

Histopathological evaluation of canine mammary gland tumours: A study of 92 cases*

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Summary

Neoplasms of the mammary glands are the most common tumours in female dogs, albeit rare cases in male dogs are reported as well. Canine mammary tumours (CMT) are a naturally occurring heterogeneous group of cancers with a high incidence rate of up to 25-50% among females. Despite many years of research, the aetiology and high incidence of these tumours are still poorly understood. There is a need to present epidemiological data on mammary tumour occurrence in different breeds of dogs in different countries to select prognostic risk factors and identify breeds with higher susceptibility to tumour development. The aim of this study was to describe histopathological findings for 92 animals, including 87 female and five male dogs, diagnosed with mammary gland tumours (MGTs) in Poland and to determine such epidemiological characteristics as age, breed and size as well as their relationship with tumour incidence and malignancy. Histopathological analyses showed that 82 (89.1%) of the 92 dogs had malignant tumours, seven dogs (7.6%) had benign tumours, and three dogs (3.3%) had non-neoplastic changes in the form of dysplasias. Thirty (33.7%) of the 89 dogs with mammary gland tumours had more than one neoplasia. The highest number of cases were epithelial tumours (79.8%), followed by mesenchymal (14.6%) and mixed (5.6%) tumours. The vast majority of malignant tumours were tubulopapillary carcinomas (33.7%), complex carcinomas (24.7%) and solid carcinomas (11.2%). It is worth noting a large variation in the degree of tumour malignancy among the tubulopapillary carcinoma cases. The present study showed a higher incidence of mammary gland tumours in female dogs aged 8-13 years. The vast majority of female cases were diagnosed at the age of 12 years. The average year of surgical intervention in the male dogs was 9 years. Among 25 breeds of dogs in which MGTs were noted, the highest number of affected animals were crossbreeds (30.3%), German Shepherds (23.6%) and English Cocker Spaniels (9.0%). The large size of the tumour (≥ 5 cm) was strongly associated with its malignancy.

Keywords: dog, MGT, carcinoma, malignancy, neoplasm

The incidence of tumours in companion animals, especially dogs, is increasing (4). The most common neoplasm is mammary gland tumour (MGT) in female dogs, accounting for 25-50% of all types of tumours diagnosed (5). Cases of MGTs are also occasionally reported in male dogs (9, 11, 12).

Well-known risk factors for the development of canine MGTs are age and exposure to ovarian hormones. Therefore, the risk of tumour may be significantly reduced by performing ovariohysterectomy (OHE) at an early age (29). If OHE is performed before the first

heat cycle, the risk of mammary tumour is decreased drastically to 0.5%. It is estimated at 8% after the first heat cycle and 26% after the second cycle. It should be noted, however, that later sterilisation does not have any protective effects: the risk is the same as for intact females (25). The available data indicate the highest occurrence of CMT in dogs aged from 8 to 12 years (3, 6). Depending on the group tested, the age of the highest incidence of tumour development is reported as 8 (3), 9 (19) or 11 (28) years.

Malignant tumours and large tumours in older dogs are diagnosed more frequently than benign neoplasms in younger animals (18, 29). The vast majority of

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described cases concern adult dogs suffering from a malignant tumour with very different histological evaluations and a varied degree of malignancy, such as adenocarcinoma (12), tubulopapillary carcinomas GI, GII and GIII (15, 27), complex carcinoma GI (7, 27), osteosarcoma (29) or squamous cell carcinoma (26).

A histopathological assessment of tumours is a crucial part of veterinary diagnostics, essential for correct identification of the tumour and for customised treatment. Therefore, histopathology is regarded as a gold standard in the diagnosis of MGTs in dogs (2). It should also be noted that histopathological evaluations of tumour tissue, together with molecular analyses, show a more complete nature of tumorigenesis, which is still poorly understood. Therefore, dogs with MGTs are an excellent animal model to study the development of different types of tumours of varying malignancy to improve the understanding of molecular changes occurring at the cellular level (29).

The incidence of mammary gland tumours has been reported by various groups of researchers from Poland (7, 15) and other countries, e.g. India (10, 18), Italy (5, 24), Portugal (19), Spain (17) or Taiwan (3). The aim of the present study was to describe histopathological findings in 92 dogs diagnosed with MGTs and evaluate the proportion of neoplastic vs. non-neoplastic changes and the malignant vs. benign status of tumours diagnosed as neoplastic, including assessment of special types of neoplasms. Next, the results were associated with the available characteristics of the patients and compared with other studies to identify the most common types of canine MGTs and breeds of dogs that are predisposed to these tumours. In addition, this paper presents rare cases of MGTs in male dogs.

Material and methods

Tumour tissues were collected from 92 dogs, including 87 females and five males, from local veterinary clinics in Poland in the years 2018-2022. The tissues were placed in sterile containers and evaluated histopathologically. The post-operative tumour tissues were archived and analysed at the laboratory of the Department of Pathomorphology and Forensic Medicine, Faculty of Veterinary Medicine, University of Life Sciences in Lublin, Poland.

The samples were routinely fixed with 10% buffered formalin (pH 7.2) for 24 h and then passed through increasing concentrations of alcoholic solutions to acetone and xylene. Next, the tissues were embedded in paraffin blocks in a tissue processor (Leica TP-1020, Leica Biosystems, Nussloch, Germany). After that, 4 µm thick tissue sections were prepared with a sled microtome (Leica SR-200, Leica Biosystems, Nussloch, Germany) and placed on microscope slides. For histopathological evaluation, the preparations were stained with hematoxylin and eosin (HE) and examined under a light microscope (Olympus BX43, Tokyo, Japan) coupled with a digital camera (Olympus SC100, Tokyo, Japan).

The microscopic assessment was based on the WHO histological classification of canine mammary tumours (13)

complemented by the latest criteria published by Zappulli et al. (31). Malignant tumours of epithelial origin were classified according to Goldschmidt et al. (8), using a three-stage grading of histological malignancy: GI – low, GII – intermediate, and GIII – high grade of malignancy. The grades of malignancy were determined by summing point values assigned to the following histomorphological traits: tubule formation, nuclear and cellular pleomorphisms and mitotic index. Such parameters as the presence of necrotic foci, peritumoral/lymphatic invasion and regional lymph node metastasis were also noted (8).

Characteristics of the animals, including their breed, age and size, as well as such properties of the tumours as their number, size, histopathological type, degree of malignancy and tissue of origin, are presented in Table 1. After surgical intervention, the tumour size was assessed in the ranges of < 1 cm, 1-2 cm, 2-3 cm, 4-5 cm, ≥ 5 cm, ≥ 10 cm and ≥ 15 cm, and the tumour was classified based on the TNM system of the WHO guidelines as small (< 3 cm), medium (3-5 cm) or large (> 5 cm) (16). The breed of the dog was described according to the Fédération Cynologique Internationale (FCI, International Canine Federation), but the size of the dog was specified based on the American Kennel Club (AKC) data (<https://www.akc.org>). Regrettably, not all information was available for each animal.

Results and discussion

Histopathological evaluation. The tumour tissues collected from 92 animals diagnosed with MGTs were evaluated histopathologically. Microscopic analyses showed that three out of the 92 dogs (3.3%) had non-neoplasia in the form of fibrocystic dysplasias, 82 animals (89.1%) had malignant tumours, and seven dogs (7.6%) had benign tumours (Tab. 1). The occurrence of dysplasia as non-neoplastic changes in the mammary gland was also reported by other authors (14, 18).

The vast majority of tumours were of epithelial origin (79.8%), followed by mesenchymal (14.6%) and mixed (5.6%) tumours. The malignant tumours of epithelial origin (68, 76.4%) were carcinomas: mostly tubulopapillary carcinomas (33.7%), complex carcinomas (24.7%) and solid carcinomas (11.2%). Thirty out of the 68 carcinomas (44.1%) were tubulopapillary carcinomas with different degrees of malignancy: GI (14/30), GII (12/30) and GIII (4/30) (Fig. 1).

The malignant epithelial neoplasms were represented by solid carcinomas GII (10), GIII (1), comedo-carcinoma GIII (1) and anaplastic carcinoma GIII (1) (Tab. 1). Complex carcinomas GI (16), GII (5) were noted as well. Examples of microscopic analyses of simple carcinomas in the form of tubulopapillary carcinomas (GI (2A) and GII (2B)) and complex carcinomas (GI (2C) and GII (2D)) are presented in Figure 2.

Malignant tumours of epithelial origin which were not classified as *in situ*, simple or complex neoplasms were described as special types of carcinomas (8, 23). In this study, the fewest samples were special types of tumours, such as spindle cell carcinoma GII (1) (Tab. 1).

Tab. 1. List of dogs diagnosed with MGTs, histopathological assessment and characteristics of individuals

	Breed of the dog according to FCI	Age (years)	Sex	Size of the dog according to AKC*	Tumour type	Number of tumours	Size of tumour (cm)	Histopathological evaluation according to (13, 31)	Malignancy degree based on (8)	
1	American Staffordshire Terrier	10	F	M/L	benign neoplasm	three	< 1	benign mixed tumour	–	
2	Collie Rough	12		L	malignant mesenchymal tumours	one	n.d.***	lipoma	GI	
3		6		S			malignant mixed tumours	n.d.		malignant mixed tumour
4		7		M	malignant epithelial tumours		1-2	complex carcinoma ¹	GI	
5								S		three
6		9			hyperplasia/dysplasia	one	n.d.	fibrocystic dysplasia	–	
7		10		M	malignant epithelial tumours	one, disintegrative	≥ 10	tubulopapillary carcinoma ¹	GI	
8						one	n.d.	complex carcinoma ³		
9				L	malignant epithelial tumours	many*** infiltrated	n.d.	tubulopapillary carcinoma ⁴	GII	
10		11		M		malignant mesenchymal tumours	one	1-2	complex carcinoma ²	GI
11		12	≥ 15		sarcoma			–		
12		Crossbreed	12	M	malignant epithelial tumours	one, disintegrative	≥ 5	solid carcinoma ⁴	GI	
13	≥ 10						solid carcinoma ⁴	GII		
14	13		M	malignant mesenchymal tumours	one	≥ 15	hemangiopericytoma ⁴	–		
15						2-3	tubulopapillary carcinoma	GI		
16	14		S	malignant epithelial tumours	one, disintegrative	≥ 5	solid carcinoma	GII		
17						three	1-5		complex carcinoma ¹	GI
18	15		M	malignant epithelial tumours	one	2-3	spindle cell carcinoma	GII		
19	16					myxosarcoma	–			
20	16		M	malignant mesenchymal tumours	one	≥ 15	chondroblastic sarcoma	–		
21						≥ 10	tubulopapillary carcinoma	GII		
22	18		malignant mesenchymal tumours	one, disintegrative	≥ 5	osteochondrosarcoma	–			
23	Dachshund	10	S/M	malignant epithelial tumours	one	2-3	complex carcinoma	GII		
24		many			0.5 to 2-3	complex carcinoma	GI			
25		11		malignant mixed tumours	two	n.d.	malignant mixed tumour	–		
26		14			one	≥ 10	complex carcinoma ^{1, 3}	GI		
27		15			many	≥ 5				
28		10			many, disseminated	n.d.	tubulopapillary carcinoma		GII	
29	12	one	≥ 5	papillary-cystic type carcinoma ^{1, 2}	GI					
30	Doberman Pinscher	10	L	malignant epithelial tumours		≥ 10	complex carcinoma	GII		
31	Dogo Argentino	9			M	many		minor	GI	
32	English Cocker Spaniel	6	F		M	many, disintegrative	≥ 15	GI		
33		11				three	< 1, 1-2	1. tubulopapillary carcinoma 2. solid carcinoma	GI, GII	
34		12				many	4-10	tubulopapillary carcinoma	GII	
35		13				one	n.d.	GIII		
36						many, disintegrative	≥ 10	complex carcinoma	GII	
37		15				malignant mesenchymal tumours	many, disseminated	n.d.	melanosarcoma	–
38						malignant epithelial tumours	two	2-3	solid carcinoma	GII

	Breed of the dog according to FCI	Age (years)	Sex	Size of the dog according to AKC*	Tumour type	Number of tumours	Size of tumour (cm)	Histopathological evaluation according to (13, 31)	Malignancy degree based on (8)	
47	French Bulldog	6	F	S/M	benign neoplasm	one	2-3	adenoma	–	
48	German Pinscher	11		S	malignant epithelial tumours		n.d.	complex carcinoma	GII	
49		16		M			4-5	tubulopapillary carcinoma	GI	
50	German Shepherd Dog	5	M	L	malignant mesenchymal tumours	one, disintegrative	≥ 15	osteosarcoma	GII	
51		7					n.d.		–	
52		8			malignant epithelial tumours	one	≥ 5	tubulopapillary carcinoma ¹	GI	
53			one, disintegrative			≥ 15	GII			
54			one, disintegrative			≥ 10	GIII			
55			one			≥ 15	complex carcinoma	GI		
56		n.d.	–							
57		9	one, disintegrative		≥ 5	solid carcinoma ³	GII			
58			n.d.		–					
59			malignant mesenchymal tumours		two	–	mast cell tumour ³	GIII		
60		11	M		malignant epithelial tumours	one, disintegrative	≥ 5	solid carcinoma	GII	
61		12				n.d.	–	tubulopapillary carcinoma ¹	GIII	
62						one	≥ 10	solid carcinoma	GII	
63						one, disintegrative	≥ 5	tubulopapillary carcinoma	GIII	
64						one	≥ 15	tubulopapillary carcinoma	GII	
65		n.d.					–	complex carcinoma	GI	
66		13					n.d.	–	anaplastic carcinoma ²	GIII
67		14					≥ 5	tubulopapillary carcinoma	GI	
68		≥ 5					solid carcinoma	GII		
69	15	≥ 15		osteosarcoma		–				
70	n.d.	n.d.	–	tubulopapillary carcinoma ²	GII					
71	Golden Retriever	10	M	malignant epithelial tumours	many	< 1	complex carcinoma ²	GI		
72	Great Dane	7	XL	malignant epithelial tumours	one	1-2	tubulopapillary carcinoma			
73	Italian Cane Croso	8	F	L/G	hyperplasia/dysplasia	two	≥ 5	fibrocystic dysplasia	–	
74	Italian Greyhound	9		S	malignant epithelial tumours	one	1-2	complex carcinoma	GI	
75	Labrador Retriever	9		L	malignant epithelial tumours		≥ 15	tubulopapillary carcinoma	GII	
76		12			malignant mesenchymal tumours	n.d.	fibrosarcoma	–		
77	Miniature Schnauzer	6		S	malignant epithelial tumours	two	≥ 5, 1-2	complex carcinoma	GI	
78		12			benign neoplasm	n.d.	benign mixed tumour	–		
79		12			benign neoplasm	n.d.	simple adenoma			
80	Polish Lowland Sheepdog	7		M	malignant epithelial tumours	one	4-5	squamous cell carcinoma ¹	GII	
81		13				n.d.	complex carcinoma	GI		
82	13	≥ 5		squamous cell carcinoma	GI					
83	Prague Ratter	10		S	hyperplasia/dysplasia	one	1-2	fibrocystic dysplasia	–	
84		14			hyperplasia/dysplasia	one	3-4	tubulopapillary carcinoma	GI	
85	Schnauzer	11		M	malignant epithelial tumours	many	n.d.	complex carcinoma ¹		GII
86	Shih Tzu	13		S		one		tubular carcinoma		
87	Siberian Husky	9		M/L		one, disintegrative	≥ 5	tubulopapillary carcinoma	GI	
88	Staffordshire Bull Terrier	11		M		many, disintegrative	n.d.	complex carcinoma ²	GII	
89	Tatra Shepherd dog	12		M/L		one, disintegrative	≥ 15	–	GII	
90	Wire Fox Terrier	8	S	two		≥ 5; 3-4	tubulopapillary carcinoma	GII		
91	Yorkshire Terrier	5		three		≥ 5	–	GI		
92		6		benign neoplasm	four	< 1	complex adenoma	–		

Explanations: * the size of the dogs was determined according to the animal's body weight and according to the American Kennel Club breed standards; viz (S) small (< 9 kg), (M) medium (9.5-22.5 kg), (L) large (23-45 kg), (G) giant (> 45 kg); ** many – there were 5 to 10 tumours; *** n.d. – no data. ¹ – the tumour was palpable much earlier than the appointment at a veterinary clinic; ² – reoccurrences of tumour; ³ – dogs with confirmed lack of sterilisation; ⁴ – German Shepherd-type crossbreeds.

The findings are consistent with reports by other authors indicating that malignant tumours are more frequent than benign neoplasms (18). Depending on the size of the animal group tested, the rate of malignancy of tumours was estimated at 56.0% (432/771) (2), 64.3% (36/56) (18) and 72.2% (26/36) (10).

As reported by Sapiernyński (23), epithelial-origin carcinomas are the most common malignant mammary gland tumours diagnosed in dogs. The histopathological evaluations performed in this study, as well, showed that the majority of the neoplasms were malignant epithelial-origin tumours (79.8%). Among them, tubulopapillary carcinomas (33.7%), complex carcinomas (24.7%) and solid carcinomas (11.2%) were most numerous. These results confirm that simple carcinomas (in our study, tubulopapillary and solid carcinomas) are the most commonly diagnosed MGTs in dogs. In simple carcinomas, the parenchyma is composed of only glandular epithelium; hence, these carcinomas are of epithelial origin (23, 8). The present study shows that simple carcinomas accounted for 45.6% of all carcinomas. Similar results were obtained by other researchers: Tavasoly et al. (30) reported that simple carcinomas constituted 56.8%. On the other hand, an analysis of 79 cases of malignant MGTs by Chang et al. (3) indicated that 23.0% were simple carcinomas. In another study, simple carcinomas accounted for 37.3% of all tumour samples analysed (24).

The histopathological evaluation showed that 12 out of the 82 samples (14.6%) were malignant tumours of mesenchymal origin, i.e. sarcomas (9) (chondroblastic sarcomas, fibrosarcoma, melanomasarcoma, myxosarcoma, osteochondrosarcoma, osteosarcomas, sarcoma), haemangiopericytoma (1) and mast cell tumours (2) (Tab. 1, Fig. 1). The last two cases were malignant mixed tumours.

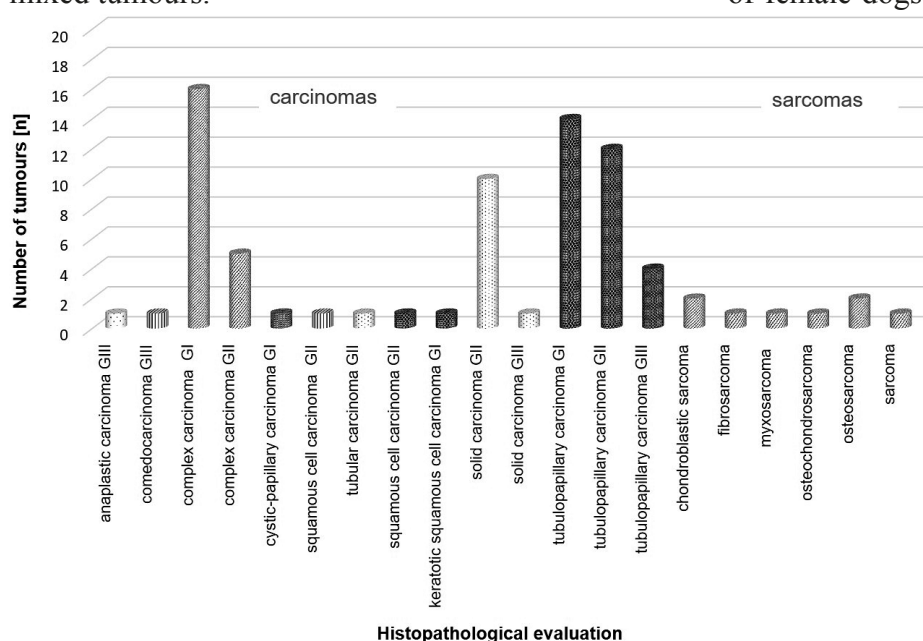


Fig. 1. Examples of carcinomas and sarcomas observed in the diagnosed dogs. The most common tumours were complex carcinomas GI (16), solid carcinomas GII (10) and tubulopapillary carcinomas GI (14) and GII (12)

Two of the sarcomas detected in our study were osteosarcomas (16.7%). This is consistent with reports that this type of neoplasms is more common among sarcomas (2, 8, 20, 28). A study by Ariyaratna et al. (2) indicated that only 32 of 771 tumour samples were sarcomas (4.2%), with the highest rate of osteosarcomas (8/32; 25.0%) and haemangiosarcomas (8/32; 25.0%). These results confirm that sarcomas are a minority of tumours diagnosed in dogs. Other types of sarcomas, such as fibrosarcoma or chondrosarcoma, are quite rare (8, 2). Only few cases of sarcomas were identified in the present study (Tab. 1).

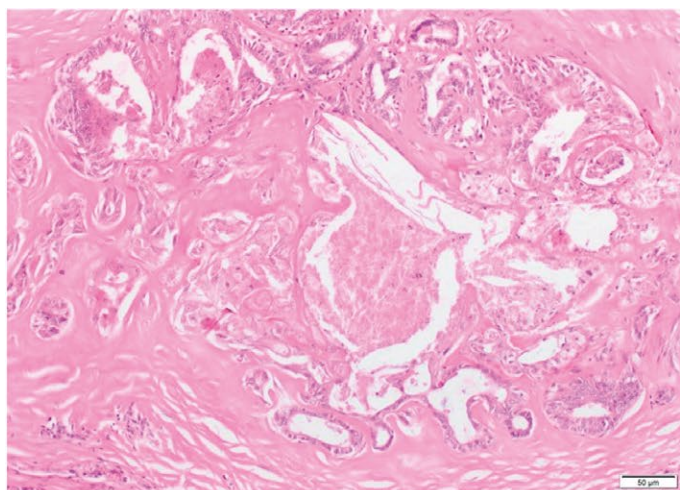
Seven out of the 89 dogs (5.6%) had benign mammary gland tumours. Among them, there were three animals with tumours of epithelial origin, i.e. adenoma (1), simple adenoma (1) and complex adenoma (1), one mesenchymal neoplasm, i.e. lipoma, and three benign mixed tumours (Tab. 1). This is consistent with results obtained by other authors, who reported that benign MGTs constituted a minority of cases (18). In a study by Pastora et al. (17), 11.9% of histopathologically evaluated tumours were benign, whereas in another study (18) they amounted to 17.8%.

Relationship between tumours diagnosed and characteristics of dogs. The present study showed the occurrence of MGTs in female dogs aged from 5 to 18 years. The incidence of tumours was higher in animals aged between 8 and 13 years (57/86, 66.3%) than it was in older dogs aged 14-18 years (18/86, 20.9%) or younger animals aged 5-7 years (12/86, 13.9%). It is worth noting that among the animals aged 8-13 years, the highest number of female dogs were diagnosed at the age of 12 years (17/86, 19.8%).

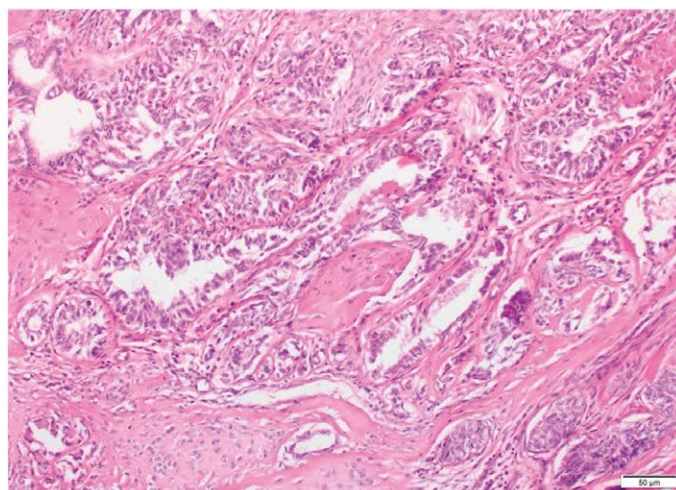
An important factor in the aetiology of the disease is the age of the patient. In our study, the average age of female dogs diagnosed with MGTs was 12 years.

However, other authors report the average age of female dogs with MGTs as 8 (3), 9 (2), 10 (24) or 10-12 years (10). In a study by Chang et al. (3), tumours in dogs were first identified at the age of 8 years, whereas 12 years was the most common age at which tumours were surgically removed (3). The disparities in the age of diagnosis of MGTs may be related to differences in breeds of dogs included in studies and different numbers of animals examined.

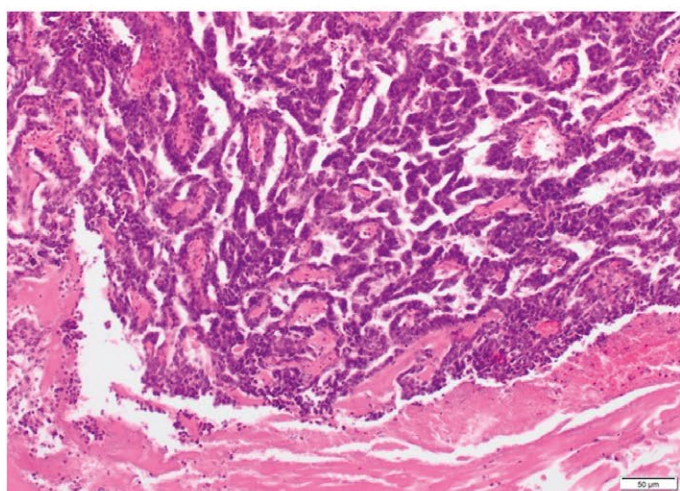
It is worth noting that the present study shows rare cases of MGTs in male Dogo Argentino (1), German Shepherds (2), Golden Retriever (1) and Crossbreed (1) dogs aged from 7 to 12 years, the average age of diagnosis being 9 years old. The histopathological evaluations



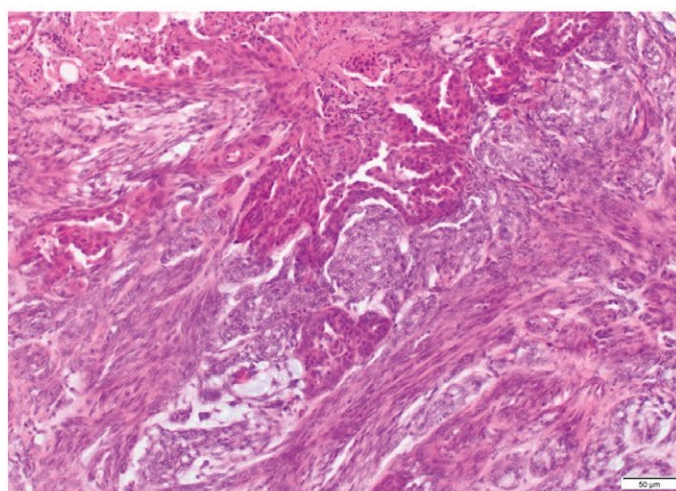
2A. Tubulopapillary carcinoma, GI. Visible proliferating tumour cells forming tubular structures and growth of fibrous connective tissue (H&E x 100).



2C. Complex carcinoma, GI. Visible partial obliteration of the glandular structure and myoepithelial cells (H&E x 100).



2B. Tubulopapillary carcinoma, GII. Visible proliferating tumour cells forming papillary structures and foci of necrosis (H&E x 100).



2D. Complex carcinoma, GII. Visible infiltrating epithelial cells, myoepithelial cells and foci of necrosis (H&E x 100).

Fig. 2. Microscopic observations during histopathological evaluations of tubulopapillary carcinoma GI (2A), GII (2B) and complex carcinoma GI (2C) and GII (2D). Specific characteristics of each tumour type and the degree of its malignancy are described below each image

showed that all tumours (5/5) were malignant, and most were of epithelial origin (carcinomas, 80%), with only one originating from mesenchymal tissue (osteosarcoma) (Tab. 1). Similarly, Han et al. (9) described three cases of MGTs in male Cocker Spaniel (1) and Shih Tzu (2) aged from 5 to 12 years, with an average age of diagnosis of 9 years. On the other hand, Saba et al. (21) described eight male dogs with MGTs with a higher median age of 11.5 years, and the majority of the cases were benign tumours of epithelial origin. Mammary gland tumours were observed in even older male dogs, e.g. in 13-year-olds (11, 32). These findings show a high heterogeneity of mammary gland tumours in terms of the sex of the animal, as well the type of tumour and the time of its development.

The dogs diagnosed with mammary gland tumours represented 25 different breeds as well as crossbreeds. Among them, the highest number of animals suffering from mammary gland tumours were crossbreeds (27/89, 30.3%), especially in the age range from 10 to 12 years (10/27), followed by German Shepherds (21/89, 23.6%) and English Cocker Spaniels (8/89, 9.0%) (Tab. 1). It is worth emphasising that three of the 27 affected crossbreeds were German Shepherd-type crossbreeds. This may indicate a breed-related predisposition underlying the susceptibility to MGTs in German Shepherds. However, this hypothesis should be verified by genetic analyses. In other breeds of dogs, single or up to three cases of MGTs were diagnosed.

Similarly, Dhami et al. (6) reported an increased incidence of MGTs in German Shepherds (36.5%)

Tab. 2. Size of the mammary gland tumour and its association with the type of tumour

Tumour size (cm)	WHO TNM size classification ¹	Benign		Malignant		Total		
		n	%	n	%	n		
< 1	small	2	66.7	4	6.7	6		
1-2		–	–	7	11.7	7		
2-3		1	33.3	7		8		
3-4	medium	–	–	3	5.0	3		
4-5				4	6.7	4		
≥ 5	large			16	26.7	16		
≥ 10				8	13.4	8		
≥ 15				11	18.4	11		
Total		3	100	60	100	63		

Explanation: ¹ – tumour size classification based on Owen (16)

and crossbreeds (11.1%) in comparison to other dog breeds. The results presented by other authors also confirm the higher incidence of these tumours in German Shepherds (1, 18, 20, 22, 27).

Interestingly, 30 (33.7%) of the 89 dogs with mammary gland tumours had more than one neoplasia. In 15 out of the 30 dogs, there were up to four tumours. In the other 15 animals, the number of tumours was described as “many”, which means from 5 to 10 tumours; they were usually small (e.g. sample No. 31, from 0.5 to 2-3 cm). According to the available data, the number of tumours was not associated with their size or type. Some carcinomas had the form of a single small neoplasm (Tab. 1, sample No. 6, 1-2 cm) and multi-tumours (from 5 to 10; Tab. 1, sample No. 38, ≥ 15 cm or No. 71, < 1 cm).

Data on the size and type of tumours are presented in Table 2. They indicate that the dog's owner usually came to the veterinary clinic when the tumour was large, that is, ≥ 5 cm (26.7%), ≥ 10 cm (13.4%), or ≥ 15 cm (18.4%), rather than small (< 3 cm). This was probably related to the possibility to palpate and observe the neoplasm. It is consistent with the remark by one of the owners that the tumour was palpated prior to the appointment at the veterinary clinic (annotation “1” in Tab. 1).

An interesting issue addressed in this study is the strong association between the tumour size and malignancy. Malignant tumours were significantly larger (> 3 cm to > 15 cm) than benign tumours (up to 3 cm) and more numerous. Surgical intervention revealed that many large (≥ 5 cm) malignant tumours were disintegrative. Some tumours were also disseminated within the mammary gland (Tab. 1).

This was also noted by Sorenmo et al. (29), who suggest that malignant tumours develop from pre-existing lesions within benign tumours. This suggestion is supported by the low incidence of small malignant neoplasms and the histopathological progression related to the increased tumour size. In their study, the average median diameter of malignant tumours was

4.7 cm (29). Another study performed by Ariyaratna et al. (2) showed that the majority of small (< 3 cm) were benign tumours (76.4%) but among medium-sized (3-5 cm) neoplasms only 32.3% were benign. All large tumours (> 5 cm) were histologically categorised as malignant. These results emphasise the strong relationship between the size of a tumour and its benign or malignant status.

In addition to tumour, other signs of disease were also observed in the affected dogs. These included calcifications, extensive extravasation, pyometra, abscesses of the mammary gland and ovarian or uterus cysts. Furthermore, tumour reoccurrence was observed in six cases (annotation “2” in Tab. 1). However, in only three dogs, the time of renewed tumour development was given: 7 years (complex carcinoma GI), 4 years (papillary-cystic type carcinoma GI) and 10 months (anaplastic carcinoma GIII). Unfortunately, it was impossible to compare the renewed tumours with the earlier types of neoplasms, because the dogs' owners had changed the veterinary clinic in the meantime or no previous histopathological evaluation had been performed.

In conclusion, the results of this study show that MGTs were highly heterogeneous and that most of them were malignant tumours of epithelial origin. The large size of the tumour was related to its malignancy.

To date, no specific characteristics of dogs have been associated with the development of MGTs. It should be emphasized that histopathological assessment is a necessary crucial step for an accurate diagnosis.

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