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MAMMARY TUMORS IN DOGS: SURVEY OF
CLINICAL AND PATHOLOGICAL CHARACTERISTICS

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INTRODUCTION

Canine mammary tumors represent an important part in the evaluation of toxicological studies of long duration. The assessment of the safety of numerous hormone steroids is partly achieved by studying Beagles for as long as seven years. However, it is not known whether the most suitable breed is being employed. There is need for more information regarding the normal tumor incidence in dogs, especially tumors of the mammary gland.

Information on this subject is rather scanty and the findings vary widely, usually due to the diversified nature of the population under study (9). The literature on canine mammary tumors does show marked variation in opinion (11, 13). The objective of this survey was to obtain further information for the characterization of mammary tumors. Dogs are used extensively for the long term evaluation of carcinogenic potential of chemical compounds and new drugs, and data from these studies are extrapolated for human use. Consequently, the precise analysis and interpretation of canine tumor response is necessary for evaluations to be assessed in their proper perspective (12). In assessing the significance of mammary gland lesions in drug safety, consideration should be given to the fact that mammary tumors are frequent in dogs and a strong species sensitivity exists. Emphasis has been given here to the analysis of historical data as related to types of

tumors found, incidence, age distribution, breed and sex susceptibility.

MATERIALS AND METHODS

Source - The Department of Pathology (Ontario Veterinary College) and the Veterinary Services Branch (Guelph) of the Ontario Ministry of Agriculture and Food was the primary source for all demographic and pathological data. The scope of this retrieval was primarily to narrow the search from mid 1966 to mid 1971. A total of five years of experience involving 13,795 canine cases was reviewed within this period. The yearly distribution of cases in this study is shown in Table I. The material was composed mainly by surgical specimens and a small number of necropsies which were submitted for consultation. In a significant number of cases, it was necessary to contact the practitioners who originally submitted the specimens, so more complete clinical data could be secured as well as follow-up reviews.

Data handling - Every case recorded between July 1, 1966 and June 30, 1971 was entered in *ad hoc* individual forms which contained the basic identification including the date, case number, breed, sex and age. In addition, a brief clinical history in some instances was obtained and included the incidence of spaying, pregnancies and estrous cycles. Specific pathological data were related to the tumor found. When possible, its diagrammatic location was attempted as well as other data concerning size and additional characteristics.

RESULTS

A total of 6,754 or 49% of the cases constituted tumors of different types from different organs. Of these, approximately 720 or 11%

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TABLE I
YEARLY DISTRIBUTION OF CANINE CASES INCLUDED IN THIS STUDY

Year	1966 ^a	1967	1968	1969	1970	1971 ^a	Total
No. of Cases ^b	1766	2137	2184	2942	3380	1356	13,795
(%)	13	15	16	21	25	10	100
Cases with Tumors	863	1035	1043	1414	1711	688	6,754
(%)	49	48	48	48	51	50	49
Mammary Tumor Cases	80	94	110	171	183	82	720
(%)	9	9	11	12	11	12	11

^aSix months.

^bThe number of surgical and post-mortem canine cases in the files.

were related to the mammary glands (Table I). This primary sample population of 720 tumors was further analyzed as follows:

Incidence of tumor types – For the purposes of analyzing the frequency of the type of tumor found, all clinical reports were separated into five categories according to the histological diagnoses found in the records. The results are shown in Figure 1. Five percent were found not representing a tumor histologically and mixed mammary tumors accounted for nearly one-half of all diagnosed tumors while adenocarcinomas represented a 37% incidence rate.

Age distribution – Correlation with age was made in 357 cases. The age distribution of these tumors is shown in Figure 2. About 62% of the tumors were seen in animals between seven and 11 years of age while 90% were found between the ages of four and 13. Approximately 31% occurred from one to seven years and 3% of the dogs under three years of age had tumors. The mean tumor incidence was found at 8.8 years of age.

Age distribution and tumor type – The relative age distribution of mammary mixed tumors, adenomas and adenocarcinomas is shown in Figure 3. The incidence of tumors was progressive from three to nine years of age, after which the frequency declined and reached its lowest at 15 years. The frequency distribution within each tumor type was analyzed in these tumors and is presented in Figure 4. Mixed tumors were found between four to 13 years (94%), 64% were within seven to 11 years and 33% occurred between one to seven years. Although the incidence at onset is low, it appears that the initial occurrence is similar for both mixed tumors and adenocarcinomas. Sixty-two percent of the adenocarcinomas found were within seven and 11 years, 90% occurred from four to 13 years and 22% were seen from one to seven. All

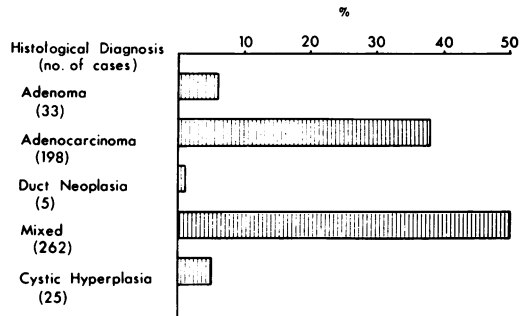


FIGURE 1. Incidence of tumor types. Five categories were established from the histological diagnosis. Mixed tumors were the most common finding.

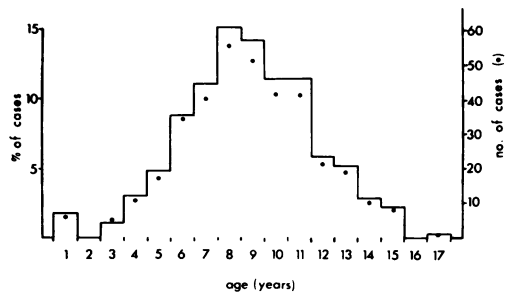


FIGURE 2. Age distribution of all mammary tumors. Mean age of the dogs was 8.8 years.

adenomas but one were found between four and 11 years, 32% of which occurred at seven years and 52% were found within the first seven years of life. The mean age of dogs with adenomas, adenocarcinomas or mixed tumors was 7.9, 9.6 and 8.6 years, respectively.

Sex – In 357 specimens, the sex was established, six of which were males (1.7%). In the tumors found in males, two were adenocarcinomas and four were mixed. The majority of cases were intact females or females neutered at the time of tumor removal. In 17 cases, it

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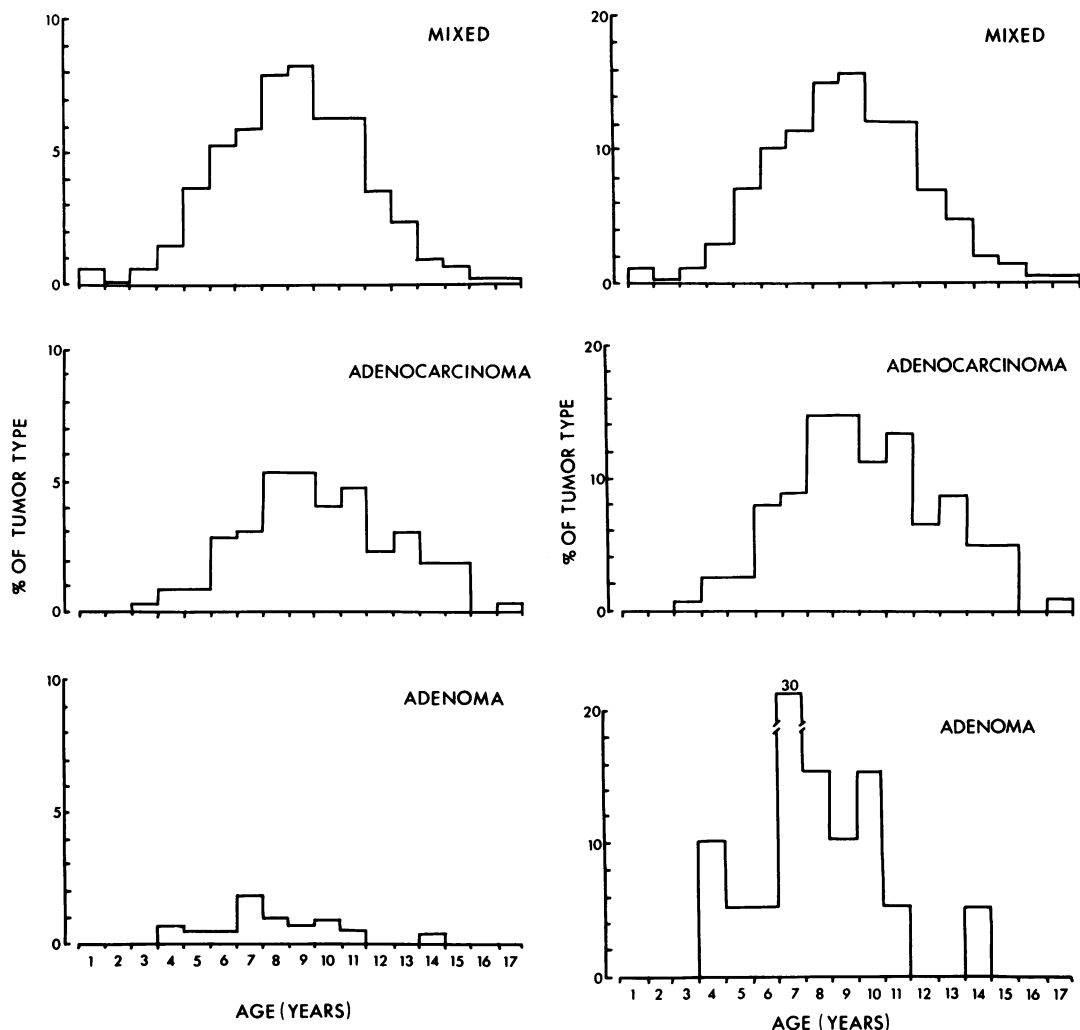


FIGURE 3. Comparison of the relative age distribution of dogs having mammary mixed tumors, adenocarcinomas or adenomas is shown.

was established that ovariectomy had been performed prior to the appearance of the tumor (Figure 5). Five of these cases were juveniles or young adults while the rest were females between five to 13 years of age at the time of surgery.

Breed – The analysis of tumor distribution by breed was carried out according to the type of tumor frequency in all breeds and by the distribution of a particular type of tumor within a breed. The results are presented in Tables II and III respectively. The Poodle was the more susceptible breed, accounting for 25% of all tumors. The highest incidence of adenocarcinomas and mixed tumors was seen in Poodles while adenomas were frequent in Cocker Spaniels. Beagles had a relatively low

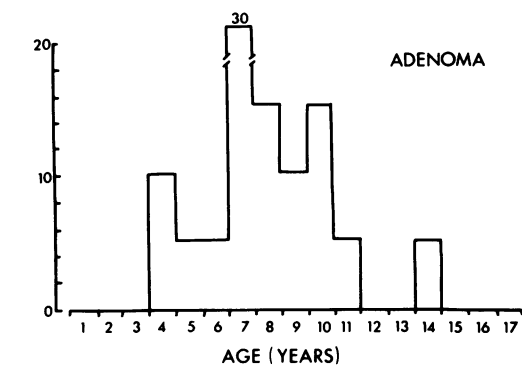


FIGURE 4. Frequency distribution by age for each of the following tumors: mixed, adenocarcinoma and adenoma is shown in relation to the age of the dog.

incidence of 3.6% for all tumors, while the incidence of adenocarcinoma and adenoma was about twice that of mixed tumors in this breed.

The majority of tumors in Poodles, Dachshunds, German Shepherds, Spaniels and Manchester Terriers were mixed. Terriers, Beagles, Springer Spaniels and Collies were the breeds in which adenocarcinomas were most frequently found (60 to 70%).

Size – Difficulty was encountered in determining the size of the tumors reported. This was due to the variety of common object (apples, eggs, etc.) terms used for the description. It was then arbitrarily decided to adjust these sizes to the average diameter of the related

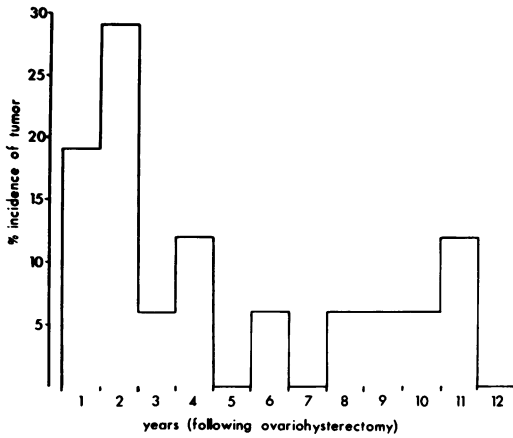


FIGURE 5. Ovariectomy had been performed in 17 dogs prior to the appearance of a mammary tumor. This figure indicates the number of years after ovariectomy that elapsed prior to the appearance of a mammary tumor.

object. The results are shown in Figure 6. Approximately 28% of all tumors ranged between two to four cm. No correlation was found between size and tumor type (Table IV).

Site – A description of the specific location of the tumor was found in 99 records. The anatomical distribution of tumors by gland is shown in Table V. The highest incidence occurred in the inguinal pair (36%) and a relatively even distribution was seen in the remaining pairs, while a high incidence (37%)

of multiple localization was found. However, the term “multiple” did not differentiate whether more than one gland was involved by a tumor or more than one tumor was found in various glands. Thus, multiple tumor localization was further analyzed and patterns were characterized in Figure 7, indicating the frequencies found.

The distribution of tumor type within a particular pattern was also analyzed and the results shown in Figure 7. There was an even distribution of adenocarcinomas and mixed types in single tumors associated with one gland (pattern 1). However, when multiple tumors affecting several glands were studied, it was found that mixed tumors accounted for 61% of all cases (pattern 3). No single mixed tumor was found in more than one gland while adenomas and adenocarcinomas involved more than one gland (pattern 2).

Tumor recurrence – The analysis of the influences of ovariectomy was carried out in 108 cases where the tumors were removed surgically. In 49 of these cases, ovariectomy was performed together with the tumor excision. Tumors reappeared in 32% of the 108 cases. In addition, tumors recurred in 21 of 49 cases with simultaneous ovariectomy and in 13 of the 59 with tumor ablation alone (Figure 8). In analyzing the recurrence of each tumor according to its type, 54% of adenocarcinomas reappeared while only 21% of mixed tumors recurred (Table VI).

TABLE II
INCIDENCE OF MAMMARY TUMOR TYPE ACCORDING TO BREED

	All (N ^a)	Types	Adenoma	Adeno-carcinoma	Mixed	Duct carcinoma
Poodle	(86)	25.6	6.3	23.0	29.6 ^b	
Mongrel	(37)	11.0	12.5	10.1	11.7	
Cocker Spaniel	(20)	6.0	18.8	5.0	5.0	50.0
Dachshund	(17)	5.1	6.3	2.9	6.7	
German Shepherd	(15)	4.5	—	4.3	5.0	
Labrador	(13)	3.8	—	4.3	3.9	
Terrier ^c	(13)	3.8	6.2	6.5	1.7	
Beagle	(12)	3.5	6.2	5.0	2.2	
Chihuahua	(12)	3.5	12.5	1.4	4.5	
Boxer	(11)	3.3	6.2	3.6	2.8	
Spaniel ^e	(10)	3.0	6.2	0.7	4.5	
Kerry Blue Terrier	(10)	3.0	—	2.9	3.4	
Springer Spaniel	(10)	3.0	—	4.3	2.2	
Collie	(6)	1.8	6.3	2.9	0.6	
Boston Terrier	(6)	1.8	—	2.2	1.1	50.0
Manchester Terrier	(6)	1.8	—	1.4	2.2	
Other ^d	(52)	15.5	12.5	19.5	12.9	
Total	(336)	100.0	100.0	100.0	100.0	100.0

^aNumber of cases.

^bExpressed as percent of cases with a tumor type.

^cVariety not established.

^dIncludes 26 known breeds with five cases or less.

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TABLE III
DISTRIBUTION OF TUMOUR TYPE WITHIN BREED^a

	Adenoma	Adeno- carcinoma	Mixed	Duct carcinoma
Poodle	1.2	37.2	61.6	—
Mongrel	5.4	37.8	56.7	—
Cocker Spaniel	15.0	35.0	45.0	5.0
Dachshund	5.9	23.5	70.6	—
German Shepherd	—	40.0	60.0	—
Labrador	—	46.1	53.8	—
Terrier ^b	7.7	69.2	23.1	—
Beagle	8.3	58.3	33.3	—
Chihuahua	16.7	16.7	66.7	—
Boxer	9.1	45.4	45.4	—
Spaniel ^b	10.0	10.0	80.0	—
Kerry Blue Terrier	—	40.0	60.0	—
Springer Spaniel	—	60.0	40.0	—
Collie	16.7	66.7	16.7	—
Boston Terrier	—	50.0	33.3	16.7
Manchester Terrier	—	33.3	66.7	—
Other ^c	3.8	51.9	44.2	—
All breeds	4.8	41.4	53.3	0.6

^aExpressed as percent of all tumors found in each breed.

^bVariety not established.

^cIncludes 26 known breeds with five cases or less.

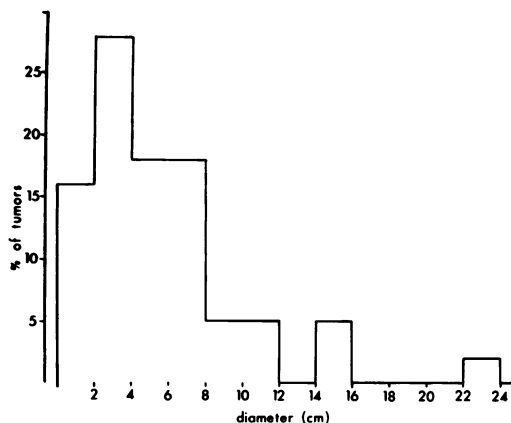


FIGURE 6. Size of tumors. Most tumors were eight centimeters or less in size.

DISCUSSION

Mammary tumors are the most common neoplasia in dogs. Many investigators have reported this finding (1, 2, 8, 9, 11, 13) and the mammary tumors studied for this report represent a high percentage of the tumors found on dogs during the survey period. Jabara (9) has postulated that tumors are found more frequently on dogs than other domestic species because dogs are permitted to live longer. The incidence of mammary tumor in dogs differs from that in humans primarily in that the mixed tumor represents approximately half of canine mammary neoplasias (6, 9). The dog has five pairs of mammary glands and consequently has more active

TABLE IV
SIZE OF MAMMARY TUMORS BY TYPE

Tumor	Diameter (cm)
Adenoma	6.40±0.97 ^a
Adenocarcinoma	5.72±0.72
Mixed	6.10±0.93
All Types	5.97±0.55

^aMean ± standard error.

TABLE V
LOCATION OF TUMOR

Mammary Gland Area	(%)
1. Cranial Thoracic	13
2. Caudal Thoracic	7
3. Cranial Abdominal	2
4. Caudal Abdominal	4
5. Inguinal	36
6. Multiple	37

TABLE VI
ANALYSIS OF MAMMARY TUMOR RECURRENCE IN 108 CASES WITH SURGICAL ABLATION OF THE PRIMARY TUMOR

	No. of Cases ^a	Recurrence	Recurrence Index ^b
Adenoma	5	0	0
Adenocarcinoma	37	20	54
Mixed	66	14	21
Total	108	34	32

^aCases with surgical removal of tumor.

^bThe percentage of tumors reappearing after surgical ablation.

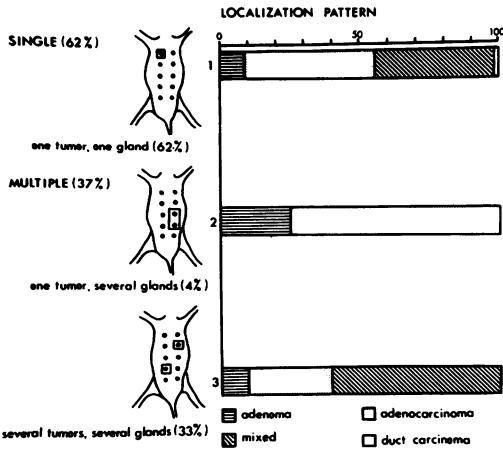


FIGURE 7. Patterns of tumor localization. Two categories, single or multiple, were identified for tumor localization. "Multiple" was divided into two different patterns.

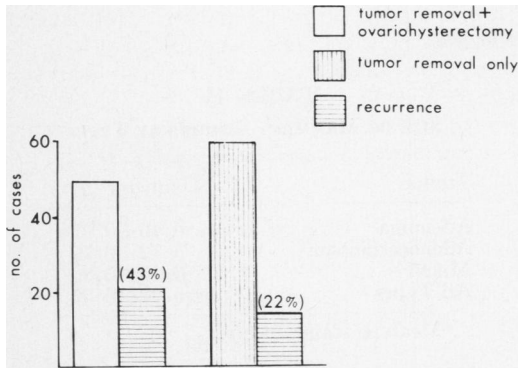


FIGURE 8. Analysis of tumor recurrence and ovariectomy. Tumors recurred in 43% of the cases which had undergone ovariectomy at the time of tumor removal.

anatomical sites in which mammary tumors can develop. Nelson *et al* (12), in studying the effects of progestogens in Beagles and making comparisons with human data, found them highly sensitive to this class of compound. This difference in sensitivity could explain the variation between humans and dogs in incidence and type of mammary tumor.

Mammary tumors primarily affect the aged dog. Several workers report the maximum incidence occurs during the six to ten-year range in dogs (3, 5, 7, 9, 11). Apparently benign tumors have a mean age incidence slightly lower than that of malignant tumors (6, 7, 8); nine to ten years for benign tumors; ten to 11 years for malignancies. Tumors of the mammary gland are relatively rare prior to five years of age (9).

A significant protective factor for female

dogs against the development of mammary tumors is oophorectomy. Sex influences play a strong role in mammary tumor development, and tumors are rare in males and in females which are spayed during the first year of life. (2, 5, 7, 8, 9, 13). Multiparity has also been shown to have a protective effect against tumor development (1, 11) although some disagree (13).

The variation introduced by breed needs more investigation. Dorn *et al* (5) found purebred dogs to be over-represented among mammary tumor cases and postulated a genetic influence in its etiology. Breeds have been reported to have similar age patterns (3) although differences in life-span are significant. Definition of breed influences did not emerge clearly in this investigation. An attempt to classify the population at risk on breed and census failed because such records are not necessarily kept in detail in the area under study. Data accumulated have been analyzed and presented but no thorough study of relationships could be made without the population facts.

Size of tumors proved difficult to determine and no correlation could be made. Fidler *et al* (7) found no statistically significant size differences though they do state malignant tumors were larger than benign. Field observations are unreliable due to the inaccuracy of the owner's recollection as to the date of appearance of the tumor. Therefore it is difficult to relate size to the rate of growth and type of tumor.

The inguinal, caudal abdominal and cranial abdominal mammary glands respectively are the most frequent sites for tumor development. This has been observed by many workers (2, 4, 6, 7, 9, 10, 11). The most caudal glands are the largest and maintain secretory ability longer than other pairs and hence may have a greater propensity for tumor development (7). The presence of more abundant glandular tissue in the caudal pairs could also be a factor (4). Frequently more than one gland had developed a tumor. Single, mixed-type tumors, one in each of several glands, were found in this study in a significant number of cases. These findings reflect in the pattern of the most frequent types of canine mammary tumors. It is in this area that more study is needed. Are mixed tumors benign in most cases or do they have a high potentiality for malignancy? Should all mixed tumors be regarded as malignant? Definition of malignancy for mixed tumors is difficult and further studies could assist in this evaluation.

One area of possible controversy which

could benefit from further study is the practice of performing oophorectomy at the time of tumor ablation. Brodey *et al* (3) found no documented proof that this procedure increases postoperative survival time but did find a possible reduction in neoplastic occurrences in remaining mammary tissue. The cases under study for this report tend to the finding that oophorectomy along with excision of the neoplasia does not influence tumor recurrence. Perhaps a larger experience than the one included in this paper should confirm or deny these findings.

It is hoped that the definition of species responses will lead to more exacting results which will give the investigator improved tools for predicting the probability of occurrence in humans. From this survey, it is felt that dogs and humans do not share sufficient response characteristics for determining the carcinogenicity potential of hormone steroids in mammary glands.

SUMMARY

A comprehensive survey was carried out in an effort to analyze the clinico-pathological characteristics of mammary tumors in dogs. Neoplasia constituted 49% of the lesions affecting this species. Tumors of the mammary gland constituted approximately 11% of all cases where neoplasia was established. Only 5% of the clinical tumors reported did not represent histologically abnormal growths. Mixed tumors accounted for 50% of all mammary neoplasia, while adenocarcinomas were 37%. The mean age of dogs with mammary tumors of all types was 8.8 years. In animals with adenomas, mixed tumors and adenocarcinomas, the mean ages were 7.9, 8.6 and 9.6 years respectively. The pattern of localization of tumors was analyzed and it was found that most frequently, adenomas and adenocarcinomas were usually single tumors affecting a single gland, while mixed tumors were multiple, involving more than one gland. Dogs are extensively used for analyzing mammary carcinogenic response of experimental compounds. The survey of data reveals that the direct extrapolation of findings from dog to man is not justifiable, at least when it concerns neoplastic mammary gland changes.

RÉSUMÉ

Les auteurs ont effectué un étude approfondie visant à analyser les caractères clinico-pathologiques des tumeurs mammaires canines. Ils réalisèrent qu'elles représentaient 49% des lésions affectant cette espèce. Les

tumeurs mammaires constituaient environ 11% de tous les néoplasmes canins. Seulement 5% des lésions classifiées comme tumorales par les cliniciens ne répondaient pas aux critères histologiques des néoplasmes. Les tumeurs mixtes représentaient 50% de tous les néoplasmes mammaires, tandis que les adénocarcinomes n'en constituaient que 37%. L'âge moyen des sujets affectés de tumeurs mammaires s'établissait à 8.8 ans. L'âge moyen de ceux qui souffraient d'adénomes, de tumeurs mixtes et d'adénocarcinomes s'établissait respectivement à 7.9, 8.6 et 9.6 ans. Une analyse de la localisation des tumeurs mammaires révéla que les adénomes et les adénocarcinomes étaient le plus souvent uniques et n'affectaient ainsi qu'une glande; par ailleurs, les tumeurs mixtes étaient multiples et affectaient donc plus d'une glande. On utilise beaucoup les chiens pour analyser la réponse de leurs carcinomes mammaires aux agents thérapeutiques expérimentaux. Une analyse des données disponibles a révélé qu'on ne peut appliquer directement à la médecine humaine les observations enregistrées chez les chiens, du moins en ce qui concerne les tumeurs mammaires.

ACKNOWLEDGMENTS

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BOOK REVIEW

Veterinary Encyclopedia, Supplement 172.
Published by Medical Book Company,
Copenhagen, Denmark. 1972.

The original, four-volume *Veterinary Encyclopedia* was reviewed in the *Canadian Veterinary Journal* in 1970 (11:41). This supplement consists of about 200 pages, numbered variously, to be inserted in the original volumes in replacement of specific pages. A new section on antibiotics of 20 pages is the longest contribution, and there are a number of articles on wildlife: duck plague and virus hepatitis, diseases of game animals, rabbit

diseases, and trichomoniasis of pigeons. Revisions or additions have been made to articles on bovine acetoneemia, avian leucosis complex, diseases of cats, external parasites of birds, foot rot in sheep, equine viral respiratory diseases, piglet dysentery, and the like. A supplementary index is also provided. The format is the same as in the original, and there are several photographs, drawings, and diagrams. Each article is signed by the authors, all of whom are from Europe or South Africa. Those who own the original will find this a useful supplement.

F. M. Loew.

ANALYSE DE VOLUME

"Les caniches, chiens de race, chiens de compagnie". Pierre Dohet et Dr Pierre J. André.
Publié par Marabout, éditions Loisirs,
Belgique. 1973. 122 pages.

Ce volume format de poche s'adresse uniquement aux amateurs de chiens de race Caniche.

Publié en Europe et écrit par des européens, ce volume n'en est pas moins intéressant pour les canadiens, à quelques détails près: on y retrouve même les noms et adresses de clubs et d'éleveurs québécois.

Certains détails certes, comme pour l'enregistrement, demeurent spécifiques à l'Europe, mais dans l'ensemble, ce livre a une portée universelle.

On y retrouve de judicieux conseils sur le choix du chiot, son élevage et sur l'entretien général et spécifique du Caniche.

Les standards morphologiques ainsi que les modalités de la tonte sont discutés et illustrés.

Un chapitre est consacré aux maladies affectant particulièrement cette race et à l'immunisation contre les maladies infectieuses. Assez superficiel, ce chapitre devrait être cependant très utile aux propriétaires de Caniches en les sensibilisant aux soins spéciaux préconisés pour leur animal.

En résumé, un bon volume de renseignements sur le Caniche, bien rédigé et intéressant à lire.

J. Flipo.