

A retrospective study of feline cutaneous tumors in Korea from 2013 to 2018

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Abstract: This study examined the relative incidence of feline cutaneous tumors according to age, breed, sex, and site predilection for these tumors. Biopsy samples were examined and diagnosed from the histopathology. Over a 72-month period, from January 2013 to December 2018, 478 feline biopsy samples were received from veterinary practitioners across the nation. Of these, 232 (48.54%) cases were skin masses. Among them, 73.71% (171/232) were neoplastic lesions and 26.29% (61/232) were non-neoplastic. Twenty-two different types of cutaneous neoplasms were diagnosed as epithelial tumors (15.79%), mesenchymal tumors (83.63%), or melanocytic tumor (0.58%). The four most common tumors were mast cell tumor (60.23%), lipoma (5.85%), basal cell carcinoma (4.68%), and fibrosarcoma (4.68%), which comprised 75.44% of all tumor cases. Cutaneous tumors were located most commonly in the head of the cat (43.27%) and in the Korean shorthaired breed (75.44%). According to this study, cutaneous tumors were the most common tumor types in feline neoplasms in Korea. The incidence of cutaneous tumors was highest in Korean shorthaired cats, the most prevalent breed in Korea. Mast cell tumors are the most common skin neoplasm in Korea and can affect very young cats.

Keywords: biopsy, cat, neoplasms, skin

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Introduction

Tumors are devastating diseases in both humans and companion animals. Although less common than in dogs, tumors have been observed frequently among the feline population in recent years [1]. Previous studies have shown that the skin is the most common site for tumors in the felines aside from the lymphoid system [2-5]. On the other hand, according to recent studies, cutaneous tumors represent the most common neoplasm in cats and account for approximately 27% in Switzerland [6] and 55% in Italy [7]. The incidence of feline cutaneous tumors varies between studies; however, the consensus is that the four most common cutaneous tumor types are basal cell tumor, fibrosarcoma, squamous cell carcinoma (SCC), and mast cell tumor (MCT) [8-10].

Recently, numerous surveys and studies from extensive data collections have been performed, covering broad aspects of veterinary oncology research. These reports include breed, sex, and site predilection for a range of feline tumors [9,10]. On the other hand, the results of these studies may have been affected by differences in data sources, sample numbers, size of the geographical region assessed, availability of population data, and the depth and specification of data evaluation [9]. Moreover, there is no information available on the incidence of feline cutaneous tumors in Korea. This study examined the relative incidence of cutaneous tumors in the Korean feline population using samples from January 2013 to December 2018. Furthermore, the age, breed, sex, and site predilections for the most common neoplasms were also assessed.

Materials and Methods

A total of 478 feline biopsy samples were submitted to the Department of Veterinary Pathology at the Jeju National University for diagnosis during designated periods from January 2013 to December 2018. The formalin-fixed tissue specimens were obtained from veterinary practitioners in local animal hospitals across the nation. The submitted samples were processed routinely and paraffin-embedded tissue blocks were sectioned into 4- μ m slices. The

sections were then deparaffinized, rehydrated through a graded series of alcohol, and stained with hematoxylin and eosin. Replicate sections of particular cases were also stained with special stains, such as toluidine blue and periodic acid-Schiff, to confirm the diagnosis. Following the diagnosis, only skin masses were included in this study. Masses from mammary glands and cases with an inadequate history were not included. Tumors arising from the ears and anal gland region were included. For all cases included in this study, the age, breed, sex and neuter status of the cat, and location of the biopsy sample were recorded.

Cutaneous masses were classified as either neoplastic or non-neoplastic (including cysts, hamartomas, inflammatory, and hyperplastic or pigmentary growths forming a mass-type lesion). Neoplastic masses were categorized further into one of three groups based upon their embryological origin as epithelial, mesenchymal, or melanocytic.

Results

During the 72-month period, of 478 feline biopsy samples, 232 (48.54%) cases were diagnosed as skin masses. Among them, 73.71% (171/232) were neoplastic lesions and 26.29% (61/232) were non-neoplastic. The three most common diagnoses in non-neoplastic lesions were panniculitis (13 cases), follicular cyst (6 cases), and folliculitis (6 cases). Twenty-two

different types of cutaneous neoplasms were diagnosed and classified into epithelial tumors (15.79%, 27/171), mesenchymal tumors (83.63%, 143/171), and melanocytic tumor (0.58%, 1/171). Among them, 84.21% ($n = 144$) were benign and 15.79% ($n = 27$) were malignant. Among the benign and malignant neoplasms, mesenchymal origin tumors were the most frequent subtype, accounting for 88.19% (127/144) and 59.26% (16/27) of all benign and malignant neoplasms, respectively. Tumors of epithelial and melanocytic origin in benign tumors were 11.11% (16/144) and 0.69% (1/144), respectively. Among the malignant neoplasms, the incidence of an epithelial origin was 40.74% (11/27) (Table 1). The four most common tumor types were MCT ($n = 103$; 60.23%), lipoma ($n = 10$; 5.85%), basal cell carcinoma ($n = 8$; 4.68%), and fibrosarcoma ($n = 8$; 4.68%). Table 2 provides detailed information, including the incidence of individual tumors, sex distribution, and mean and median age. Fig. 1 shows rep-

Table 1. Classification of cutaneous tumors according to the histologic origin and malignancy

Origin	Benign	Malignant	Total
Epithelial	16	11	27
Mesenchymal	127	16	143
Melanocytic	1	-	1
Total	144	27	171

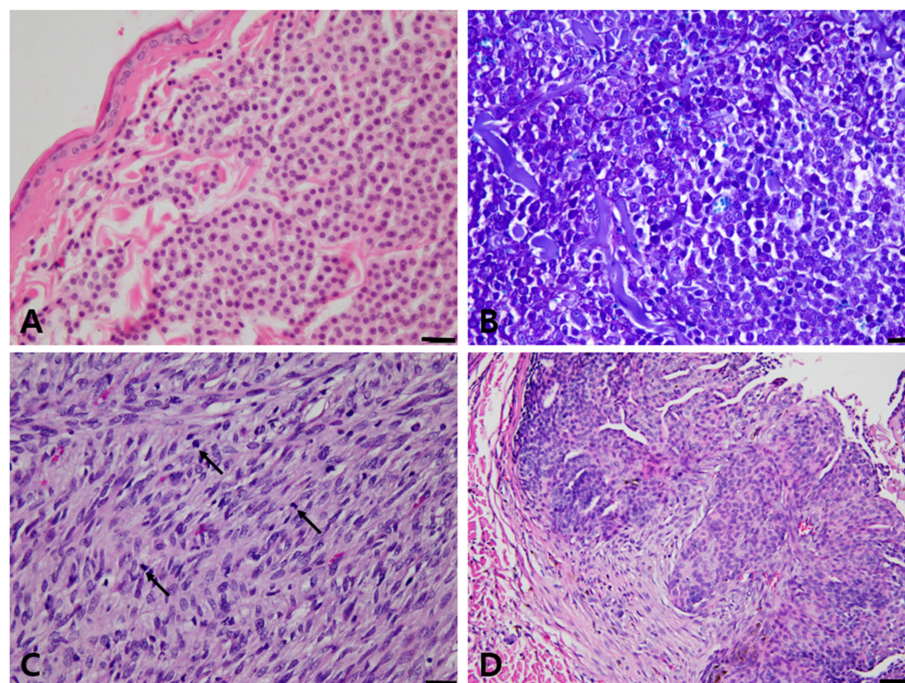
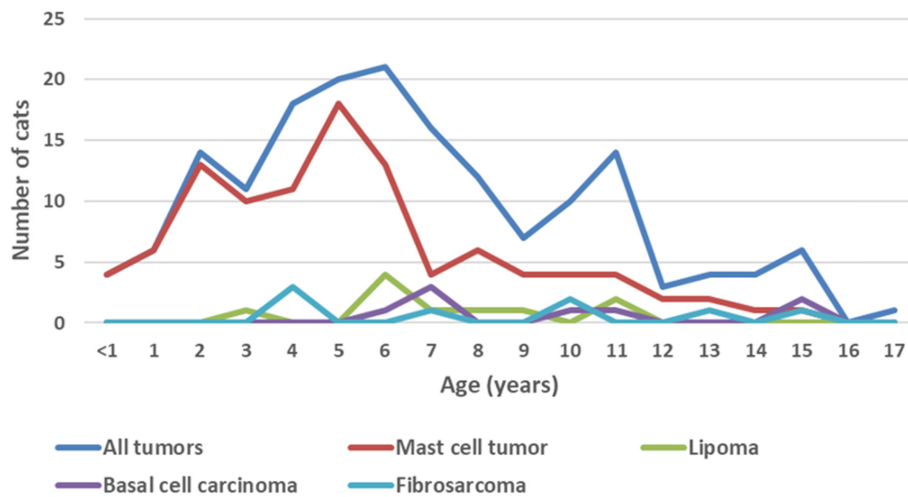


Fig. 1. Photographs of feline cutaneous tumors. (A) Mast cell tumor (MCT), well-differentiated type. Compact accumulation of neoplastic mast cells with fine, basophilic, cytoplasmic granules without eosinophil infiltration. Hematoxylin and eosin (H&E). Bar = 20 μ m. (B) MCT. The mast cells contained numerous metachromatic purple granules in the cytoplasm. Toluidine blue stain. Bar = 20 μ m. (C) Fibrosarcoma. The pleomorphic spindle cells arranged in interlacing pattern with numerous high mitotic figures (arrows). H&E. Bar = 20 μ m. (D) Basal cell carcinoma. Invasive neoplastic basal cells with a surrounding desmoplastic response. H&E. Bar = 50 μ m.

Table 2. Cutaneous tumors from 171 cats with the number of affected cats, male:female ratio, mean and median age

Tumor type	No. of cases (%)	Male : female ratio	Median age (range)	Mean age (SD)
Mast cell tumor	103 (60.23)	0.98	5 (3m-15y)	5.08 (3.33)
Lipoma	10 (5.85)	1.00	6 (3-11y)	7.3 (2.50)
Basal cell carcinoma	8 (4.68)	1.67	8.5 (6-15y)	9.75 (3.65)
Fibrosarcoma	8 (4.68)	1.00	10 (4-15y)	8.38 (4.31)
Basal cell tumor	6 (3.51)	1.00	7 (5-11y)	7.17 (2.04)
Sebaceous adenoma	6 (3.51)	5.00	10 (6-15y)	9.67 (3.39)
Fibroma	5 (2.92)	0.67	8 (4-14y)	9 (3.74)
Histiocytic sarcoma	5 (2.92)	4.00	9 (4-11y)	7.2 (3.11)
Histiocytoma	4 (2.34)	1.00	9 (2-13y)	8.25 (4.86)
Apocrine cystadenoma	2 (1.17)	1.00	10 (9-11y)	10 (1.41)
Hemangioma	2 (1.17)	2 male	9.5 (7-12y)	9.5 (3.54)
Lymphoma	2 (1.17)	2 male	4.5 (4-5y)	4.5 (0.71)
Apocrine adenoma	1 (0.58)	1 female	14	14
Apocrine carcinoma	1 (0.58)	1 male	8	8
Ceruminous gland carcinoma	1 (0.58)	1 female	7	7
Hemangiosarcoma	1 (0.58)	1 male	8	8
Leiomyosarcoma	1 (0.58)	1 female	17	17
Leiomyoma	1 (0.58)	1 male	15	15
Myxosarcoma	1 (0.58)	1 male	10	10
Melanoma	1 (0.58)	1 female	14	14
Inverted papilloma	1 (0.58)	1 male	11	11
Squamous cell carcinoma	1 (0.58)	1 female	7	7

SD, standard deviation.

**Fig. 2.** Number of the four most common cutaneous tumors according to feline ages. More than half of the cutaneous tumors occurred between 4 and 8 years of age.

representative photomicrographs of cutaneous tumors, such as MCT, fibrosarcoma, and basal cell carcinoma.

Age

The age of the cats with skin mass ranged from under one year up to 17 years with a median age of 6 years at the time of surgical excision. More than half of the cutaneous tumors

occurred between 4 and 8 years of age (Fig. 2). On the other hand, there were no significant correlations between the cats' age and the occurrence of benign or malignant neoplasms.

Breed

Cats suffering from cutaneous tumors were classified into 13 different breeds. The cats with the greatest number of

cutaneous tumors were Korean shorthair (KSH, $n = 129$; 75.44%), followed by Persian ($n = 11$; 6.43%) and Turkish angora ($n = 10$; 5.85%). Table 3 provides detailed information on the feline breeds.

Table 3. Prevalence of cutaneous tumors according to the feline breeds ($n = 171$)

Breed	Values
Korean shorthair	129 (75.44)
Persian	11 (6.43)
Turkish angora	10 (5.85)
Russian blue	7 (4.09)
American shorthair	3 (1.75)
Siamese	3 (1.75)
Abyssinian	2 (1.17)
Scottish fold	1 (0.58)
British shorthair	1 (0.58)
Maine coon	1 (0.58)
Oriental shorthair	1 (0.58)
Munchkin	1 (0.58)
Scottish straight	1 (0.58)

Values are presented as number (%).

Sex

Of the cutaneous tumors, 53.21% (91/171) and 46.79% (80/171) were found in male and female cats, respectively. There was no significant sex predilection for feline cutaneous tumors. On the other hand, sebaceous adenoma and histiocytic sarcoma were more frequent in male cats than in female cats.

Anatomic location

The cutaneous tumors were found most commonly on the head (43.27%; 74/171), followed in order by the trunk (30.99%; 53/171), extremities (19.30%; 33/171), and neck (6.43%; 11/171). Table 4 provides further details regarding the location of the tumors.

Diagnosis

MCT

MCTs were the most common cutaneous tumors in this study, accounting for 60.23% (103/171) of all neoplastic skin masses. Within the diagnostic criteria, the majority of MCTs were classified as the mastocytic form ($n = 101$; 98.06%) and the remaining cases were the histiocytic type ($n = 2$; 1.94%). The KSH cat breed ($n = 87$; 84.47%) had the highest incidence of MCT. The average age of cats with MCT was 5.08

Table 4. Number of cutaneous tumors according to the location of skin mass in 171 cats

Tumor type	Values			
	Head	Neck	Trunk	Extremities
Mast cell tumor ($n = 103$)	59 (57.28)	5 (4.85)	19 (18.45)	20 (19.42)
Lipoma ($n = 10$)			7 (70.00)	3 (30.00)
Basal cell carcinoma ($n = 8$)	2 (25.00)		5 (62.50)	1 (12.50)
Fibrosarcoma ($n = 8$)		2 (25.00)	4 (50.00)	2 (25.00)
Basal cell tumor ($n = 6$)	2 (33.33)		3 (50.00)	1 (16.67)
Sebaceous adenoma ($n = 6$)	1 (16.67)		4 (66.67)	1 (16.67)
Fibroma ($n = 5$)	2 (40.00)	2 (40.00)	1 (20.00)	
Histiocytic sarcoma ($n = 5$)	1 (20.00)		2 (40.00)	2 (40.00)
Histiocytoma ($n = 4$)	2 (50.00)	1 (25.00)	1 (25.00)	
Apocrine cystadenoma ($n = 2$)	2 (100.00)			
Hemangioma ($n = 2$)	1 (50.00)			1 (50.00)
Lymphoma ($n = 2$)			2 (100.00)	
Apocrine adenoma ($n = 1$)	1 (100.00)			
Apocrine carcinoma ($n = 1$)			1 (100.00)	
Ceruminous gland carcinoma ($n = 1$)	1 (100.00)			
Hemangiosarcoma ($n = 1$)			1 (100.00)	
Leiomyosarcoma ($n = 1$)		1 (100.00)		
Leiomyoma ($n = 1$)				1 (100.00)
Myxosarcoma ($n = 1$)			1 (100.00)	
Melanoma ($n = 1$)			1 (100.00)	
Inverted papilloma ($n = 1$)			1 (100.00)	
Squamous cell carcinoma ($n = 1$)				1 (100.00)
Total	74 (43.27)	11 (6.43)	53 (30.99)	33 (19.30)

Values are presented as number (%).

Table 5. Comparison of prevalence of the most common cutaneous tumors in this study with relevant data from other surveys

Tumor type	Prevalence (%)				
	This study	USA [*]	United Kingdom [†]	United Kingdom [‡]	Switzerland [§]
Mast cell tumor	60.23	21.1	7.69	6.7	6.7
Lipoma	5.85	0.3	2.3	5.7	NR
Basal cell carcinoma	4.68	NR	NR	2.8	NR
Fibrosarcoma	4.68	14.7	25.4	19.5	NR
Basal cell tumor	3.51	26.1	14.8	22.6	14.4
Sebaceous adenoma	3.51	4.4	2.3	NR	NR
Squamous cell carcinoma	0.58	15.2	17.4	11.4	11.7

NR, not reported. ^{*}From Miller et al. [8]; [†]Bostock [10]; [‡]Ho et al. [9]; [§]Graf et al. [11].

years, and the ages of the cats affected ranged from three months to 15 years. These tumors were located predominantly in the head (57.28%), particularly in the ear, followed by the extremities (19.42%).

Other tumors

Ten cases of lipoma (9 KSH and one Siamese) accounted for 5.85% of cutaneous tumors. The most common site was the trunk, followed by the extremities. Eight cases (4.68%) of basal cell carcinoma and six cases (3.51%) of basal cell tumors were encountered. The trunk was the most common site of basal cell origin tumors. Eight cases of fibrosarcoma accounted for 4.68% of skin tumors. These included feline injection-site sarcomas with the histological phenotype of a fibrosarcoma. Overall, the most common site for this tumor was the trunk (50%).

Discussion

Based on this investigation, the incidence of cutaneous tumors in feline biopsy samples was 35.77% (171/478) and cutaneous tumors were the most common of all tumor types. These findings are in accordance with a report from Switzerland (34.79%), but higher than a report from the USA (9.6%) [6,8]. As the largest and the most exposed organ of the body, the skin is exposed continuously to various chemical and physical insults along with other environmental factors [6,9]. The majority of cutaneous tumors (84.21%) diagnosed in this study were benign. This finding did not match with earlier reports from other countries. According to previous studies, malignant tumors comprise a high proportion of skin tumors: approximately 76.1% in Switzerland [11] and 52.7% in the UK [9]. The differences between this study and other reports may be closely related to the small sample size and the predominance of MCT. In this study, the most common type of cutaneous tumor was MCT, and the majority of them were histologically benign in Korea.

Previous studies indicated that basal cell tumor, fibrosarcoma, SCC, and MCTs were the top four skin tumors in cats. On the other hand, the individual proportion of these tumors was somewhat different in those studies [8,9]. The overall

prevalence of the top four tumors in cats in the UK decreased gradually from 65.3% in the 1970s [10] to 60.3% in the 2000s [9]. These tumors accounted for 77.1% [8] of all cutaneous tumors in 1980s in USA and 71.5% [11] in a recent Swiss study. In the present study, the four most common cutaneous tumors were MCTs, lipoma, basal cell carcinoma, and fibrosarcoma, accounting for 75.44% of all cutaneous tumors. Similar to other studies, MCTs and fibrosarcoma were included in the top four tumors and accounted for 64.91% of feline cutaneous tumors in Korea.

According to a large scale retrospective study with long period records of more than 40 years, the tumor frequency in European shorthair cats (40.94%), a type of non-pedigree cat, was higher than in pedigree breeds, such as Persian (25.88%), Siamese (32.80%), Abyssinian (21.84%), and Turkish angora (33.14%) [6]. In this study, cutaneous tumors were diagnosed in 13 breeds of cat and accounted for the majority in KSH (75.44%) and minor pedigree breeds (24.56%). KSH cats accounted for 65.9% of all feline sample submissions to the laboratory, and the remainder of the cat population (34.1%) comprised various pedigree breeds. Overall the tumor frequency of cutaneous tumors was higher in KSH cats (40.95%, 129/315) than in pedigree breeds, including Persian (20.0%, 11/55), Turkish angora (35.71%, 10/28), Russian blue (38.88%, 7/18), and other breeds. KSH cats are the most prevalent breed in Korea; hence, periodic monitoring and owner awareness of feline skin tumors will be necessary to prevent the development of tumors in these breeds.

Feline MCTs were the most common cutaneous tumors in this study, comprising 60.23% of all neoplastic skin masses. This result is quite different from that of previous surveys in other countries (Table 5). The proportion of MCTs in feline skin tumors in this study was 3- or 9-times higher than the results from other nations including the US (21.1%) [8], UK (6.7-7.7%) [9,10] and Switzerland (6.7%) [11]. Increased risk of MCTs for Siamese cats and a male sex predilection were reported previously [8]. On the other hand, an extremely high incidence of MCTs was found in KSH cats (84.47%) than in other breeds, including Persian (4.85%), Turkish angora (2.91%), and Siamese (0.97%) cats without an apparent sex predilection. The geographic variations in the prevalence of

MCTs might be related to the proportion of pedigree cats in the feline population in Korea. The median age of cats diagnosed with MCTs was five years (ranging from three months to 15 years), and significantly different from the median age of 10 years reported in previous studies [8,9]. In accordance with other studies [9,12], four cats with MCTs in this study were very young (<one 1 year of age). These tumors were located predominantly on the head (57.28%), extremities (19.42%), trunk (18.45%), and neck (4.85%). The head has been the most common site of MCTs in previous studies, as well as in the present study. MCTs are classified as one of three histological types: well-differentiated mastocytic, pleomorphic mastocytic, and atypical, also called histiocytic [13,14]. Most feline cutaneous MCTs are clinically benign and are cured by complete surgical excision. On the other hand, a small portion of MCTs may show aggressive behavior and ultimately lead to lymph node metastases, visceral organ involvement, and/or cutaneous dissemination [13].

With the exception of MCTs, lipomas, basal cell carcinomas, and fibrosarcomas were included in the top four tumors and accounted for 15.21% of all cutaneous tumors in this study. Lipoma was the second most common skin tumor and affected six-year-old cats on average. Although the incidence was relatively low, lipoma was the fifth most common tumor in the UK study (5.7%) [9]. Basal cell carcinoma and fibrosarcoma were the third and fourth most common skin tumors and affected cats with a mean age of 8.5 and 10 years, respectively. Therefore, malignant tumors were diagnosed more frequently than benign tumors in old aged cats in this study. Fibrosarcomas were found to be the first or second most common skin tumors in other countries [9-11]. The occurrence of this tumor was closely associated with the prevalence of feline leukemia virus (FeLV) infection and an injection of vaccine against rabies and FeLV in cats. Therefore, the risk factors associated with the development of this tumor might be different in Korean feline populations compared to other countries. In a previous study for the seroprevalence of FeLV and feline immunodeficiency virus (FIV), approximately 1.1% of cats (10/875) were seropositive for FeLV and no cat was positive for FIV in Korea [15]. The overall seroprevalence of FeLV and FIV were much lower than in other countries. Moreover, the incidence of fibrosarcomas ranges from one case per 1,000-10,000 vaccinated cats in North America [16,17]. Although there is no data available on the incidence of fibrosarcoma associated with vaccine injections in Korean feline populations, the risk of developing this tumor might be low.

Compared to other countries, this study showed that benign cutaneous tumors are more prevalent than malignant tumors in cats in Korea. MCTs are the most common skin neoplasms in Korea and can affect very young cats. This study was based on clinical samples submitted for diagnosis in Jeju National University from practitioners across the nation. Although the results of this study cannot describe the prevalence of feline tumors in Korea accurately, they serve as

fundamental data that can be used to support future investigations. To clarify the entity of feline neoplasm further, more in depth, and nation-wide surveillance will be necessary.

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