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Primary bone tumors in dogs and cats: 98 cases

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ABSTRACT

The aim of this study is to contribute to the current literature by determining the distribution of bone tumors in dogs and cats by breed, age, gender and location. Bone tumors are more common in dogs than cats, and the most common primary bone tumor in both species is osteosarcoma. The biopsy and necropsy reports of the Ankara University, Faculty of Veterinary Medicine, Department of Pathology , were retrospectively studied examining for cases of primary bone tumors in dogs and cats. This study's period encompassed from 2001 through 2020 (20 years). A total of 98 bone tumors were detected 70 in dogs and 28 in cats. Of the cases in dogs, 13 (18.57%) were necropsy, while 57 (81.43%) were biopsy. Sex distribution of bone tumors is in female dogs (n:28, 40%) and in male dogs (n:38, 54.29%). Also, females (n:17, 60.7%) and males (n:11, 39.3%) were observed in cats. in dogs, although 57.14% (n=40) were purebreds and 31.43% (n=22) were mongrel breeds, in cats, 75% of them were mongrel (n=21) and 7.1% (n=2) were purebred. While locations of tumors in dogs were appendicular (65.71%, n=46), axial (30%, n=21), locations of tumors in cats were appendicular (50%, n=14), axial (39.29%, n=11) and both appendicular and axial (10.71%, n:3). While 13 benign (18.57%) and 57 malignant (81.43%) tumors were observed in dogs, 4 benign (14.29%) and 24 malignant (85.71%) tumors were observed in cats. The data were analyzed in the SPSS program and no significant relationship was detected between the data (P>0.05). This study would contribute and conduce the comparative oncology for dogs and cats.

Köpek ve kedilerde primer kemik tümörleri: 98 vaka

ÖZET

Bu çalışmanın amacı kedi ve köpeklerde kemik tümörlerinin ırk, yaş, cinsiyet ve lokasyona göre dağılımını belirleyerek güncel literatüre katkı sağlamaktır. Kemik tümörleri köpeklerde kedilere göre daha yaygındır ve her iki türde de en sık görülen primer kemik tümörü osteosarkomdur. Ankara Üniversitesi Veteriner Fakültesi Patoloji Anabilim Dalı biyopsi ve nekropsi raporları, köpek ve kedilerde primer kemik tümörü olguları retrospektif olarak incelendi. Bu çalışmanın dönemi 2001'den 2020'ye kadar (20 yıl) kapsamaktadır. Köpeklerde 70, kedilerde 28 olmak üzere toplam 98 kemik tümörü tespit edildi. Köpeklerde görülen vakaların 13'ü (%18,57) nekropsi, 57'si (%81,43) ise biyopsi idi. Kemik tümörlerinin cinsiyet dağılımı dişi köpeklerde (n:28, %40) ve erkek köpeklerde (n:38, %54,29) görülmektedir. Ayrıca kedilerde dişilerde (n:17, %60,7) ve erkeklerde (n:11, %39,3) gözlendi. Köpeklerin %57,14'ü (n=40) safkan, %31,43'ü (n=22) melez ırk olmasına rağmen, kedilerde %75'i (n=21) melez ve %7,1'i (n=2) safkandı. Köpeklerde tümörlerin yerleşim yerleri apendiküler (%65,71, n=46), aksiyal (%30, n=21) iken, kedilerde tümörlerin yerleşim yerleri apendiküler (%50, n=14), aksiyel (%39,29, n=11) ve hem apendiküler hem de aksiyaldi (%10,71, n:3). Köpeklerde 13 benign (%18,57) ve 57 malign (%81,43) tümör görülürken, kedilerde 4 benign (%14,29) ve 24 malign (%85,71) tümör görüldü. Veriler SPSS programında analiz edilmiş ve veriler arasında anlamlı bir ilişki tespit edilememiştir (P>0.05). Bu çalışma kedi ve köpeklerin karşılaştırmalı onkolojisine katkı sağlayacak ve yol gösterecektir.

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1. Introduction

Bone tumors include either the axial (vertebra, pelvis, ribs and skull) or appendicular (limbs like humerus, tibia etc.) skeleton. Bone tumors are classified as primary and secondary. Osteoma, osteochondroma, chondroma are primary benign tumors of bone, while osteosarcoma, giant cell tumor of bone, chondrosarcoma, fibrosarcoma are primary malignant tumors of bone (1,2).

Bone tumors are more common in dogs than cats, and the most common primary bone tumor in both species is osteosarcoma. Osteosarcoma is the most common primary bone tumor and is quite aggressive (3-5). In contrast to animals, primary bone tumors in humans are uncommon (6) and mostly benign, whereas secondary bone tumors, especially metastatic carcinomas, are malignant. Lungs and lymph nodes are the organs where bone tumors metastasize most frequently (1).

Large and giant dog breeds such as St. Bernard, Great Dane, Boxer, German shepherd dog and Irish setter are more susceptible to osteosarcomas. Age of tumor formation in dogs usually is between 6-9 years old. Some studies have shown that male dogs are more affected than female dogs (5,7). There is no significant difference in age, breed or gender in cats (8).

The aim of this study is to explain to pathological findings of bone tumors, their distribution and incidence and to contribute to the current literature by determining the distribution of primary bone tumors in dogs and cats by breed, age, gender and location in the period 2001 to 2020.

2. Material and Methods

The biopsy and necropsy reports of the Ankara University, Faculty of Veterinary Medicine, Department of Pathology, were retrospectively studied examining for cases of primary bone tumors in dogs and cats. This study's period encompassed from 2001 through 2020 (20 years). Data supplied from the reports contained the occurrence of metastasis in the necropsy cases, distributions of age, breed, gender, anatomical location of the tumors and histological components. A total of 98 bone tumors were detected 70 in dogs and 28 in cats. Of the cases in dogs, 13 (18.57%) were necropsy, while 57 (81.43%) were biopsy. Also, 6 of these 13 necropsy cases in dogs also had metastases (Table 1). Additionally, in this study, there was not about two different bone tumors in the same case.

Table 1: Information about dogs with metastasis detected.
Tablo 1: *Metastazı tespit edilen köpekler hakkında bilgiler.*

Number	Breed	Age	Gender	Localization	Diagnose	Site of metastasis
1.	Mongrel	7	Male	-	Chondroosteofibrosarcoma	Lung
2.	Labrador retriever	9	Male	Sinus	Osteosarcoma	Lung
3.	Mongrel	15	Female	Humerus	Osteosarcoma	Lung, kidney, and pancreas
4.	German shepherd	3	Female	Humerus	Fibrochondrosteosarcoma	Lung
5.	Mongrel	5	Male	Forelimb	Fibrosteoochondrosarcoma	Lung and scapular lymph node
6.	Labrador retriever	8	Male	Skull	Osteosarcoma	Lung

For pathological examinations, the tissue specimens were hold in decalcification solutions. The samples were fixed in 10% buffered formalin solution (pH 7.2-7.4) and then processed routinely, embedded in paraffin, sectioned at 5 μm, and stained with Hematoxylin Eosin and Masson's trichrome stains (9). All findings were evaluated and diagnosed under light microscopy (Leica DM 4000) and photographed (Leica DFC-280).

Statistical analysis

Chi-square analysis was applied to the data in the SPSS (V26) program. The groups were compared with each other in pairs. For this purpose, subgroupings were made in some of the within-group data. For the breed distribution of cats and dogs, data were analyzed for each breed and the breeds were grouped as purebred/hybrid (Purebred Status). For age, classifications were preferred for cats (kitten, mature adult, senior, etc.) and dogs (Puppy, Juvenile, Mature Adult, etc.). For localization, tumors observed in cats and dogs were grouped as axial, appendicular and axial/appendicular and analyzed. For malignancy, tumors were grouped into benign and malignant in both cats and dogs. For gender, only male/female distinction was made. Within groups; "diagnosis" – "tumor characteristic" and "purity" – "Species" groups; Since "tumor characteristic" and "purity" are subgroups of the "species" group, they were not compared. In cases where any animal from the above had missing data, that animal was excluded from the relevant data analysis. According to the results obtained, the relationship was considered significant when $P<0.05$.

3. Results

Although the sex distribution of bone tumors is in female dogs (n:28, 40%) and in male dogs (n:38, 54.29%), there was no gender information on the dogs (n:4, 5.71%). Also, females (n:17, 60.7%) and males (n:11, 39.3%) were observed in cats.

Considering the breed distribution in dogs, although 57.14% (n=40) were purebreds and 31.43% (n=22) were mongrel breeds, 11.43% (n=8) could not find breed information in the records. Among the purebred breeds, the three breeds with the most tumors are Kangal (n=8, 11.43%), Terrier (n=7, 10%) and German Shephard (n=6, 8.57%), respectively. The least bone tumors were with breeds Turkish Mastiff, Siberian husky, Mastiff bulldog, Colie, Cocker, Boxer and Belgian Malinois (each one n=1, 1.43%), followed by Labrador Retriever (n:5, 7.14%), Rottweiler (n=3, 4.29%) and Golden Retriever (n=4, 5.71%) followed. Considering the breed distribution in cats, while 7.1% (n=2) were purebreds and 75% (n=21) were mongrel breeds, 5 animals (17.9%) in cats could not be found in the records. The purebred breeds were Bombay (n:1) and Ankara (n:1) breeds.

The dogs in the study were classified according to age by Harvey (10) and the cats by Quimby et al. (11). When the age distribution of animals in dogs was examined, the group with the most tumors was the Late Senior (10-11 years) group (27.14%, n=19), followed respectively by Early Senior (7-9 years) (25.71%, n=18), Mature Adult (2-6 years) (22.86%, n=16), Geriatric (12 years and older) (20%, n=14). In addition, 2 of the animals included in the study were Juvenile (6-12 months) (2.86%) and one of them was Puppy (0-5 months) (1.43%). In cats, when grouped according to age, it is seen that the group with the most tumors is Senior (10 years-older) (42.9%, n=12). This group was followed by Young Adult (1-6 years) (25%, n=7), Mature Adult (7-10 years) (21.4%, n=6) and most recently Kitten (0-up to 1 year) (3.6%, n:1). Age information of 7.1% (n=2) of the cats is not recorded.

While locations of tumors in dogs were appendicular (65.71%, n=46), axial (30%, n=21), locations of tumors in cats were appendicular (50%, n=14), axial (39.29%, n=11) and both appendicular and axial (10.71%, n:3). There was no information of tumor location in dogs (4.29%, n:3). Commonly detected appendicular tumor locations in dogs were respectively humerus (17.39%, n=8), and femur (13.04%, n=6), whereas appendicular tumor locations in cats were hindlimb (35.7%, n=5), tail and metatarsus (14.29%, each one n=2) (Figure 1).

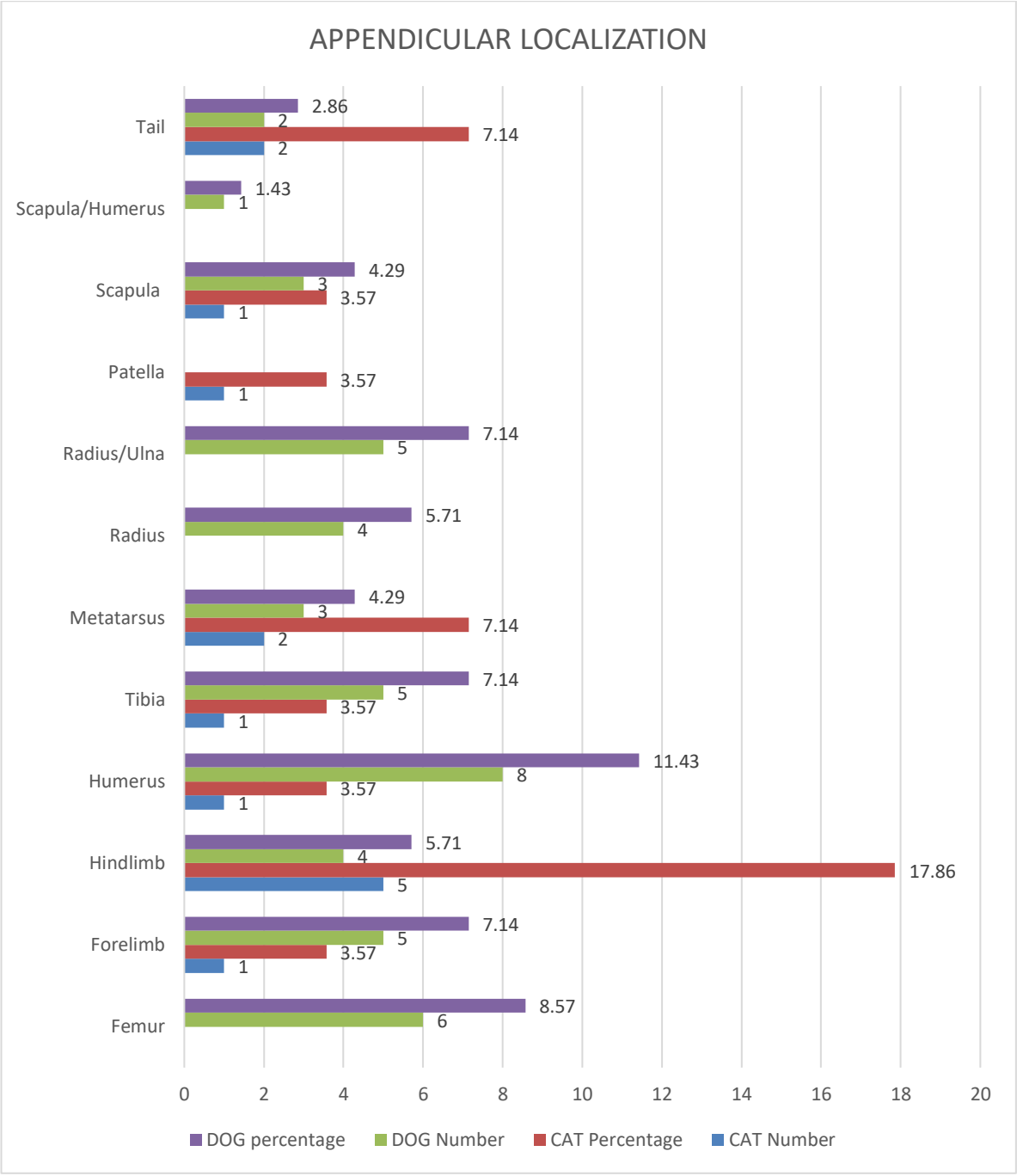

Figure 1: Appendicular localization of primary bone tumors noted in dogs and cats.
Şekil 1: *Köpek ve kedilerde görülen primer kemik tümörlerinin apendiküler lokalizasyonu.*

Axial tumor localizations in dogs and cats were most commonly detected in the sinus, (38.1%, n=8), and (36.4%, n=4), respectively (Figure 2).

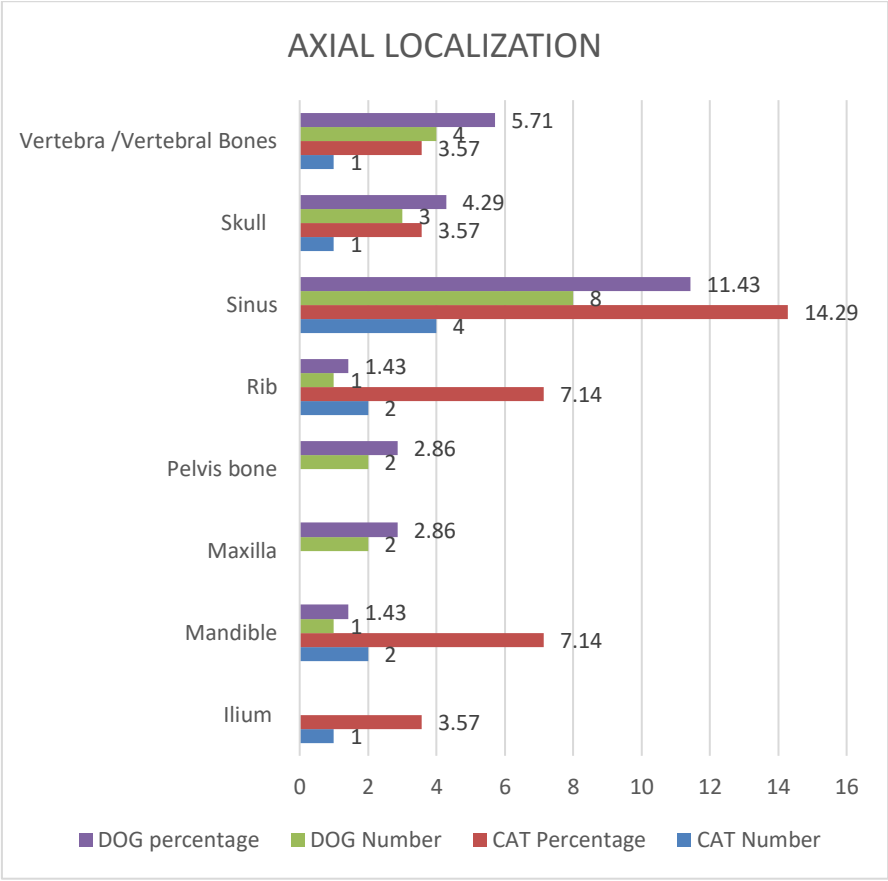

Figure 2: Axial localization of primary bone tumors noted in dogs and cats.
Şekil 2: *Köpek ve kedilerde görülen primer kemik tümörlerinin aksiyal lokalizasyonu.*

While 13 benign (18.57%) and 57 malignant (81.43%) tumors were observed in dogs, 4 benign (14.29%) and 24 malignant (85.71%) tumors were observed in cats (Figure 3).

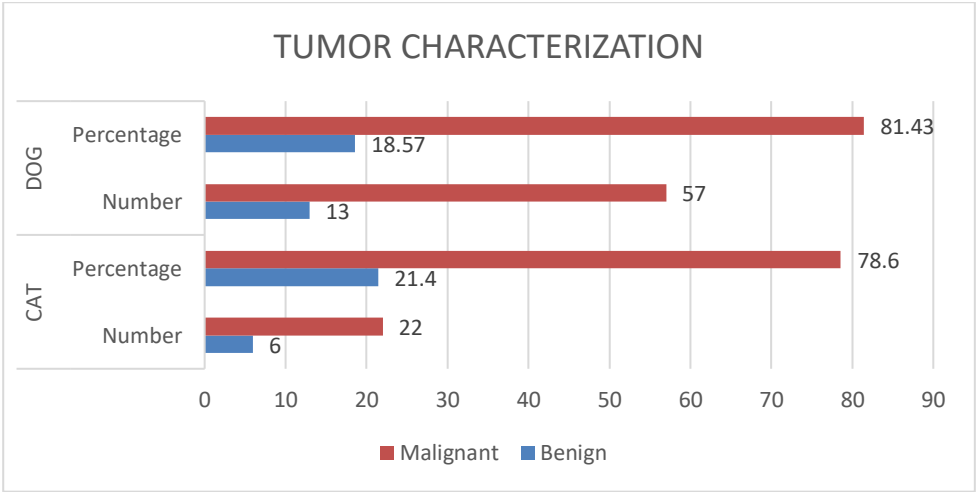

Figure 3: Tumor characterization of primary bone tumors noted in dogs and cats.
Şekil 3: *Köpeklerde ve kedilerde görülen birincil kemik tümörlerinin tümör karakterizasyonu.*

The most common benign tumors in dogs were osteoma (30.77%, n=4) and chondroma (23.07%, n=3) (Figures 6a-b). Osteosarcoma was the most common malignant tumor in dogs with a rate of 40.35% (n=23) (Figures 4, 5 and 6d-e). Fibrosarcoma (Figure 6c), chondrosarcoma etc. were also detected in dogs.

While benign tumors of the bone in cats were fibrochondrosteoma (50%, n=2), fibroma and chondrosteoma (25%, each one n=1), the most common malignant tumors were osteosarcoma (n=6, 25%) and giant cell-rich osteosarcoma (n=4, 16.67%) (Figures 4, Figure 5).

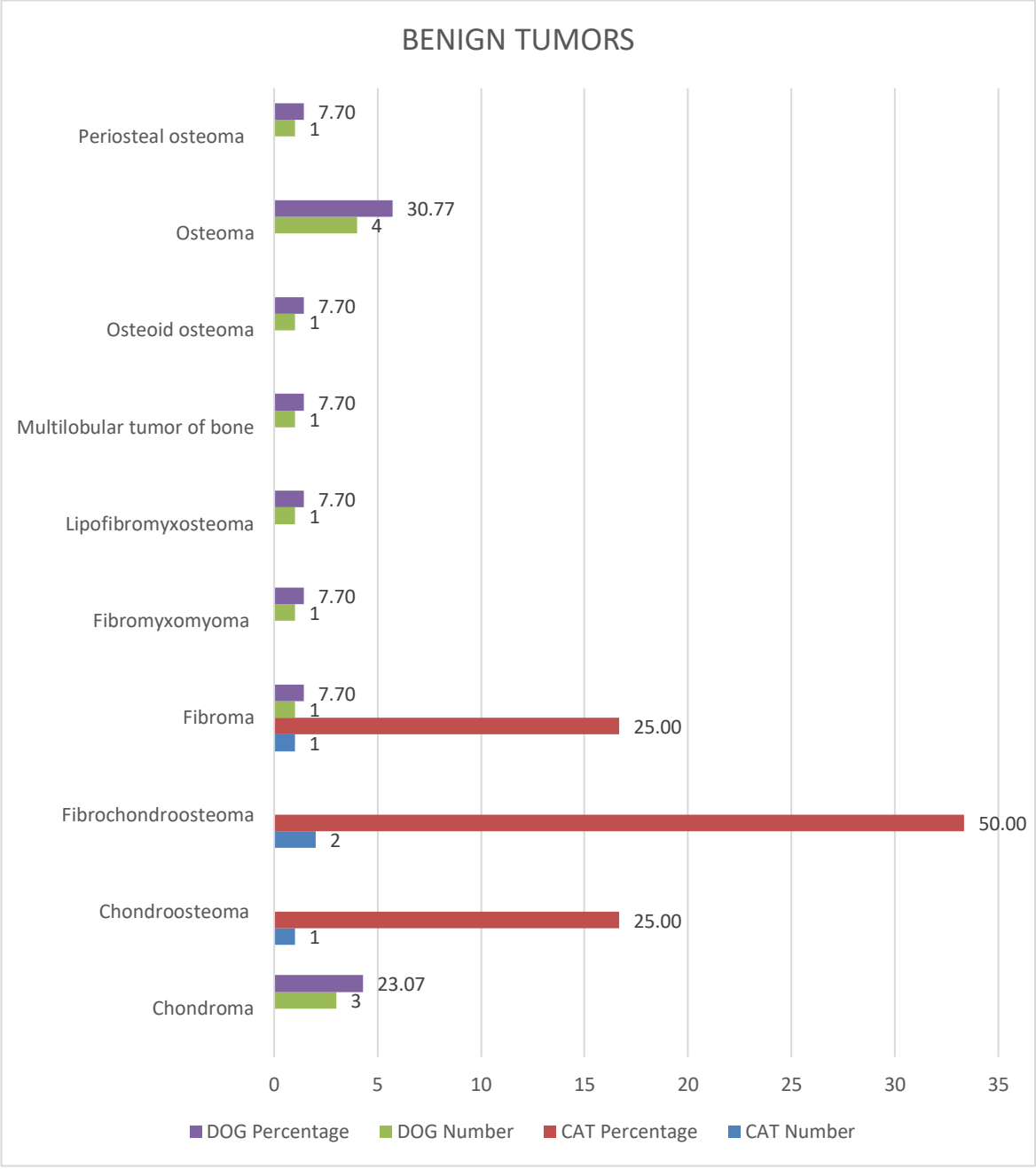

Figure 4: Benign primary bone tumors noted in dogs and cats.
Şekil 4: *Köpek ve kedilerde görülen iyi huylu primer kemik tümörleri.*

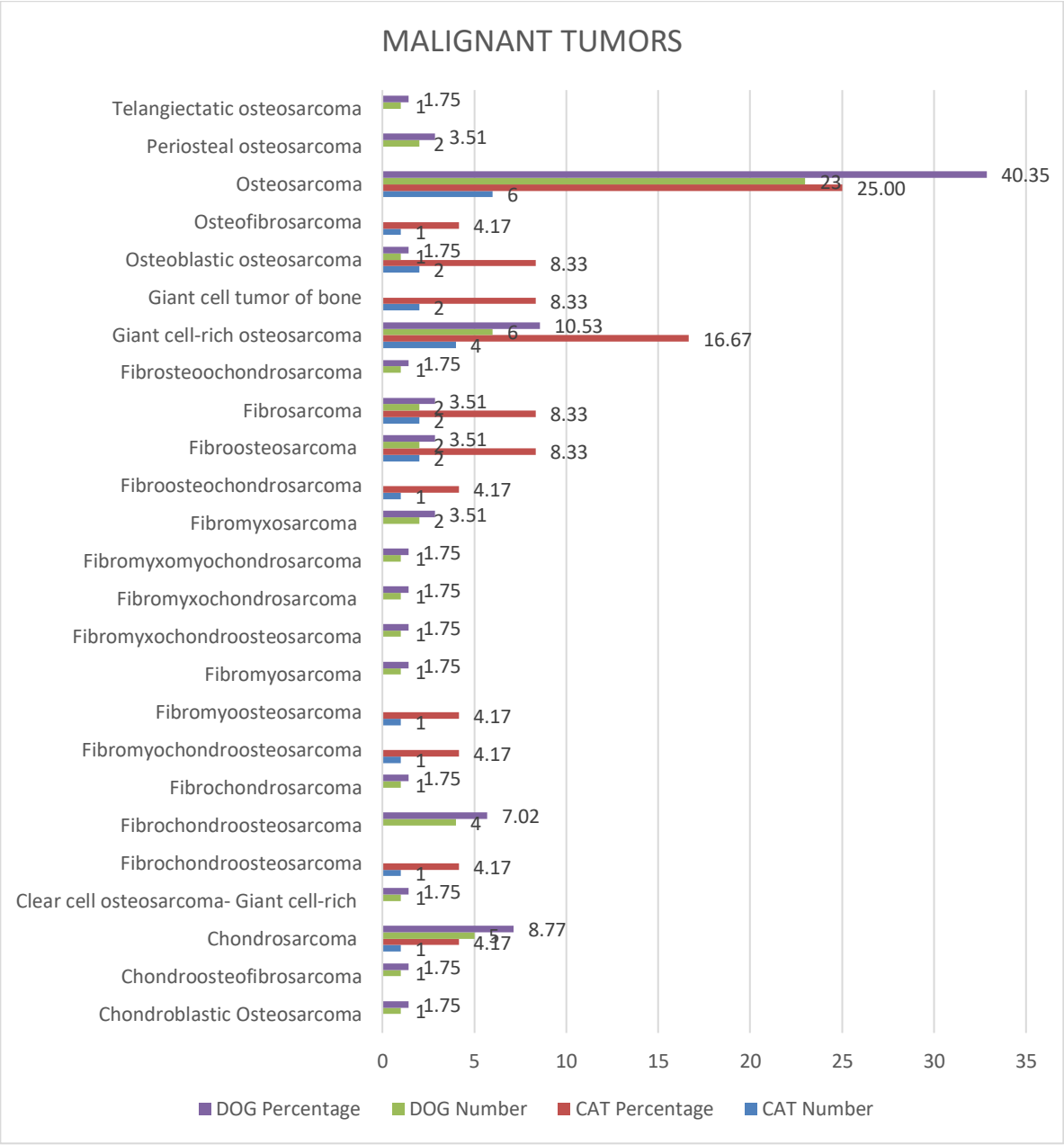

Figure 5: Malignant primary bone tumors noted in dogs and cats.
Şekil 5: *Köpek ve kedilerde görülen malign primer kemik tümörleri.*

In the necropsies performed, metastases of primary bone tumors (osteosarcoma) in dogs were found in the lung (n:6) (Figure 6f), lymph node (n:1), kidney (n:1) and pancreas (n:1). No metastasis was observed in cats.

Statistical results

Groups such as breed, age, gender, localization, diagnosis, tumor characteristics and pure breed were compared in pairs in the SPSS program. No significant results were detected in the analyzes (P>0.05).

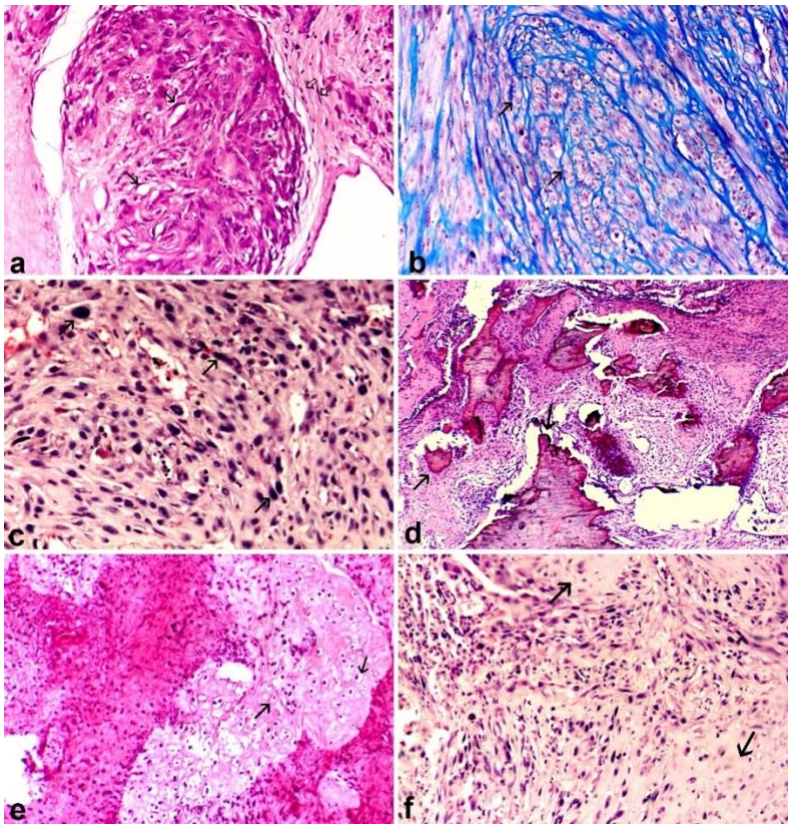

Figure 6: Histopathological images of some tumors occured in dogs. **a.** Chondroma; uniformly structured chondrocytes and chondroblasts (black arrows), connective tissue capsule formed by fibrocytes and fibroblasts surrounding the chondroma (white arrows), HE, x400. **b.** Chondroma; uniform chondrocytes and chondroblasts (black arrows), Masson's trichrome stain, x400 **c.** Fibrosarcoma; atypical fibrocytes and fibroblasts (black arrows), HE, x400. **d.** Osteosarcoma; bone trabeculae and dense calcium precipitates (black arrows), HE, x100. **e.** Osteosarcoma; atypical osteoblasts (black arrows) with dense bone trabeculae and calcium precipitates, HE, x100. **f.** Lung metastasis of osteosarcoma; bone foci in the lung (black arrows), HE, x400.

Şekil 6: *Köpeklerde meydana gelen bazı tümörlerin histopatolojik görüntüleri.* ***a****. Kondroma; uniform yapıdaki konrositler ve kondroblastlar (siyah oklar), kondromun etrafın çevreleyen fibrosit ve fibroblastların oluşturduğı bağdokudan kapsül (beyaz oklar), HE, x400.* ***b.*** *Kondroma; unifom yapıdaki kondrosit ve kondroblastlar (siyah oklar), Masson's trichrome stain, x400****c.*** *Fibrosarkoma; atipik fibrosit ve fibroblastlar (siyah oklar), HE, x400.****d.*** *Osteosarkoma; kemik trabekülleri ve yoğun kalsiyum çöküntüler (siyah oklar), HE, x100.****e.*** *Osteosarkoma; yoğun kemik trabekülleri ve kalsiyum çöküntüleri ile atipik osteoblastlar (siyah oklar), HE, x100.* ***f.*** *Osteosarkomanın akciğer metastazı; akciğerde kemik odakları (siyah oklar), HE, x400.*

4. Discussion and Conclusion

Canine primary tumors, especially osteosarcomas, serve as models for human osteosarcomas, the most common malignant bone tumor in children (12,13). Therefore, it is necessary to examine primary bone tumors in dogs in detail.

In some literature, more bone tumors were found in male dogs and cats (7,14,15), and this information in dogs is compatible with this study (n: 38, 54.29%). However, the opposite situation was detected in cats. It has been noted that more tumors occur in female cats (n:17, 60.7%) than in male cats (n:11, 39.3%).

In the study, bone tumors were mostly observed in large breed dogs such as Kangal, German Shepherd, Turkish Mastiff, Siberian husky, Collie, Belgian Malinois, Rottweiler and Golden Retriever, and these data are also compatible with the literature (7, 16, 17). It was also stated in this study that it was also seen in small dogs such as terriers (n=7) and cocker (n=1). Nowadays, it has been observed that it is frequently noted in small breed dogs such as terriers, since they are easily fed at home in our country. A similar situation also applies to cats. Since tabby breed cats are bred a lot both on the street and at home in our country, they could have a very high risk of tumors (75%).

Although the age range of tumor formation in dogs is mostly stated in the literature as between 6-10 years of age (7, 16, 17), unfortunately, our study found that the highest rate is between the ages of 10-11 (Late Senior) group (27.14%, n=19). Secondly, the highest rate is observed in the 7-9 years (Early Senior) range (25.71%, n=18), while the 2-6 years (Mature Adult) range (22.86%, n=16) and 12 years and older (Geriatric) (20%, n=14) groups were also animal numbers at very similar and high rates. Interestingly, bone tumors were detected in only 3 animals between 0-12 months of age. In a study on osteomas in cats, the median age was 9 years (15). In this study, the highest rate in cats aged 10 and above (Senior) was most noted (42.9%, n = 12). It was seen in the age range of 1-6 years (Young Adult) (25%, n=7) and in the age range of 7-10 years (Mature Adult) (21.4%, n=6), respectively. Only one cat was between 0-1 years old. In this study, the highest rates were observed in dogs and cats aged 10 years and above. However, it was also noted that the age of tumor formation (to young adult) decreased in both cats and dogs.

Trost et al. (7) examined 90 primary bone tumors in dogs in a study over a 22-year period and 89 of them were malignant and only one was benign. 78 of 89 tumors were diagnosed as osteosarcoma (86.7%). When the anatomical location was examined, it was determined that the tumors were appendicular - 79.5% (n:62/78), axial - 19.2% (n:15/78) and appendicular/axial - 1.3% (n:1). While osteosarcomas were observed at forelimb (n:48), humerus (n:20), radius/ulna (n:13) from the appendicular skeleton respectively, osteosarcomas were noted head (n:7) and vertebral bones (n:4) from the axial skeleton. In present study, for dogs the appendicular skeleton was about two times more affected than the axial skeleton in this study. But no difference was observed between the two skeletal parts in cats. While axial tumor localizations in dogs and cats were most commonly detected in the sinus, (38.1%, n=8), appendicular tumor location in cats was mostly at hindlimb (35.7%, n=5), appendicular tumor location in dogs was mostly at humerus (17.39%, n=8).

In a study conducted on cats in Japan, tumors were detected in 1070 cats over a 23-year period. Only 26 of these tumors were bones and joints tumors and 8 of them were benign and were distributed as osteoma (n: 3), osteochondroma (n: 3), chondroma (n: 1). Additionally, among the 18 malignant tumors of the bones and joints, the majority were osteosarcoma (n:14) (4). Fiani et al. (15) examined the oral and maxillofacial regions tumors in cats in a study for 10 years and noted 7 cases of osteoma. In the present study, 4 benign (14.29%) and 24 malignant (85.71%) tumors were observed in cats. the most common malignant tumors of the bone were osteosarcoma (n=6, 25%) and giant cell-rich osteosarcoma (n=4, 16.67%). Osteosarcoma was the most common tumor like in dogs.

Although the preliminary diagnosis of primary bone tumors in dogs and cats seems to be related to the anatomical location and radiological appearance of the lesion, definitive diagnosis always needs histological examination of these tumor samples (18,19). However, if possible, immunohistochemistry should be performed in some cases to clarify the diagnosis (detect connective tissue or muscle tissue etc.). It is especially advantageous in helping to make a complete and accurate diagnosis (20).

This study was prepared to evaluate the distribution of bone tumors in dogs and cats in terms of breed, age, gender and location, to lay the foundation for future studies and to shed light on clinicians. It would also contribute and conduce the comparative oncology for dogs and cats.

Conflict of Interest

The authors stated that they did not have anyreal, potential or perceived conflict of interest.

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Authors' Contributions

Motivation / Concept: Arda Selin TUNÇ, Mehmet SAĞLAM
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Control/Supervision: Osman KUTSAL
Data Collection and / or Processing: Arda Selin TUNÇ, Kürşat FİLİKCİ
Analysis and / or Interpretation: Arda Selin TUNÇ, Kürşat FİLİKCİ
Literature Review: Arda Selin TUNÇ
Writing the Article: Arda Selin TUNÇ
Critical Review: Mehmet SAĞLAM, Osman KUTSAL

Ethical Approval

An ethical statement was received from the authors that the data, information and documents presented in this article were obtained within the framework of academic and ethical rules and that all information, documents, evaluations and results were presented in accordance with scientific ethics and moral rules.

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