nuclear atypia with presence of inflammatory cells are all the features indicating that the tumour is malignant in nature.

Histopathology of vaginal leiomyoma tissue showed interlacing bundles of spindle-shaped smooth muscle cells with elongated, cigar-shaped nuclei and eosinophilic cytoplasm surrounded by densely arranged cells.

Histopathology of sertoli cell tumour with polygonal cells arranged in irregular cords, having abundant cytoplasm and prominent nucleoli. Histopathology of testicular seminoma revealed neoplastic cells with clear cytoplasm, vesicular nuclei, prominent nucleoli, mitotic activity, and pleomorphism within connective tissue partitions.

Histopathology of TVT tumour cells revealed centrally located, round to oval nuclei displaying vesicular chromatin, prominent nucleoli, occasional mitotic figures, and areas of mild nuclear pleomorphism. Histopathology of mast cell tumour revealed densely packed cells with metachromatic granular cytoplasm, round central nuclei, occasional nucleoli, and scattered mitotic figures indicating proliferation. Histopathology of fibrosarcoma revealed densely packed spindle-shaped neoplastic cells arranged in interlacing fascicles and whorled patterns, exhibiting nuclear pleomorphism.

Histochemistry (with Mason's Trichrome)

Masson's Trichrome staining was applied to tumour sections where fibrous tissue was more prominent on initial H&E examination. In vaginal leiomyoma revealed the tumour mass to be enclosed by a fibrous connective tissue capsule, which appeared as densely arranged blue-stained fibers. Histochemistry of ovarian haemangiosarcoma showing irregular cavernous vascular areas lined by pleomorphic anaplastic surrounded by dense fibrous connective tissue appearing blue.

Table 1: Breed-wise distribution canine tumours during the period 2019-2024

Sl. No	Breeds	Cases Reported	Percentage (%)
1	Nondescript	81	30.22
2	Labrador retriever	50	18.6
3	Golden retriever	35	13.05
4	Pomeranian	29	10.8
5	Dobermann	13	4.8
6	German shepherd	12	4.47
7	Dachshund	9	3.35
8	Cocker Spaniel	7	2.61
9	Rottweiler	5	1.86
10	Pug	5	1.86
11	Beagle	5	1.86
12	Mudhol Hound	5	1.86
13	Pit bull	4	1.49
14	Husky	4	1.49
15	Saint Bernard	2	0.74
16	Dogo Argentino	2	0.74
Total		268	100

Table 2: Breed wise distribution of reproductive tract tumours during the period 2019-2024

Sl. No.	Breeds	Cases Reported	Percentage (%)
1	Non Descript	48	39.6
2	Labrador	23	19
3	Golden retriever	16	13.20
4	Pomeranian	12	9.90
5	German shepherd	7	5.78
6	Daschund	5	4.13
7	Mudhol	4	3.30
8	Pitbull	2	1.65
9	Pug	2	1.65
10	Siberian Husky	1	0.80
11	Rottweiler	1	0.80
Total		121	100

Table 3: Age-wise distribution of canine tumours during the period 2019-2024

Sl. No.	Age	Cases Reported	Percentage (%)
1	1-4	26	9.7
2	4-8	83	30.97
3	8-12	142	52.98
4	>12	17	6.34
Total		268	100

Table 4: Age wise distribution of canine reproductive tract tumours during the period 2019-2024

Sl. No.	Age	Cases Reported	Percentage (%)
1	1-4	13	10.74
2	4-8	67	55.37
3	8-12	37	30.57
4	>12	4	3.30
Total		121	100

Table 5: Sex wise distribution of canine tumors during the period 2019-2024

Sl. No.	Sex	Cases Reported	Percentage (%)
1	Female	144	67.6
2	Male	69	32.39
Total		268	100

Table 6: Distribution of canine tumours based on tissue origin during study period July 2024 to June 2025

Sl. No	Tumors	No. of dogs affected	Percentage (%)
1	Epithelial tumors	25	37.31
2	Non epithelial tumors	42	62.68
Total		67	

Table 7: Classification of non-epithelial tumors recorded during the study period July 2024 to June 2025

Types	Specific type	Total cases (N = 42)	Incidence (%)	Overall Incidence (%)
Round cell tumours (n = 32)	TVT *(Lymphosarcoma)	23	54.76	76.19
	Mast cell tumour	6	14.28	
	Lymphoma (Cutaneous)	2	4.76	
	Histiocytoma (Cutaneous)	1	2.38	
Reproductive tract tumours(n = 9)	Vaginal leiomyoma	4	9.52	21.42
	Sertoli cell tumour	2	4.76	
	Ovarian haemangiosarcoma	1	2.38	
	Testicular seminoma	1	2.38	
	Vaginal leiomyosarcoma	1	2.38	
Others (n = 1)	Fibrosarcoma	1	2.38	2.38
Total		42	100	100

(*) : Though TVT (Transmissible Veneral Tumour) is also considered as reproductive tract tumour histologically it is a round cell tumour

Table 8: Breed-wise distribution of non-epithelial tumours during the study period July 2024 to June 2025

S. No	Breed	Cases reported (N = 42)	Percent (%)
1	Non-Descript	14	33.33%
2	Labrador	8	19.04%
3	Pomeranian	4	9.52%
4	Golden Retriever	4	9.52%
5	German Shepherd	4	9.52%
6	Dachshund	3	7.14%
7	Rottweiler	2	4.76%
8	Dobermann	1	2.38%
9	Shih Tzu	1	2.38%
10	Beagle	1	2.38%
Total		42	100

Table 9: Age-wise distribution of non-epithelial tumors during the study period July 2024 to June 2025

S. No	Age (years)	Cases reported(N = 42)	Percent (%)
1	1-4	5	11.90
2	4-8	24	57.14
3	9-12	10	23.80
4	>12	3	7.14
Total		42	100.00

Table 10: Sex-wise distribution of non-epithelial tumours during the study period July 2024 to June 2025

Sex	Cases reported (N = 42)	Percent (%)
Male	18	42.80
Female	24	57.14
Total	42	100.00

Table 11: Haematological and biochemical parameters of canine tumours according to type of non-epithelial tumours

S. No	Parameter	Type of tumours			Reference range (Priyadarshni <i>et al.</i> , 2021) ^[25]
		Round cell tumours	Smooth muscle tumours	Reproductive tract tumours	
1	Haemoglobin (Hgb) (g/dl)	12.4±0.04	10.52±1.94	10.8±0.9	14.2-19.2
2	Packed cell volume (PCV) (%)	39.5±0.99	30.84±5.78	32.1±1.8	29-55
3	Red blood cells (RBC) (x 10 ⁶ /µl)	5.34±0.38	5.03±0.99	5.2±0.4	5.5-8.5
4	White blood cells (WBC) (x 10 ³ /µl)	18.99±0.97	19.76±3.94	18.6±1.6	5.9-16.6
5	Platelets (PLT) (x 10 ³ /dl)	315.6±32.38	255±52.48	260±15.2	211-621
6	Granulocytes (%)	77.6±1.76	75.8±2.38	74.9±1.4	58-72
7	Lymphocytes (%)	18.4±1.594	14.6±1.30	15.2±0.7	12-30
8	Monocytes (%)	7.98±0.350	8.14±1.14	8.7±0.6	1-9
9	Creatinine (mg/dl)	1.04±0.139	1.034±0.303	1.05±0.12	0.5-1.7
10	Serum Glutamic Pyruvic Transaminase (SGPT) (u/l)	38.3±0.34	24.84±4.38	25.1±1.7	10-109



Fig 1: Gross picture of vaginal leiomyoma showing firm, nodular circumscribed mass with encapsulation.



Fig 4: Gross picture of mast cell tumour with small, rounded, well circumscribed, slightly irregular surface.



Fig 2: Gross picture of testicular seminoma with round to oval and firm, with smooth multinodular surface.



Fig 5: Gross picture of ovarian haemangiosarcoma appears as large, irregularly ovoid, and lobulated mass with smooth external surface covered by thin glistening serosa surface



Fig 3: Gross picture Sertoli cell tumour showing multinodular pattern separated by fine fibrous septa



Fig 6: Gross picture of TVT on male dog penis showing irregular, lobulated, cauliflower-like mass with nodules with ulcerated and hemorrhagic areas.



Fig 7: Gross picture of fibrosarcoma showing large, irregular, encapsulated circumscribed firm mass with ulceration, uneven surface, and areas of necrosis/hemorrhage.

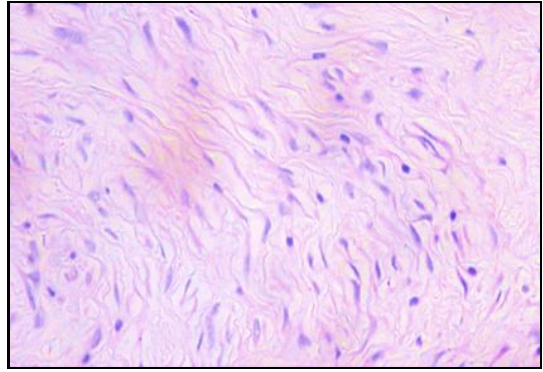


Fig 11: Histopathology findings of well differentiated leiomyosarcoma with Spindle cells and cigar shaped nuclei arranged in sheets and whorls (H&E X 400)

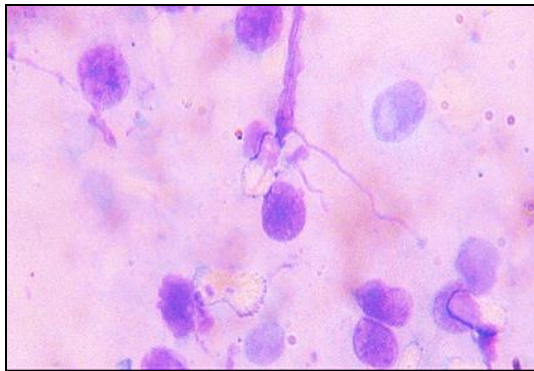


Fig 8: Cytology of mast cell tumour showing numerous discrete, round to oval cells with distinct purple metachromatic granules (Giemsa X1000)

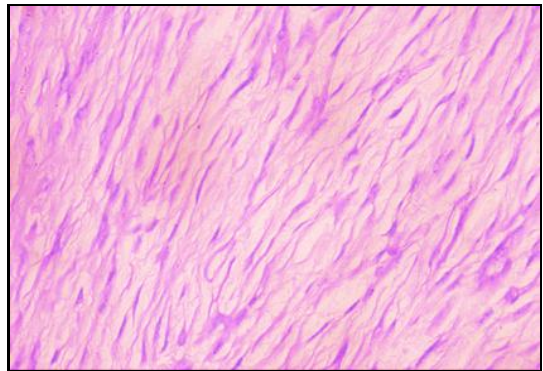


Fig 12: Histopathology findings of leiomyoma with densely arranged linear bundles of spindle cells with cylindrical elongated nuclei (H&E X 400)

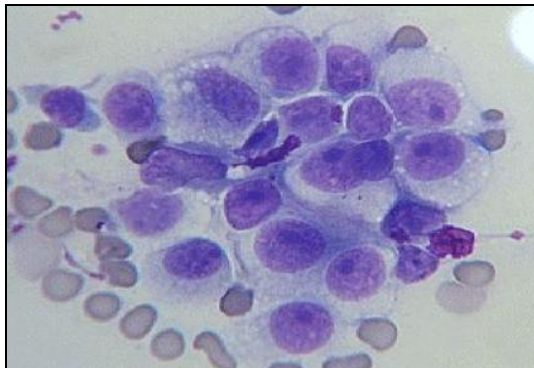


Fig 9: Cytology of TVT showing round anaplastic lymphocytes, increased N:C ratio, cytoplasmic vacuolations and basophilia. (Giemsa X 1000)

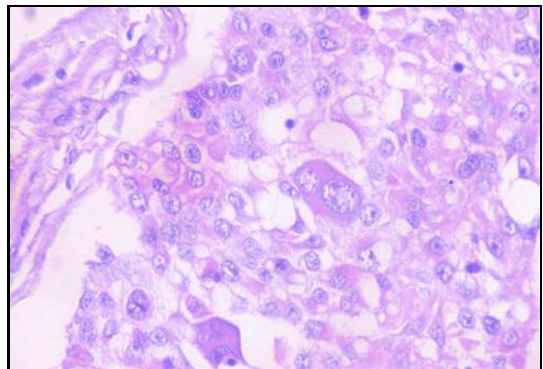


Fig 13: Histopathology findings of sertoli cell tumour with polygonal cells arranged in irregular cords, having abundant cytoplasm and prominent nucleoli (H&E X 400)

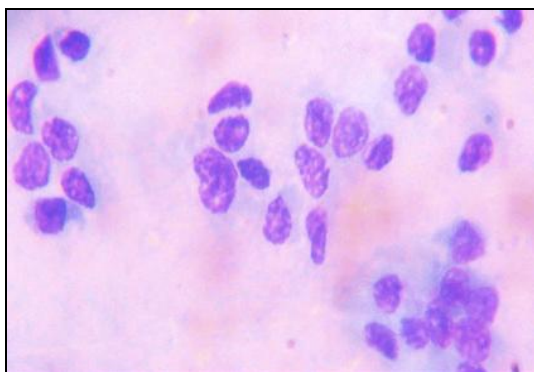


Fig 10: Cytology of testicular seminoma showing round to polygonal cells with pale cytoplasm, large nuclei with pleomorphism and irregular chromatin (Giemsa X 1000)

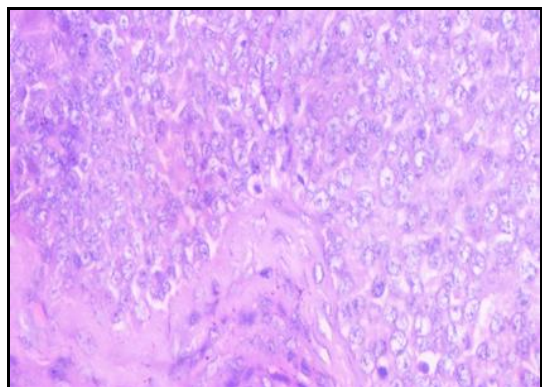


Fig 14: Histopathology findings of testicular seminoma showing neoplastic cells with clear cytoplasm, vesicular nuclei, prominent nucleoli, mitotic activity. (H&E X 400)

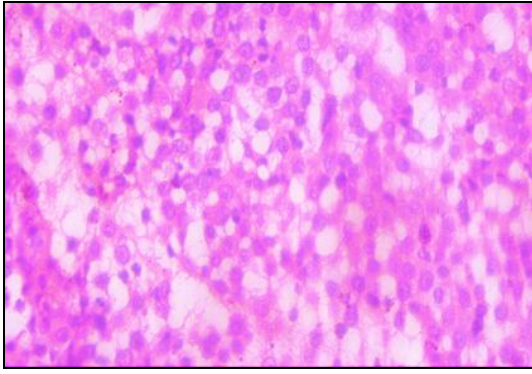


Fig 15: Histopathology findings of TVT tumour cells with centrally located, round to oval nuclei displaying vesicular chromatin, prominent nucleoli (H&E X 400)

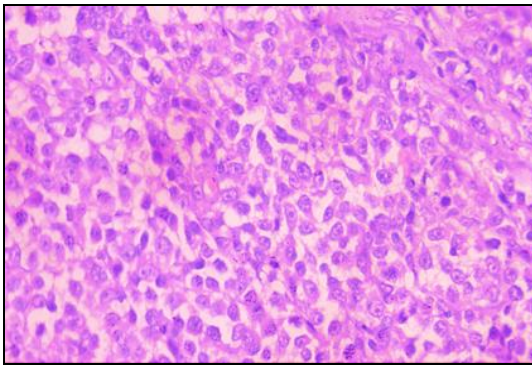


Fig 16: Histopathology findings of mast cell tumour with metachromatic granular cytoplasm, round central nuclei, occasional nucleoli, and scattered mitotic figure. (H&E X 400)

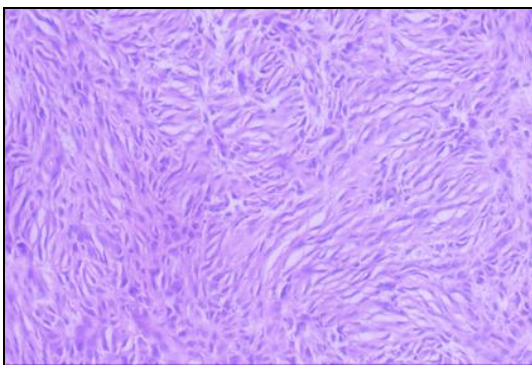


Fig 17: Histopathology findings of fibrosarcoma revealing densely packed spindle-shaped neoplastic cells arranged in interlacing fascicles and whorled patterns, exhibiting nuclear pleomorphism. (H&E X 400)

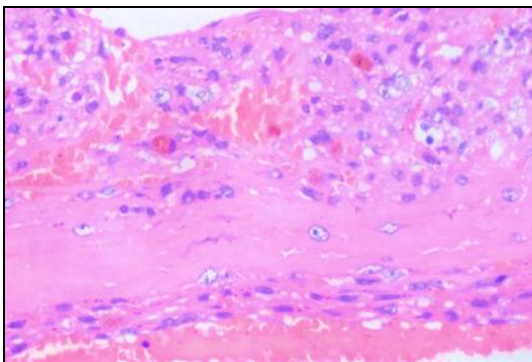


Fig 18: Histopathology findings of Ovarian haemangiosarcoma with evident cellular pleomorphism of endothelial lining and areas of cancerous vascular tissue filled with blood (H&E X 400)

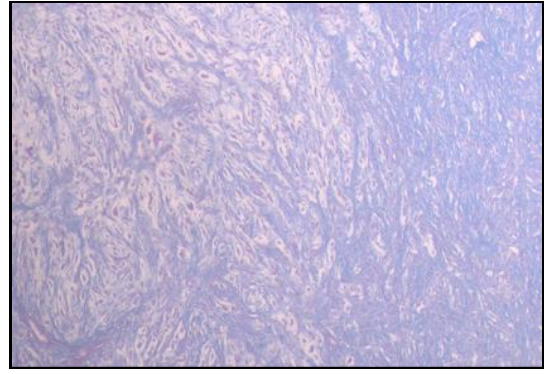


Fig 19: Histochemistry findings with Masson's Trichrome of leiomyoma shows abundant blue-stained collagen fibers in the periphery, Spindle-shaped cells with reddish cytoplasm. (MT X 400)

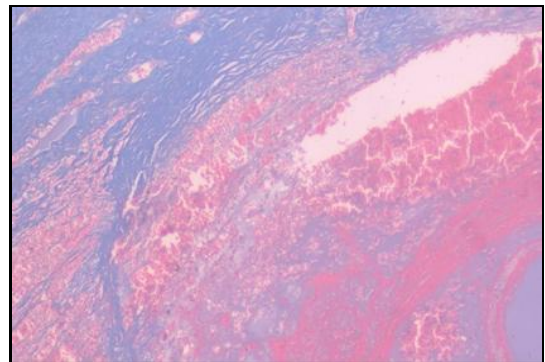


Fig 20: Histochemistry findings with Masson's Trichrome of ovarian haemangiosarcoma showing irregular vascular areas lined by anaplastic cells surrounded by dense fibrous connective tissue appearing blue. (MT X 400)

Discussion

The present study was undertaken to evaluate the occurrence and characterization of canine non-epithelial tumors, with special emphasis on smooth muscle tumours of reproductive tract, in and around Shivamogga, Karnataka. A five-year retrospective analysis (2019-2024) coupled with a one-year prospective investigation (2024-2025) was carried out using clinical records, gross pathology, cytology, histopathology, histochemistry. The findings provide valuable region-specific data on canine tumor epidemiology and biological behavior.

Occurrence of canine Tumors

The retrospective study, revealed a tumour prevalence of 3.09% among 8,671 canine cases, closely comparable to the 3.18% reported by Wang *et al.* (2021)^[31], but slightly lower than the 4.2% documented by Cohen *et al.* (1974)^[7]. This variation may be attributed to underdiagnosis or limited access to advanced diagnostic facilities. Nonetheless, the findings emphasize the clinical importance of canine neoplasia and the need for improved diagnostics, increased owner awareness, and further epidemiological studies.

In the present study, reproductive tract tumours constituted 47.76% (32/67) of all neoplasms, making them the most common tumour type in dogs and highlighting their clinical and epidemiological importance. This finding is consistent with earlier reports by Laissaoui *et al.* (2024)^[17], Kumar *et al.* (2020)^[16], and Wang *et al.* (2021)^[31], who also identified the reproductive system as the most frequently affected site, with proportions ranging from 36% to 40%.

The comparatively higher prevalence observed in this study may be attributed to regional factors such as lower rates of spaying and neutering, differences in study population and case selection, and the retrospective nature of clinical case reporting. Additionally, reproductive tumours are often more readily detected due to their external location and pronounced clinical signs, which may contribute to their increased representation. Overall, these findings reinforce the significant role of reproductive tract tumours in canine oncology.

Breed Predisposition

Breed-wise analysis revealed a higher overall tumor incidence in non-descript dogs, likely reflecting their larger population size and increased presentation to government veterinary facilities. Among pure breeds, Labrador Retrievers, Golden Retrievers, and Pomeranians showed higher tumor incidence. Notably, The higher occurrence of reproductive tract tumours in non-descript dogs in this study likely reflects their greater population in the study area. In contrast, earlier studies (Chandravathi *et al.*, 2014; Hamid *et al.*, 2014) [6, 10] have reported higher incidence in purebred dogs such as Labradors and Pomeranians, possibly due to genetic predisposition and breed popularity. These findings highlight the influence of both breed susceptibility and population demographics in canine tumour epidemiology. Overall, while certain pure breeds may be predisposed, non-descript dogs also constitute a significant proportion of cases, emphasizing the need for routine screening and early detection across all dog populations.

Age Distribution

Age was a significant determinant of tumor occurrence. The majority of tumors were recorded in dogs aged 4-12 years, with peak incidence in the 8-12 years group. For reproductive tract tumors showed a similar age distribution, consistent with the established understanding that cancer is predominantly a disease of aging. Accumulation of somatic mutations, decline in immune surveillance, and prolonged exposure to reproductive hormones contribute to increased neoplastic risk in older dogs.

These findings align with previous reports (Patel *et al.*, 2024; Babu *et al.*, 2012; Chandravathi *et al.*, 2014) [24, 2, 6], suggesting that tumor development is more common in middle-aged dogs, likely due to cumulative carcinogen exposure and time required for tumor progression. Some studies, however, noted peak incidence in slightly older age groups (Hamid *et al.*, 2014) [10], reflecting variation in tumor type and population.

Sex Predisposition

The present study revealed a higher tumour prevalence in females (67.60%) compared to males (32.39%) over five years, indicating a clear female predisposition. A similar trend was observed in the one-year analysis of non-epithelial tumours, with 57.14% in females and 42.80% in males. These findings are consistent with earlier reports (Majie and Maji, 2013; Kumar *et al.*, 2020; Patel *et al.*, 2024) [19, 16, 24], although some studies have reported equal or slightly varied distributions.

The increased incidence in females is likely associated with the influence of sex hormones and reproductive factors such as estrous cycles, pregnancy, and lactation. Supporting this, studies in species like cats—where routine spaying is

common—show no significant sex-related difference in tumour occurrence, suggesting that reproductive management practices play a key role in the observed female bias in canine tumours (Brilhante *et al.*, 2025) [5].

Hematobiochemical Findings

Dogs with reproductive tract and other non-epithelial tumors exhibited mild anemia and leukocytosis, findings consistent with tumor-associated chronic inflammation and altered hematopoiesis. Similar hematological changes have been reported in canine mammary tumor cases (Kumar *et al.*, 2020) [16]. Other biochemical parameters remained within normal limits, supporting previous observations that routine hematobiochemistry alone has limited diagnostic or prognostic value (Kose *et al.*, 2013) [14]. However, these parameters can serve as supportive indicators when interpreted alongside pathological findings.

Gross Pathology and Cytology

Gross examination revealed considerable heterogeneity in tumor size, shape, and consistency, particularly among mammary tumors. Such variability reflects differences in tumor type, duration, and biological behavior and is consistent with earlier descriptions (Goldschmidt *et al.*, 2002) [9].

Cytological evaluation proved useful in differentiating benign from malignant lesions based on cellular pleomorphism, nuclear atypia, and background features. The cytological findings in the present study were comparable to earlier reports demonstrating high concordance between cytology and histopathology (Hosseini *et al.*, 2014; Balachandran *et al.*, 2025) [11, 3]. Nevertheless, mixed and complex tumors required histopathological confirmation, reinforcing the role of cytology as a rapid screening tool rather than a definitive diagnostic method.

Histopathology

Histopathological evaluation revealed a diverse range of tumour types, with transmissible venereal tumours being the most common non-epithelial neoplasm, followed by mast cell tumours, vaginal leiomyomas, and testicular tumours such as seminomas and Sertoli cell tumours. Characteristic microscopic features aided diagnosis, including granular round cells in mast cell tumours, spindle-shaped cells in fibrosarcomas, and vascular channel formation in hemangiosarcomas. Smooth muscle tumours were identified by bundles of well-differentiated fibres in leiomyomas, whereas leiomyosarcomas showed cellular atypia and increased mitotic activity, confirming malignancy.

Histochemistry

Masson's Trichrome staining in the present study demonstrated distinct features across tumor types. The vaginal leiomyoma appeared as a well-encapsulated mass with a blue-staining fibrous capsule and interlacing bundles of neoplastic smooth muscle cells showing mild pleomorphism, consistent with smooth muscle origin and limited stromal deposition. In contrast, vascular tumors exhibited irregular channels lined by pleomorphic endothelial cells, accompanied by extensive hemorrhage, extravasated erythrocytes, and abundant collagen within the stroma, indicating fragile neoplastic vasculature. These observations are in agreement with previous reports, where leiomyomas showed predominantly red-stained smooth

muscle fibers with minimal collagen (Brady *et al.*, 2022) [4], and haemangiosarcomas displayed marked hemorrhage and prominent collagenous stroma (Jangir *et al.*, 2017) [12].

Conclusion

The present study documented an overall prevalence of 3.09% of canine tumors in and around Shivamogga, Karnataka, with a higher incidence observed in female dogs, middle-aged to older animals, and certain breeds such as non-descript dogs, Labradors, and Pomeranians. Haematological changes, particularly anaemia and leucocytosis, were consistent markers of disease, while biochemical values remained within normal ranges. Gross and cytological features provided useful preliminary diagnostic information, but histopathology and histochemistry were essential for definitive classification. These observations emphasize the importance of integrating classical pathology with histochemistry approaches for improved understanding, early diagnosis, and management of canine non-epithelial tumours.

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