Article

Scrotal tumors in dogs: A retrospective study of 676 cases (1986–2010)

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Abstract — The objective of this study was to determine common tumor types that occur on the canine scrotum in relation to other cutaneous locations and to identify potential risk factors for specific scrotal tumor development. A retrospective study was conducted and the database of pathology reports from the Surgical Pathology Service of the Department of Pathology and Toxicology, School of Veterinary Medicine, University of Pennsylvania from 1986 to 2010 was searched for canine neoplastic scrotal and non-scrotal cutaneous lesions. Neoplastic lesions were evaluated based on diagnosis, breed, age, and number and location of tumors (scrotal versus non-scrotal cutaneous). Mast cell tumor, melanocytoma, malignant melanoma, vascular hamartoma, hemangiosarcoma, hemangioma, and cutaneous histiocytoma were the most common tumor types identified on the canine scrotum. Breed predispositions and mean age at diagnosis were identified for each tumor type and should be considered when planning surgical excision of a canine scrotal tumor.

Résumé — Tumeurs scrotales chez les chiens : étude rétrospective de 676 cas (1986–2010). Cette étude avait pour objectif de déterminer les types communs de tumeurs qui se produisent sur le scrotum canin par rapport à d'autres endroits cutanés et d'identifier les facteurs de risque potentiels pour le développement de tumeurs scrotales spécifiques. Une étude rétrospective a été réalisée et une recherche a été effectuée dans la base de données des rapports de pathologie du Service de pathologie chirurgicale du Département de pathologie et de toxicologie de l'École de médecine vétérinaire de l'Université de la Pennsylvanie de 1986 à 2010 pour les lésions scrotales néoplasiques et les lésions cutanées non scrotales canines. Les lésions néoplasiques ont été évaluées en fonction du diagnostic, de la race, de l'âge ainsi que du nombre et de l'emplacement des tumeurs (scrotales par opposition à cutanées non scrotales). Les tumeurs à mastocytes, les mélanocytomes, les mélanomes malins, les hamartomes vasculaires, les hémangiosarcomes, les hémangiomes et les histiocytomes cutanés étaient les types les plus communs de tumeurs identifiées sur le scrotum canin. Les prédispositions des races et l'âge moyen lors du diagnostic ont été identifiés pour chaque type de tumeur et devraient être considérés lors de la planification de l'excision chirurgicale d'une tumeur scrotale canine.

(Traduit par Isabelle Vallières)

Can Vet J 2014;55:1229–1233

Introduction

Specialized areas of skin can be found on the nose, digital pads, external auditory meatus, mucocutaneous junctions, and the scrotum (1). Regional variation of the skin with regards to type and amount of hair present, distribution and type of glands, and skin thickness allows the animal to develop functional adaptations to its environment and may alter the pattern of disease that arises in specialized skin areas.

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The skin of the scrotum is thinner than other skin, is typically pigmented, and may contain fine hairs on the surface (2). The scrotum is also unique in that it is glabrous skin. The dermal layer contains well-developed sebaceous and apocrine glands (1,2). The dartos muscle lies below the scrotal skin, and is composed of smooth muscle and a mixture of collagen and elastic fibers (1,2). A well-developed counter-current vascular heat exchanger is present below the dartos and may influence development of vascular hamartomas in the scrotal region. These progressive vascular malformations have been reported, and are typically seen in older dogs with pigmented scrotal skin (3–5). Arterial supply to the scrotum is directly from the scrotal arteries and indirectly from the perineal arteries, both of which are branches of the external pudenal. Hemorrhage from a vascular lesion in the scrotum can be significant, and there are reports of exsanguination (5,6). Venous drainage is accomplished by satellite branches of the arterial supply (2). Lymphatics drain to the superficial inguinal lymph nodes (2).

There have been many studies of canine skin tumors, but no studies have specifically evaluated tumors that arise in the scrotum (3,7–15). A review of cutaneous scrotal lesions in dogs briefly described scrotal neoplasms and their histologic

Table 1. Scrotal tumors ($n = 676$) from 655 dogs

Diagnosis	Total	%
Round cell neoplasms	396	58.6
Mesenchymal neoplasms	92	13.6
Melanocytic	80	11.8
Hamartomas	52	7.7
Epithelial	29	4.3
Cysts and tumor-like lesions	27	4.0

Table 2. Percent of specific cutaneous tumors located on the scrotum

Diagnosis	% on scrotum
Vascular hamartoma	36.2
Melanocytoma	1.0
Malignant melanoma	2.9
Histiocytoma	0.1
Hemangioma	0.7
Hemangiosarcoma	1.9
Mast cell tumor, low-grade	1.6
Mast cell tumor, high-grade	3.6

appearance, but did not elaborate on prevalence and potential risk factors in these patients (4). Mast cell tumors have been documented as the most common scrotal neoplasm in the dog; however, there is a paucity of information on other tumor types (2,14,16,17). The aim of this study was to identify those tumors that arise most commonly on the canine scrotum and their prevalence compared with other cutaneous locations, and to determine if any predisposing factors exist in dogs.

Materials and methods

Study design

Histopathology reports from cases submitted to the Surgical Pathology Service of the Department of Pathology and Toxicology, School of Veterinary Medicine, University of Pennsylvania from 1986 to 2010 were searched for canine scrotal and cutaneous non-scrotal lesions. Information obtained from the database included age, breed, diagnosis, number and location (scrotal versus non-scrotal) of all cutaneous tumors diagnosed over the same period, and presence of additional scrotal tumors. Any sample that was diagnosed solely with a non-neoplastic lesion was excluded. Data on tumor type were reported as absolute number and as a percentage of the total number of masses included in data analysis. Age at diagnosis was reported as a mean.

Mast cell tumors were re-classified as low grade and high grade in an attempt to correlate with the recently published mast cell tumor grading scheme (18). For the purposes of this study, previously reported grade 1 and 2 mast cell tumors were reclassified as low-grade and previously reported grade 3 were reclassified as high-grade mast cell tumors (19).

Statistical analysis

The SAS/STAT (R) 9.2 program was used to run statistical analysis. Cochran-Mantel-Haenszel statistics were used to calculate the logit common odds ratio. Confidence intervals (95% CI) were determined using Greenland and Robins variance estimate. *P*-values were calculated using the Breslow-Day test for homogeneity of the odds ratio, which can be approximated by a Pearson chi-squared distribution with q-1 degrees of freedom.

Case selection

There were 676 scrotal tumors among the 337 762 cases in the database submitted between January 1, 1986 and December 31, 2010. All inflammatory lesions of the scrotum were excluded.

Results

A total of 165 054 cutaneous neoplasms were submitted during the study period. Of these, 655 patients were diagnosed with scrotal tumors, so that scrotal neoplastic lesions represented 0.4% of all neoplasms. Twenty-one dogs had a second scrotal tumor in the sample submitted. Thus, a total of 676 scrotal masses met the inclusion criteria. Castration status prior to surgical biopsy could not be definitively determined from the records examined.

Round cell neoplasms were the most prevalent, representing 396/676 tumors (58.6%). Mesenchymal neoplasms were diagnosed in 92 cases (13.6%), melanocytic neoplasms in 80 cases (11.8%), hamartomas in 52 cases (7.7%), epithelial neoplasms in 29 cases (4.3%), and cysts and tumor-like lesions in 27 cases (4.0%) (Table 1). Percentages of the specific tumors on the scrotum are presented in Table 2. Odds ratios (OR), 95% CI, and *P*-values for all identified tumors are reported in Table 3.

Mast cell tumor

Mast cell tumors comprised 54.6% (369/676) of scrotal tumors diagnosed during the study period. Low-grade tumors were 44.2% (299/676) of tumors, and high-grade tumors were 10.4% (70/676). The mean age at diagnosis was 9.3 y (+/− 2.9 y) and 10.1 y (+/− 2.7 years) for low- and high-grade scrotal mast cell tumors, respectively. Boxers, Boston terriers, and American pit bull terriers were predisposed to scrotal and non-scrotal cutaneous low-grade and high-grade mast cell tumors. Vizslas were predisposed to development of scrotal low-grade mast cell tumors and beagles were predisposed to development of scrotal high-grade mast cell tumors.

Melanocytoma

Melanocytomas comprised 7.1% (48/676) of scrotal tumors and scrotal melanocytomas were 0.9% (48/5090) of all cutaneous melanocytomas diagnosed during the study period. The mean age at diagnosis of scrotal melanocytoma was 9.4 y (+/− 2.3 y). Golden retrievers were predisposed to development of scrotal and non-scrotal melanocytomas compared with other breeds.

Malignant melanoma

Malignant melanomas comprised 4.7% (32/676) of scrotal tumors and scrotal malignant melanomas were 3.1% of all cutaneous malignant melanomas diagnosed during the study period. The mean age at diagnosis of scrotal malignant melanoma was 9.7 y (+/− 2.9 y). Standard schnauzers and miniature schnauzers were predisposed to development of scrotal and non-scrotal malignant melanoma. Giant schnauzers were predisposed to development of non-scrotal cutaneous malignant melanomas.

Table 3. Breed predispositions for scrotal and non-scrotal cutaneous tumors

Breed	Tumor type	OR	95% CI	*P*-value
American pit bull terrier	Low-grade mast cell tumor-scrotal	7.50	4.53–12.43	$P < 0.005$
	Low-grade mast cell tumor-non-scrotal	2.80	2.51–5.16	$P < 0.005$
	High-grade mast cell tumor-scrotal	15.00	6.90–32.80	$P < 0.005$
	High-grade mast cell tumor-non-scrotal	2.50	1.80–3.50	$P < 0.005$
	Vascular hamartoma-scrotal	3.20	1.00–10.1	$P = 0.035$
	Vascular hamartoma-non-scrotal	6.16	1.49–25.40	$P < 0.005$
Bassett hound	Vascular hamartoma-scrotal	4.70	1.10–19.40	$P = 0.018$
Beagle	High-grade mast cell tumor-non-scrotal	2.80	1.00–7.70	$P = 0.036$
	Histiocytoma-scrotal	4.35	1.01–18.55	$P = 0.030$
	Histiocytoma-non-scrotal	1.20	1.10–1.30	$P < 0.005$
Boston terrier	Low-grade mast cell tumor-scrotal	7.78	4.54–13.23	$P < 0.005$
	Low-grade mast cell tumor-non-scrotal	4.37	3.92–4.86	$P < 0.005$
	High-grade mast cell tumor-scrotal	4.70	1.20–19.30	$P < 0.005$
	High-grade mast cell tumor-non-scrotal	3.40	2.50–4.70	$P < 0.005$
Boxer	Low-grade mast cell tumor-scrotal	7.60	5.74–10.05	$P < 0.005$
	Low-grade mast cell tumor-non-scrotal	5.13	4.88–5.38	$P = 0$
	High-grade mast cell tumor-scrotal	3.80	1.80–8.00	$P < 0.005$
	High-grade mast cell tumor-non-scrotal	2.20	1.80–2.60	$P < 0.005$
	Vascular hamartoma-scrotal	4.80	2.90–7.90	$P < 0.005$
	Vascular hamartoma-non-scrotal	3.60	1.40–9.20	$P < 0.005$
	Hemangioma-scrotal	5.81	2.22–15.18	$P < 0.005$
	Hemangioma-non-scrotal	3.20	2.80–3.50	$P < 0.005$
	Histiocytoma-scrotal	4.36	1.29–14.66	$P = 0.009$
	Histiocytoma-non-scrotal	4.60	4.40–4.90	$P = 0.005$
Golden retriever	Melanocytoma-scrotal	2.57	1.20–5.50	$P = 0.011$
	Melanocytoma-non-scrotal	2.10	1.90–2.20	$P < 0.005$
	Hemangiosarcoma-scrotal	6.15	2.99–12.61	$P < 0.005$
	Hemangiosarcoma-non-scrotal	2.20	1.90–2.50	$P < 0.005$
Schnauzer-giant	Malignant melanoma-non-scrotal	4.60	2.10–10.40	$P < 0.005$
Schnauzer-miniature	Malignant melanoma-scrotal	17.30	7.11–42.30	$P < 0.005$
	Malignant melanoma-non-scrotal	5.00	3.90–6.40	$P < 0.005$
Schnauzer-standard	Malignant melanoma-scrotal	23.30	8.15–66.70	$P < 0.005$
	Malignant melanoma-non-scrotal	6.40	4.60–8.70	$P < 0.005$
Viszla	Low-grade mast cell tumor-scrotal	3.51	1.12–10.95	$P = 0.02$

OR — odds ration; CI — confidence interval.

Vascular hamartoma

Vascular hamartomas comprised 6.8% (46/676) of scrotal tumors, but the scrotum accounted for 36.2% (46/127) of all cutaneous vascular hamartomas diagnosed during the study period. The mean age at diagnosis of scrotal vascular hamartomas was 5.9 y (+/− 2.7 y). Boxers and American pit bull terriers were predisposed to developing scrotal vascular hamartomas; these 2 breeds and the basset hound also had a predilection for non-scrotal cutaneous hamartomas.

Hemangiosarcoma

Hemangiosarcoma comprised 5.0% (34/676) of scrotal tumors and scrotal hemangiosarcoma comprised 1.9% (34/1802) of cutaneous hemangiosarcomas diagnosed during the study period. The mean age at diagnosis of scrotal hemangiosarcoma was 8.2 y (+/− 3.0 y). Golden retrievers were predisposed to development of scrotal hemangiosarcoma and cutaneous non-scrotal hemangiosarcoma.

Hemangioma

Hemangiomas comprised 4.6% (31/676) of scrotal tumors. Scrotal hemangiomas comprised 0.7% (31/4313) of all cutaneous hemangiomas diagnosed during the study period. The mean age at diagnosis of scrotal hemangioma was 8.3 y (+/− 2.9 y). Boxers were predisposed to development of cutaneous scrotal and non-scrotal hemangiomas compared with other breeds.

Histiocytoma

Histiocytomas comprised 3.4% (23/676) of scrotal tumors. Histiocytomas of the scrotum comprised less than 0.1% (23/16,744) of all cutaneous histiocytomas diagnosed during the study period. The mean age at diagnosis of scrotal histiocytoma was 2.8 y (+/− 2.6 y). Boxers and beagles were predisposed for development of scrotal histiocytomas. Both breeds were also predisposed to development of cutaneous histiocytomas on non-scrotal skin. Four additional round cell tumors were reported on the scrotum: 1 each of a histiocytic sarcoma, a lymphohistiocytic sarcoma, and 2 round cell tumors that were not further classified.

Discussion

Mast cell tumors account for 16% to 21% of cutaneous tumors in the dog (7,8,15,20,21). They seem to have a predilection for the caudal half of dogs and occur more commonly on the rear

limbs, abdomen, perineum, and scrotum (7,14). It has been reported that mast cell tumors of the preputial, inguinal, and subungual regions and other mucocutaneous sites tend toward more aggressive behavior (22,23). More recent reports indicate that tumors in scrotal and inguinal areas behave similarly to tumors in other cutaneous locations, although, when the data are critically evaluated, there is a trend towards more aggressive behavior (23–26). The reported median disease-free interval for dogs with mast cell tumors in the inguinal or perineal region was 9.6 mo, compared with 33.9 mo for dogs with these tumors in other cutaneous sites. When dogs with preputial and scrotal mast cell tumors were specifically separated out, there was a significant difference in disease-free interval (median of 4.2 mo compared with 33.9 mo, respectively) when dogs with preputial mast cell tumors were compared with dogs with scrotal mast cell tumors (24). However, with aggressive treatment (clean surgical excision with or without definitive radiation therapy), perianal and preputial mast cell tumors have a similar biological behavior to mast cell tumors at other sites (23–26). Additional studies on biologic behavior and prognosis of mast cell tumors in the inguinal and preputial areas are warranted.

If a diagnosis of suspected mast cell tumor is made based on fine-needle aspiration, a scrotal ablation should be performed at the time of surgery (14). The increased proportion of high-grade tumors in the scrotum and improved prognosis with aggressive local control warrants scrotal ablation. Furthermore, evaluation of the inguinal lymph nodes should be undertaken at the time of surgery to exclude metastatic disease and better determine prognosis (21).

Melanocytomas and malignant melanomas comprised approximately 12% of the scrotal tumors and only 1.3% of all cutaneous tumors in this study, which is lower than previously published data in which 3% to 7% of canine skin tumors were melanocytic neoplasms (8,10,26–30). Although a previous study on the biological behavior of melanomas reported that greater than 75% of melanocytic tumors in doberman pinschers and schnauzers were behaviorally benign (31), we did not find an increased risk for these breeds to develop scrotal melanocytomas. In the scrotum there was an increased incidence of melanocytomas (60%) compared with malignant melanoma (40%); however, the percentage of malignancy was still high. Therefore, any suspected melanocytic neoplasm of the scrotum should be considered more likely to be malignant than those arising from non-scrotal haired skin and a more radical surgical approach may be appropriate. Mitotic index and pleomorphism are prognostically significant (32). These data are not available for this study, but would be of value in future studies.

Cutaneous vascular hamartomas were first described in 1954 (5) and are relatively uncommon in dogs (0.4% of all hamartomas); however, their predilection for the scrotum is noteworthy. Because they are arteriovenous malformations there may be significant blood loss from these lesions (5,6). The increased incidence of these lesions on the scrotum is most likely associated with the unique vascular and thermoregulatory function of the scrotum. A prior report identified 2.6% of all cutaneous hemangiosarcomas in a scrotal location (7). In the current study, we reported 0.7% of all cutaneous hemangiosarcoma in a scrotal location. The lower percentage of lesions on the scrotum may reflect an increased prevalence of neutered male dogs at the current time compared to when the study was published. However, since castration status could not be determined, we were unable to test this theory. The previous report also identified an increased odds of cutaneous hemangiosarcoma in several breeds, with the highest odds in Italian greyhounds (OR = 23.6), whippets (OR = 13.7), and Irish wolfhounds (OR = 13.1) (7). In that report, golden retrievers had an odds ratio of 1.7 (95% CI: 1.1 to 2.5, $P = 0.01$) for development of cutaneous hemangiosarcoma. Our data support the notion that golden retrievers are at a higher risk of developing scrotal hemangiosarcoma compared with other cutaneous locations.

Hemangiosarcomas were more prevalent than hemangiomas in the scrotum, whereas hemangiomas were much more common than hemangiosarcoma in non-scrotal skin. Boxers appeared to be predisposed to the development of scrotal and non-scrotal cutaneous hemangiomas, whereas golden retrievers appeared to be predisposed to the development of scrotal and non-scrotal cutaneous hemangiosarcomas. It is unknown whether any of the vascular neoplasms are associated with excessive ultraviolet light exposure or whether there is malignant transformation of vascular endothelium; however, future biopsy samples should be evaluated for evidence of solar elastosis, which is a hallmark of UV-light induced hemangiosarcoma (33).

Scrotal hemangiomas comprise 1.1% of all cutaneous hemangiomas (7). In this study, scrotal hemangiomas accounted for 4.59% of scrotal tumors and 0.7% of cutaneous hemangiomas. There is an increased probability of development of cutaneous hemangiomas in several breeds, with Airedale terriers, Gordon setters, boxers, soft-coated Wheaton terriers, and wire-haired fox terriers having the highest odds ratios (7). The previously reported odds ratio for boxers and development of cutaneous hemangioma was 3.1 (95% CI: 2.5 to 3.9, $P < 0.005$). Our results agree with these data.

Histiocytomas are benign tumors of Langerhans cells that are typically found in dogs less than 3 to 4 years old and occur predominantly on the head and neck (11,34). They comprise 5.5% to 7.5% of canine cutaneous tumors (12,13,30). Consistent with previous reports, our mean age at diagnosis for scrotal histiocytomas was 2.8 y (+/− 2.6 y). Scrotal histiocytomas accounted for only 3.4% of all scrotal tumors, but less than 0.01% of all cutaneous histiocytomas arose on the scrotum. These tumors tend to regress spontaneously so it is likely that these numbers under-represent the true incidence, as the lesions may regress preventing surgical removal and biopsy (11,34). Based on our data, boxers and beagles appear to be at increased risk for developing cutaneous histiocytomas at both scrotal and non-scrotal sites.

Only 4.2% of scrotal neoplasms were of epithelial origin. The most common epithelial neoplasm was squamous cell carcinoma. Low incidence of this neoplasm on skin that is exposed to ultraviolet light radiation may be due to the amount of melanin pigment that is present within the epidermis of the scrotum. However, the geographic location from which the

biopsy samples were obtained may also have influenced the low incidence of this neoplasm.

As we have demonstrated, certain dog breeds are predisposed to development of specific tumor types on the scrotal skin. This may be due to the unique anatomy of the canine scrotum and specialized adaptations in this region. Knowledge of the most common tumors types on the canine scrotum will aid the surgeon in decision-making and surgical planning. The ability to perform a scrotal ablation may aid in obtaining clean margins at the time of surgery. Conversely, the anatomic location of the scrotum in the inguinal area, where skin is otherwise limited and motion is a significant factor, may deter the surgeon from being aggressive on a first attempt at excision in this region. Identification of the common tumor types in this area should guide the surgeon when deciding between an incisional biopsy or a wide excision. This may be especially important in valuable breeding dogs and for owners who prefer to leave their dogs sexually intact.

Because of the retrospective nature of this study, we were unable to determine prognostic data for scrotal tumors. Another limitation of this study is that castration status prior to surgical biopsy could not be definitively determined from the records examined. Further studies are warranted to determine if reproductive status influences scrotal tumor development and biological behavior. Cases were evaluated by several pathologists and were classified based on their diagnosis, with the exception of mast cell tumors as previously stated. Classification and diagnostic criteria may have changed over the study period, and these changes were not accounted for in our data analysis. Also, this study did not evaluate change of tumor prevalence over time. It may be of value to determine if changes in prevalence occurred with changes in environment, husbandry, and other external factors in the life of domestic dogs.

Despite study limitations, our data found that mast cell tumors accounted for more than 50% of the cases and that certain breeds are predisposed to development of specific tumor types in a scrotal location. These predispositions should be considered prior to surgical removal of a scrotal mass. Preoperative staging, local tumor control, and the need for adjuvant chemotherapy following surgical excision may all be influenced by the knowledge of common tumor types and breed predispositions for scrotal masses. Further investigation into the biological behavior and prognosis of scrotal tumors is warranted. CVJ

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