

Retrospective evaluation of canine and feline mammary tumors diagnosed during the period from 2009 to 2022 in İzmir province

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Abstract: The aim of this retrospective study was to determine the incidence of canine and feline mammary tumors diagnosed in the Pathology Laboratory of Bornova Veterinary Control Institute in İzmir Province between January 2009 and December 2022, as well as to analyse the relationships between the age and breed characteristics of affected animals and the presence of mammary tumors. For this purpose, the available information regarding each mammary tumor case was collected from archive records. Dogs and cats with mammary tumors were divided into four age groups. All hematoxylin and eosin-stained slides of mammary tumors were histopathologically re-evaluated and classified. The study material consisted of 106 (35.81%) mammary tumor cases, of which 83 (37.55%) belonged to dogs and 23 (30.66%) to cats. The highest incidence of mammary tumors in both species was observed in the age group of 8 to 11 years. A statistically significant relationship was found between the incidences of mammary tumors according to the age groups and breeds in both species ($p < 0.05$). Terrier (28 cases) in dogs ($p = 0.000$) and mixed breed (14 cases) in cats ($p = 0.0003$) were the most commonly affected breeds by mammary tumors. In dogs, 64 (77.10%) of 83 mammary tumors were malignant and 19 (22.90%) were benign; in cats, 18 (78.26%) of 23 mammary tumors were malignant and 5 (21.74%) were benign. Malignant mammary tumors were detected more frequently in Terrier dogs (34.37%) and mixed breed cats (72.22%). The most commonly diagnosed malignant mammary tumors were mixed type carcinoma (51.56%) in dogs ($p = 0.000$) and tubular carcinoma (50%) in cats ($p = 0.005$). Benign mixed tumor (47.37%) and complex adenoma (26.32%) were the most frequently observed benign mammary tumors in dogs. Simple adenoma constituted the majority (60%, 3 cases) of benign mammary tumors in cats.

Keywords: Cat, dog, mammary tumor, retrospective study, Türkiye

İzmir ilinde 2009-2022 yılları arasında teřhis edilen köpek ve kedi meme tümörlerinin retrospektif deđerlendirmesi

Özet: Bu çalışmanın amacı, İzmir ilinde Ocak 2009-Aralık 2022 yılları arasında Bornova Veteriner Kontrol Enstitüsü Patoloji Bölümünde teřhis edilen köpek ve kedi meme tümörlerinin insidansını belirlemek ve meme tümürlü hayvanların ırk ve yař özellikleri ile meme tümörlerinin varlığı arasındaki ilişkileri arařtırmaktır. Bu amaçla her bir meme tümörü vakasına ilgili mevcut bilgiler arřiv kayıtlarından toplandı. Meme tümürlü köpek ve kediler 4 yař grubuna ayrıldı. Meme tümörlerinin hematoksilin-eozin boyanmış slaydları histopatolojik olarak yeniden deđerlendirildi ve sınıflandırıldı. Çalışma materyalini, 83 (%37,55) köpek ve 23 (%30,66) kediye ait 106 (%35,81) meme tümörü olgusu oluşturdu. Her iki türde en yüksek meme tümörü insidansı 8-11 yař grubunda görüldü. Her iki türde yař grupları ve ırklara göre meme tümörü insidansları arasında istatistiksel olarak önemli bir ilişki bulundu ($p < 0,05$). Köpeklerde Terrier (28 olgu) ($p = 0,000$) ve kedilerde melez ırk (14 olgu) ($p = 0,0003$) meme tümörlerinin en sık görüldüğü ırklardı. Köpeklerde 83 meme tümörünün 64 (%77,10)'ü malign ve 19 (%22,90)'u benign; kedilerde ise 23 meme tümörünün 18 (%78,26)'i malign ve 5 (%21,74)'i benign karakterdeydi. Malign meme tümörleri, en çok Terrier ırkı köpeklerde (%34,37) ve melez ırk kedilerde (%72,22) belirlendi. Köpeklerde en sık teřhis edilen malign meme tümörleri, mikst tip karsinom (%51,56) ($p = 0,000$) ve kedilerde tubuler karsinom (%50) ($p = 0,005$). Köpeklerde benign mikst tümör (%47,37) ve kompleks adenom (%26,32) en sık gözlenen benign meme tümörleriydi. Kedilerdeki benign meme tümörlerinin (3 olgu, %60) çoğunluđunu basit adenom oluşturdu.

Anahtar kelimeler: kedi, köpek, meme tümörü, retrospektif çalışma, Türkiye

Introduction

Mammary tumors are one of the most common tumors of dogs, cats and humans (Goldschmidt et al.,

2017). Female dogs and cats have a high incidence of mammary tumors, and mammary tumors are rarely seen in males (Munson and Moresco 2007). The

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annual incidence rate of mammary tumors in dogs has been determined as 198.8 cases in Alameda County, California (Dorn et al., 1968b) and 250 cases per 100,000 dogs in Northern Italy (Vascellari et al., 2016). In cats, the annual incidence rate of mammary tumors is lower compared to dogs and has been reported as 25.4 cases per 100,000 cats in Alameda County, California (Dorn et al., 1968b).

The incidence of mammary tumors and the impact of risk factors affecting the incidence in female dogs and cats varies according to countries and geographic regions (Dorn et al., 1968b; MacVean et al., 1978; Aydın et al., 2008; Dhimi et al., 2010; Shida et al., 2010; Vascellari et al., 2016; Pastor et al., 2018; Viana et al., 2019). It is also directly related to ovariectomy and the age at which ovariectomy is performed (Schneider et al., 1969; Misdorp 1988; Sorenmo et al., 2000). Schneider et al. (1969) have reported that neutered bitches have 12% of the mammary cancer risk as compared to intact ones and that the risk of developing mammary tumors is significantly reduced (0.5% incidence) in female dogs neutered before the first estrus. Also, ovariectomy, even when performed at an advanced age, has been detected to be to some extent protective against mammary tumor development in dogs (Misdorp, 1988; Schneider et al., 1969). Similarly, it has been shown that intact female cats have a 7-fold higher risk of mammary cancer than neutered females (Dorn et al., 1968b) and that cats neutered before 1 year of age have an 86% reduction in the risk of feline mammary carcinoma development (Overley et al., 2005).

In this retrospective study, it was aimed to determine the incidence of canine and feline mammary tumors diagnosed in the Pathology Laboratory of Bornova Veterinary Control Institute in İzmir Province between January 2009 and December 2022 and also to investigate the relationships between the age and breed characteristics of affected animals and the presence of mammary tumors.

Materials and Methods

Animals and histopathological examination

In this retrospective study, a total of 106 mammary tumor cases from 221 dog and 75 cat tumor biopsy samples that were sent to the Pathology Laboratory of Bornova Veterinary Control Institute from various

veterinary clinics in İzmir province during fourteen years between January 2009 and December 2022 were studied. Mammary tumors belonged to 83 dogs and 23 cats of different breeds and ages. The available information regarding each mammary tumor case was reviewed. The age, gender and breed characteristics of animals with mammary tumors were collected from their records. Dogs and cats with mammary tumors were divided into four age groups of 0-3, 4-7, 8-11 and 12-15 years according to their ages. The age information of 4 dogs and 1 cat, and the breed information of 5 dogs and 5 cats could not be recorded because such information wasn't available. Mammary tumors were defined as benign or malignant according to their histopathological examination protocols. All histological slides prepared from mammary tumor samples which had been previously fixed in 10% formalin and following routine tissue processing procedures, embedded in paraffin blocks, cut at 4-5 µm thickness and stained with hematoxylin and eosin were re-evaluated and classified under a light microscope, taking into account the histological classification of canine mammary tumors proposed by Goldschmidt et al. (2011) and the updated feline mammary tumor classification corresponding to this new classification in dogs (Goldschmidt et al. 2017).

Statistical analyses

Chi-square (χ^2) test was used to determine the strength of the relationships between the presence of mammary tumors and variables such as age group and breed. Similarly, the frequency of benign/malignant mammary tumors was also evaluated using the Chi-square test. T test or Mann Whitney U test was used to determine if there is a statistically significant difference between the mean ages of dogs and cats with mammary tumors and between the mean ages of animals with benign and malignant mammary tumors in both species. Statistical analyses were performed using the IBM SPSS Statistical Package Programme (version 24). Values of $p < 0.05$ were considered significant.

Results

The distribution of canine and feline mammary tumors in total tumor samples by years (2009 to 2022) is presented in Figures 1 and 2, respectively.

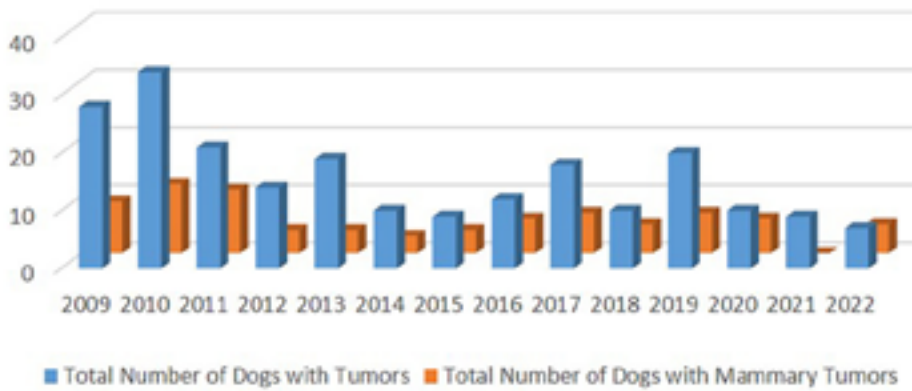


Figure 1. Distribution of canine mammary tumors in total tumor samples by years (2009-2022).

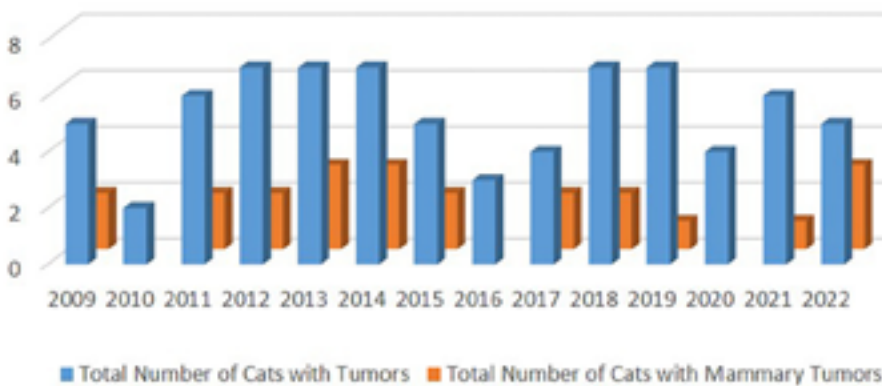


Figure 2. Distribution of feline mammary tumors in total tumor samples by years (2009-2022).

The incidence in 83 dogs and 23 cats with mammary tumors examined during the fourteen years covered by the study was determined as 37.55% and 30.66%, respectively. All mammary tumors belonged to female dogs and cats. The mean age of dogs with mammary tumors was 9.06 ± 0.36 , with a range from 3 to 15 years. The mean age of cats with mammary tumors was 10.68 ± 0.56 , with a range from 5 to 15 years. The difference between the mean ages of dogs and cats with mammary tumors was statistically significant ($p = 0.0308$). The highest

incidence of mammary tumors in dogs and cats was observed in the age group of 8 to 11 years (Table 1). Statistically, when all age groups were taken into account, the differences between the incidences of mammary tumor according to the age groups in both species were significant ($\chi^2 = 20.19$, $p = 0.0002$ in dogs; $\chi^2 = 20.91$, $p = 0.0001$ in cats). However, when early age group (0-3 years) was excluded, this difference was insignificant in dogs ($\chi^2 = 0.97$, $p = 0.62$) but was significant in cats ($\chi^2 = 10.18$, $p = 0.006$).

Table 1. Distribution of dogs and cats with mammary tumors according to the age groups.

DOGS (with tumors) n: 221	Age Groups (years)					Total	Mean Age
	0-3	4-7	8-11	12-15	UN		
Number of dogs with mammary tumors	3	25	29	22	4	83	9.06 ± 0.36
Percent (%)	3.61	30.12	34.94	26.50	4.82	37.55	-
CATS (with tumors) n: 75	Age Groups (years)					Total	Mean Age
	0-3	4-7	8-11	12-15	UN		
Number of cats with mammary tumors	-	2	14	6	1	23	10.68 ± 0.56
Percent (%)	-	8.69	60.87	26.08	4.34	30.66	-

UN: Their age is unknown

The distribution of canine and feline malignant and benign mammary tumors according to the age groups and their breeds is presented in Table 2. In dogs, 64 (77.10%) of 83 mammary tumors were malignant and 19 (22.90%) were benign; in cats, 18 (78.26%) of 23 mammary tumors were malignant and 5 (21.74%) were benign. The malignant mammary tumors were observed much more frequently than benign tumors in both species and this difference was statistically significant ($\chi^2=24.40$, $p<0.0001$ in dogs; $\chi^2=7.35$, $p<0.0067$ in cats). The average ages of dogs with benign and malignant mammary tumors were 7.94 ± 0.80 and 9.41 ± 0.39 years, respectively. The average ages of cats with benign and malignant mammary tumors were 9.60 ± 0.98 and 11.00 ± 0.66 years, respectively. However, no statistically significant relationship between the average ages of dogs or cats with benign and malignant mammary tumors was found ($p>0.05$). Twenty-five (30.12%) dogs and 10 (43.48%) cats with malignant mammary tumors were in the age group of 8 to 11 years. Eight (9.64%) dogs and 4 (17.39%) cats with benign mammary tumors were in the age groups of 4 to 7 years and 8 to 11 years, respectively (Table 2). No statistically significant difference was also found between the incidences of benign and malignant

mammary tumors according to the age groups in both species ($\chi^2=5.54$, $p=0.14$ in dogs; $\chi^2=2.88$, $p=0.24$ in cats).

As seen in Table 2, dog breeds such as Belgian Malinois, German shorthaired Pointer, Siberian Husky, English Pointer, Rottweiler, Shih Tzu, Chow Chow with one malignant or benign tumor were represented under Others. The difference between the incidences of mammary tumor according to the breeds in both species was statistically significant ($p<0.05$). Terrier (28 cases) in dogs ($\chi^2=103.33$, $p=0.000$) and mixed breed (14 cases) in cats ($\chi^2=16.33$, $p=0.0003$) were the most frequently affected breeds by mammary tumors. Malignant mammary tumors were more common in the Terriers (34.37%), followed by the Cocker Spaniels (9.37%) and German Shepherds (9.37%). The incidence of malignant mammary tumors in the Terriers showed an increase with age. The highest incidence of malignant mammary tumors in cats was found in the mixed breed (72.22%), followed by Siamese cats with 16.67% (Table 2). However, whereas no statistical association between the incidences of benign and malignant mammary tumors according to the breeds in dogs was found ($\chi^2=10.25$, $p=0.59$), the differences between these variables in cats were significant ($\chi^2=8.60$, $p=0.014$).

Table 2. Distribution of dogs and cats with malignant and benign mammary tumors according to the age groups and their breeds

Breeds	AGE GROUPS (YEARS)															
	MALIGNANT								BENIGN							
	0-3	4-7	8-11	12-15	UN	Total	Percent %	0-3	4-7	8-11	12-15	UN	Total	Percent %	Overall Total	Overall Percent (%)
DOGS																
German Shepherd	-	3	2	1	-	6	9.37	-	-	-	-	-	0	0	6	7.23
Cocker Spaniel	-	-	3	3	-	6	9.37	-	4	1	-	-	5	26.32	11	13.25
Golden Retriever	1	3	-	-	-	4	6.25	1	-	1	-	-	2	10.53	6	7.23
Labrador	-	-	2	-	-	2	3.13	-	-	-	-	-	0	0	2	2.41
Kangal dog	-	-	3	-	-	3	4.68	-	-	-	-	-	0	0	3	3.61
Terrier	-	4	8	8	2	22	34.37	-	2	2	2	-	6	31.58	28	33.74
Collie	-	-	-	1	-	1	1.56	-	-	-	1	-	1	5.26	2	2.41
Poodle	-	-	1	1	-	2	3.13	-	-	-	1	-	1	5.26	3	3.61
Doberman	-	1	1	-	-	2	3.13	-	-	-	-	-	0	0	2	2.41
English Setter	-	2	-	-	-	2	3.13	-	-	-	-	-	0	0	2	2.41
German Pinscher	-	1	1	-	-	2	3.13	-	-	-	-	-	0	0	2	2.41
Others	-	2	2	1	-	5	7.81	-	2	-	1	-	3	15.79	8	9.64
Mixed breed	-	-	1	1	-	2	3.13	1	-	-	-	-	1	5.26	3	3.61
UN*	-	1	1	1	2	5	7.81	-	-	-	-	-	0	0	5	6.03
Total	1	17	25	17	4	64	100	2	8	4	5	-	19	100	83	100
Percent (%)	1.20	20.48	30.12	20.48	4.82	77.10		2.41	9.64	4.82	6.03	-	22.90		100	
Mean Ages	3	6±0.30	9.5±0.22	13.05±0.26	-	9.41±0.39		3	5.68±0.21	8.75±0.25	12.90±0.40	-	7.94±0.80			

AGE GROUPS (YEARS)																
Breeds	MALIGNANT							BENIGN								
	0-3	4-7	8-11	12-15	UN	Total	Percent %	0-3	4-7	8-11	12-15	UN	Total	Percent %	Overall Total	Overall Percent (%)
CATS																
Siamese	-	1	1	1	-	3	16.67	-	-	-	-	-	0	0	3	13.04
Persian	-	-	-	-	-	0	0	-	-	1	-	-	1	20	1	4.35
Mixed breed	-	-	8	5	-	13	72.22	-	-	1	-	-	1	20	14	60.87
UN*	-	-	1	-	1	2	11.11	-	1	2	-	-	3	60	5	21.74
Total	-	1	10	6	1	18	100	-	1	4	-	-	5	100	23	100
Percent (%)	-	4.35	43.48	26.08	4.35	78.26		-	4.35	17.39	-	-	21.74		100	
Mean Ages	-	5	9.8±	14±	-	11±		-	6	10.5±	-	-	9.60±			
			0.36	0.26		0.66				0.50			0.98			

UN*: Their breed is unknown UN: Their age is unknown

When the types of mammary tumors are histopathologically evaluated, 51.56% of malignant mammary tumors in dogs were mixed type carcinoma (Figure 3A), 10.94% were tubulopapillary carcinoma and 10.94% were complex carcinoma. The most frequently encountered benign mammary tumors were benign mixed tumor (47.37%) (Figure 3B) and complex adenoma (26.32%) (Table 3). Whereas

no significant difference between the incidences of benign mammary tumor types according to the breeds in both species was found ($p > 0.05$), the differences between the incidences of malignant mammary tumor types were statistically significant ($p < 0.05$). Mixed type carcinoma in dogs ($\chi^2 = 93$, $p = 0.000$) and tubular carcinoma in cats ($\chi^2 = 16.66$, $p = 0.005$) were the most frequently observed malignant mammary tumors (Table 3, 4).

Table 3. Histological classification and distribution of canine mammary tumors according to the breeds

TUMOR TYPES	DOG BREEDS											Total	Percent %
	Terrier	Cocker Spaniel	German Shepherd	Turkish Kangal dog	Golden Retriever	Poodle	Mixed breed	*Others	UN	Total	Percent %		
MALIGNANT MAMMARY TUMORS													
Tubular carcinoma	-	1	1	-	-	-	-	1	-	3	4.69		
Tubulopapillary carcinoma	1	1	-	1	1	-	1	2	-	7	10.94		
Cystic-papillary carcinoma	-	-	-	-	-	1	-	1	1	3	4.69		
Solid carcinoma	1	-	-	2	1	-	-	-	1	5	7.81		
Complex carcinoma	3	-	-	-	-	1	-	3	-	7	10.94		
Mixed type carcinoma	15	4	4	-	2	-	1	4	3	33	51.56		
Intraductal papillary carcinoma	-	-	-	-	-	-	-	1	-	1	1.56		
Carcinosarcoma (Malignant mixed mammary tumor)	2	-	1	-	-	-	-	2	-	5	7.81		
Total	22	6	6	3	4	2	2	14	5	64	100		
Percent (%)	34.37	9.38	9.38	4.69	6.25	3.12	3.12	21.88	7.81	100			
BENIGN MAMMARY TUMORS													
Simple adenoma	1	-	-	-	-	-	-	1	-	2	10.52		
Intraductal papillary adenoma	1	-	-	-	1	-	-	1	-	3	15.79		
Complex adenoma	2	3	-	-	-	-	-	-	-	5	26.32		
Benign mixed tumor	2	2	-	-	1	1	1	2	-	9	47.37		
Total	6	5	-	-	2	1	1	4	-	19	100		
Percent (%)	31.58	26.32	-	-	10.52	5.26	5.26	21.06	-	100			

UN: Their breed is unknown

*Others include the dog breeds such as Labrador, Collie, Doberman, English Setter, German Pinscher with one or two malignant and benign mammary tumors.

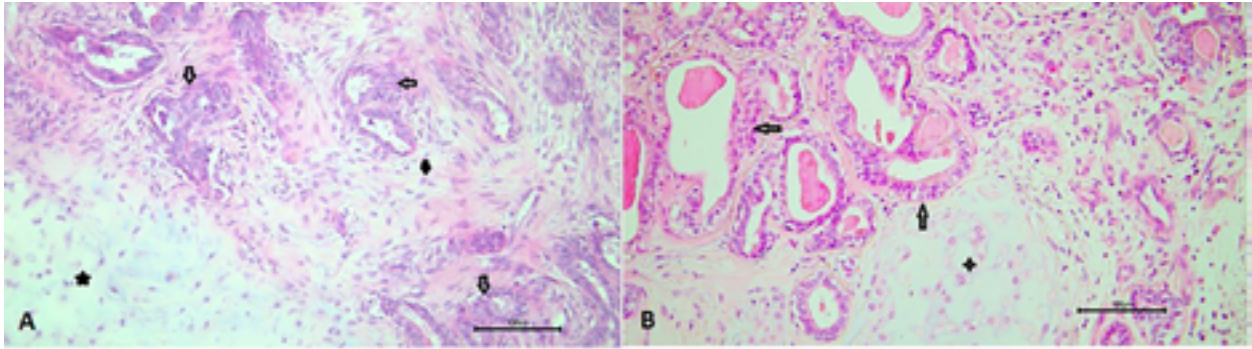


Figure 3. Hematoxylin and eosin (HE) staining of canine mammary tissues. Bars=100 µm. **A.** Mixed type carcinoma. Atypical epithelial cells arranged in irregular tubules (white arrows) with proliferating spindle-shaped myoepithelial cells (black arrow) and focus of chondroid differentiation which exhibit no atypia (asterisk). **B.** Benign mixed tumor. Mammary alveoli with hyperplastic epithelium and eosinophilic secretion (arrows) and chondroid focus (asterisk).

Mixed type carcinoma was frequently observed in the Terriers (15 cases) and to a lesser extent in the Cocker Spaniels (4 cases) and German Shepherds (4 cases). Complex adenoma was mostly seen in the Cocker Spaniels (3 cases) (Table 3). In cats, tubular

carcinoma was mostly encountered in mixed breed cats (5 cases) (Figure 4A) and the less frequently in Siamese cats (3 cases). Simple adenoma constituted the majority (60%, 3 cases) of benign mammary tumors in cats (Table 4) (Figure 4B).

Table 4. Histological classification and distribution of feline mammary tumors according to the breeds.

TUMOR TYPES	CAT BREEDS					Total	Percent %
	Siamese	Persian	Mixed breed	UN			
MALIGNANT MAMMARY TUMORS							
Tubular carcinoma	3	-	5	1	9	50	
Tubulopapillary carcinoma	-	-	1	-	1	5.56	
Cystic -papillary carcinoma	-	-	-	1	1	5.56	
Solid carcinoma	-	-	4	-	4	22.22	
Comedocarcinoma	-	-	2	-	2	11.11	
Mucinous carcinoma	-	-	1	-	1	5.56	
Total	3	-	13	2	18	100	
Percent (%)	16.67	-	72.22	11.11	100		
BENIGN MAMMARY TUMORS							
Simple adenoma	-	1	1	1	3	60	
Intraductal papillary adenoma	-	-	-	1	1	20	
Ductal adenoma	-	-	-	1	1	20	
Total	-	1	1	3	5	100	
Percent (%)	-	20	20	60	100		

UN: Their breed is unknown

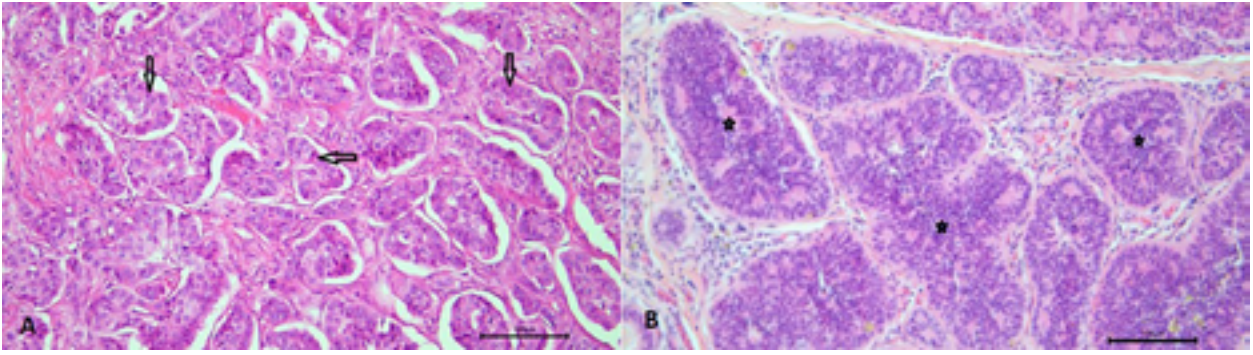


Figure 4. Hematoxylin and eosin (HE) staining of feline mammary tissues. Bars=100 µm. **A.** Tubular carcinoma. Atypical epithelial cells with tubular arrangement (arrows). **B.** Simple adenoma. The islands of uniform neoplastic cells consisting of cuboidal to columnar epithelial cells with basally located nuclei (asterisk).

Discussion and Conclusion

Retrospective epidemiological studies on neoplastic diseases represent both an important source of information by analyzing tumor behaviour over a particular time period and also a useful approach in determining the risk factors and prognostic criteria, based on clinical and histopathological features (Salas et al., 2015). In this retrospective study, data covering a 14-year period between January 2009 and December 2022 was evaluated by comparing it with data from many similar studies (Vural and Aydın 2001; Zatloukal et al., 2005; Sontas et al., 2009; Dhimi et al., 2010; Shida et al., 2010; Salas et al., 2015; Andrade et al., 2017; Pastor et al., 2018; Kuruca et al., 2019; Viana et al., 2019; Tunç and Vural 2024).

Mammary tumors are one of the most common tumors of female dogs (Mitchell et al., 1974; Salas et al., 2015; Andrade et al., 2017; Pastor et al., 2018) and constitute 41.75% of all tumors seen in female dogs (Dorn et al., 1968a). It is much less common in males and has been reported at varying rates from 0.2 to 4.3 % (Dorn et al., 1968b; Moulton et al., 1970; Mitchell et al., 1974; MacVean et al., 1978; Vural and Aydın 2001; Vascellari et al., 2009; Nunes et al., 2018). In the present study, whereas the incidence (37.55%) of canine mammary tumors determined through the retrospective data analysis in İzmir province was below the incidence rates of 39.87%, 54 % and 60.37% reported from some countries such as Gujarat, Western India (Dhimi et al., 2010), Italy (Vascellari et al., 2016) and Spain (Pastor et al., 2018), respectively, it was higher than the incidence rates reported from different provinces of Türkiye (Ertürk et al., 1971; Vural and Aydın 2001; Erer and Kiran 1993; Gülçubuk and Gürel 2003; Kuruca et al.,

2019) and from some other countries (Mitchell et al., 1974; Bhaiyat et al., 2013; Salas et al., 2015; Viana et al., 2019). It has been suggested that the territorial/regional differences in the incidence of mammary tumors may be due to various factors such as the population distribution of certain breeds with a predisposition to mammary tumors, the prolonged time between tumor onset and clinical evaluation, the exposure of dogs to different environmental pollutants and failure to implement reproductive control measures such as neutering of female dogs at a young age (<2 years) (Pérez Alenza et al., 2000; Sorenmo et al., 2000; Sontas et al., 2009; Andrade et al., 2010; Dhimi et al., 2010; Salas et al., 2015; Andrade et al., 2017; Nunes et al., 2018).

Mammary tumors in cats are reported as the third most frequently diagnosed tumors after hematopoietic system and skin tumors (Dorn et al., 1968a; Hayes and Mooney 1985) and account for 17.1% of all neoplasms in female cats (Dorn et al., 1968a). However, there are also some studies in which mammary tumors are seen the first (Gülçubuk et al., 2005) or second after skin tumors (Aydın et al., 2008; Vascellari et al., 2009; Shida et al., 2010). In Türkiye, retrospective studies evaluating different tumor types and mammary tumors in cats are much less compared to dogs (Ertürk et al., 1971; Köküslu and Akkayan 1972; Gülçubuk et al., 2005; Aydın et al., 2008). In cats, mammary tumors are mostly malignant and show a lower incidence compared to dogs (Munson and Moresco 2007). In male cats, the incidence of mammary tumors has been reported to vary from 1.1% (Vascellari et al., 2009) to less than 1 % (Hayes et al., 1981). Contrary to some studies that the lower incidence rates of mammary tumors in cats are reported (Dorn et al., 1968a; MacVean et al., 1978; Aydın et al., 2008; Vascellari et al., 2009; Shida

et al., 2010), the frequency of mammary tumors in female cats in this study was 30.66% of all feline tumors. Consistent with the literature, the incidence (30.66%) of mammary tumors in cats was lower than that (37.55%) of dogs and the majority (78.26%) of them were malignant as in dogs.

The age-specific incidence for mammary tumors in dogs shows a marked increase between 6 and 10-11 years of age and decreases after 11 years of age with a shortening of life expectancy in dog. Mammary tumors are rarely seen in dogs younger than 2 years of age (Dorn et al., 1968b; Moulton et al., 1970). In the present study, the age of dogs with mammary tumors varied from 3 to 15 years, with an average of 9.06 ± 0.36 years. The incidence of mammary tumors increased with age and the highest incidence was detected in the age group of 8 to 11 years (34.94%, n=29). Our finding is compatible with the findings of many studies that mammary tumors were the most often diagnosed in dogs between 8 and 12 years of age, with an average of 9 to 10 years (Moulton et al., 1970; MacVean et al., 1978; Egenvall et al., 2005; Zatloukal et al., 2005; Sontas et al., 2009; Dhami et al., 2010; Gupta et al., 2012; Bhaiyat et al., 2013; Salas et al., 2015; Andrade et al., 2017; Nunes et al., 2018; Tunç and Vural 2024). Also, the lowest incidence of mammary tumors in this study was found to be 3.61% in young dogs under 4 years of age. This finding is consistent with some studies that the incidence rates of 3 to 4.76% in similar age group were reported (Mitchell et al., 1974; Dhami et al., 2010; Kuruca et al., 2019; Tunç and Vural 2024). There were statistically significant differences between incidences of mammary tumor according to the age groups in the present study, compatible with observations of Vascellari et al. (2016). However, we did not detect a relationship between the incidences of benign and malignant mammary tumors according to the age groups. This finding is consistent with the finding of Salas et al. (2015).

Mammary tumors have been reported in cats between the ages of 2.5 and 19 years (mean age of 10.8 years), with an increased incidence rate from 7 to 12 years of age (Weijer et al., 1972). Also, Dorn et al. (1968b) have detected the highest tumor incidence in the age group of 10 to 11 years, with a marked increase after 9 years of age. Karabolovski et al. (2017) have reported that the mean age of detection of feline mammary tumors was 13.5 years. Unlike this finding, the mean age of 23 cats with mammary tumors in our study was 10.68 ± 0.56 years. This is similar to those reported in some

earlier studies (Weijer et al., 1972; Amorim et al., 2006; Cunha et al., 2017). In addition, as in dogs, the incidence of mammary tumors in cats also increased with age. Consistent with previous some studies (Dorn et al., 1968b; Weijer et al., 1972; Gülçubuk et al., 2005), the highest incidence rate in cats was determined in the age group of 8-11 years (60.87%, n=14) in this study.

Purebred dogs have been reported to have the higher breed predisposition to mammary tumors than mixed breed dogs (Dorn et al., 1968b; MacVean et al., 1978; Zatloukal et al., 2005; Salas et al., 2015; Vascellari et al., 2016; Pastor et al., 2018). Consistent with this evidence, the most frequently affected dog breeds by mammary tumors in the present study were Terrier with a statistically significant difference (33.74%, 28/83) and Cocker Spaniel (13.25%, 11/83), as indicated by similar findings of other some studies in Türkiye (Vural and Aydın 2001; Baştan and Zonturlu 2002; Kuruca et al., 2019; Baki Acar and Tunç 2022; Tunç and Vural 2024). This observation can be attributed to the breed popularity in and around İzmir Province under study, as reported by Perez Alenza et al. (2000) stating that breed predisposition can vary due to the different canine populations used in the studies. Additionally, the statistical relationship we found between the incidences of canine mammary tumors according to the breeds is also compatible with similar findings of Pastor et al. (2018) who detected that breed affects the development of the tumor, and of Salas et al. (2015) who showed a certain degree of association in some breeds.

Domestic shorthair, Persian and Siamese cat breeds have been suggested to have a high incidence of mammary tumors (Hayes et al., 1981; Amorim et al., 2006; Shida et al., 2010). In the pre-sent study, mammary tumors were mostly diagnosed in mixed breed cats (60.87%, 14/23) with a statistically significant difference and less frequently in Siamese cats (13.04%, 3/23). This finding is similar to observations of other some studies in which mammary tumors were detected more frequently in mixed breed and Siamese cats (Weijer et al., 1972; Cunha et al., 2017; Karabolovski et al., 2017). However, Shida et al. (2010) have reported that Persian and Siamese cats have high incidences of mammary tumors with statistically significant differences. In the present study, the high incidence of mammary tumors detected in mixed breed cats can be attributed to the fact that they constitute the majority of the domestic and stray cat population in and around İzmir Province.

Many studies in dogs have revealed that percentages of malignant mammary tumors were much higher than benign tumors, with a prevalence varying from 71.2 % to 96.15% (Vural and Aydın 2001; Oliveira et al., 2003; Zatloukal et al., 2005; Sontas et al., 2009; Pawar et al., 2015; Vascellari et al., 2016; Andrade et al., 2017; Nunes et al., 2018; Pastor et al., 2018; Kuruca et al., 2019; Tunç and Vural 2024). Similarly, we also detected more frequently canine malignant mammary tumors (77.10%, 64 cases) than benign tumors (22.90%, 19 cases). It has been reported that the high frequency of malignant mammary tumors in dogs may be associated with the criteria for histological evaluation of mammary tumors or the prolonged time between the onset of the tumor and clinical evaluation leading to the progression from benign to malignant tumors (Perez Alenza et al., 2000; Sorenmo et al., 2009; Andrade et al., 2017; Nunes et al., 2018). In addition, advanced age is accepted as an important risk factor in the formation of malignant tumors (Zatloukal et al., 2005; Sorenmo et al., 2009; Vascellari et al., 2016; Pastor et al., 2018). In the present study, the mean ages of dogs with malignant and benign mammary tumors were 9.41 ± 0.39 and 7.94 ± 0.80 years, respectively (Table 2). This finding is consistent with the finding of Sorenmo et al. (2009) who reported that the average ages of dogs with malignant and benign mammary tumors were 9.5 and 8.5 years, respectively and also supports many studies (Moulton et al., 1970; Sontas et al., 2009; Vascellari et al., 2016; Nunes et al., 2018) suggesting that benign mammary tumors occur 1 to 2 years earlier than malignant tumors. However, in contrast to some researchers (Sorenmo et al., 2009; Vascellari et al., 2016) who reported statistically significant differences, we did not find a significant difference between the average ages of dogs with benign and malignant mammary tumors, similar to the finding of Sontas et al. (2009).

Approximately 86-95% of mammary tumors in cats have been reported to be malignant (Hahn and Adams 1997; Gülçubuk et al., 2005; Amorim et al., 2006; Karabolovski et al., 2017). In the present study, the incidence of feline malignant mammary tumors was slightly lower (78.26%) than the reported percentages. The statistical difference we found between the incidences of benign and malignant mammary tumors according to the breeds in cats may be due to the absence of malignant mammary tumors in Persian cats.

Carcinomas and mixed tumors are the most commonly detected mammary tumors in dogs

(Mitchell et al., 1974; Vural and Aydın 2001; Oliveira et al., 2003; Salas et al., 2015; Andrade et al., 2017; Nunes et al., 2018; Kuruca et al., 2019; Viana et al., 2019). Since benign mixed mammary tumors are composed of benign epithelial, myoepithelial and mesenchymal cells that can undergo malignant transformation, they often cause carcinomas and less frequently carcinosarcomas and sarcomas in mixed tumors (Cassali et al., 2012). Similarly, in the present study, mixed type carcinoma was the most frequently diagnosed malignant mammary tumor in dogs with a rate of 51.56% (33 cases). This was followed by tubulopapillary carcinoma (10.94%), complex carcinoma (10.94%) and to a lesser extent by other types of carcinomas. Benign mixed tumors and less often adenomas are the most common diagnosed benign mammary tumors in dogs (Mitchell et al., 1974; Vural and Aydın 2001; Salas et al., 2015; Nunes et al., 2018; Kuruca et al., 2019; Viana et al., 2019). Consistently, we also defined benign mixed tumors and various types of adenomas in dogs, with the percentages of 47.37% and totally 52.63%, respectively. However, in this study, the percentage of benign mixed tumors was lower than the percentages reported by some researchers in Türkiye (Vural and Aydın 2001; Kuruca et al., 2019). The tendency of Terrier dogs to malignant mammary tumors (Mitchell et al., 1974; Vascellari et al., 2016) and of Cocker Spaniel dogs to adenomas (Mitchell et al., 1974) has been previously reported. Similarly, in the present study, malignant mammary tumors were mostly observed in Terriers, as reported by Kuruca et al. (2019) and Tunç and Vural (2024), and showed a higher incidence between 8 and 15 years of age. Mixed type carcinoma was detected in 68.18% of the Terrier dogs with malignant mammary tumors, unlike Kuruca et al. (2019) who reported that complex carcinoma and carcinosarcoma are seen more often in Terriers. Complex adenoma was also mostly found in Cocker Spaniels (3 cases).

In cats, the most frequently diagnosed malignant and benign mammary tumors have been reported as carcinomas/adenocarcinomas (Köküslü and Akkayan 1972; Gülçubuk et al., 2005; Amorim et al., 2006; Shida et al., 2010; Karabolovski et al., 2017) and adenomas (Gülçubuk et al., 2005; Shida et al., 2010; Karabolovski et al., 2017), respectively. In compatible with these studies, tubular carcinoma (50%) and various types of adenomas (100%) constituted the majority of feline malignant and benign mammary tumors diagnosed in the present study, respectively. Carcinomas were observed mostly in mixed breed and less often in Siamese cats (Table

4), contrary to the findings of Hayes et al. (1981) who reported that carcinomas are seen 2 times more frequent in Siamese cats than other breeds. However, the Siamese breed was the only cat breed with malignant mammary tumor at 5 years of age in our study.

In conclusion, the present study has revealed that mammary tumors were one of the most frequently diagnosed tumors in female dogs and cats in İzmir province. The most commonly affected breeds by mammary tumors were Terrier in dogs and mixed breed in cats. Malignant mammary tumors were observed much more often than benign tumors. For this reason, it is of great importance to raise awareness about mammary health and the early diagnosis of mammary tumors among pet owners. It is thought that this study will contribute to the literature by providing data on canine and feline mammary tumors.

Conflict of Interest: The authors declare that they have no conflict of interest.

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