Original research paper

Title: Tooth Resorption in Spanish Domestic Cats: Preliminary Data.

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Abstract

The objective of this study was to collect preliminary data about tooth resorption (TR) from cats treated at the Odontology Service (September 2016- June 2018), part of a University Veterinary Hospital in Spain, with specific emphasis on TR distribution per tooth. Diagnosis was based on visual /tactile inspection and intraoral dental radiographs. This cross-sectional study was carried out on 59 adult cats (27 females, 32 males). TR occurred in 39/59 cats (66.1%; 95% CI: 54.0% to 78.2%). The median number of lesioned teeth per TR-affected animal was 3. A highly significant but weak correlation was found for age and number of TR-affected teeth per individual (Spearman´s correlation ρ = 0.381, P=0.003, power= 0.853; N=59). No TR cases were detected in incisors (0/708, 0%) but TR occurred in canines (21/236, 8.9%; 95% CI: 5.4% to 12.4%), premolars (78/590, 13.2%; 95% CI: 10.5% to 15.9%) and molars (33/236, 14%; 95% CI: 9.7% to 18.3%). A significant age influence on TR was found. The greatest TR occurrence corresponded to 307 (21/59; 35.6%; 95% CI: 23.4% to 47.8%) followed by 409 (17/59; 28.8%; 95% CI: 17.2% to 40.3%), 407 (16/59; 27.1%; 95% CI: 15.7% to 38.4%) and 309 (16/59; 27.1%; 95% CI: 15.7% to 38.4%). These teeth would be considered as TR-sentinels in the studied population. These findings would be relevant for veterinarians working in dental clinics, where the TR prevalence may be high especially in older cats.

Keywords: Tooth resorption; Spanish domestic cats; Dentistry; Feline.

Abbreviations:

AVDEG: American Veterinary Dental College

C: canine

CI: confidence interval

FCGS: feline chronic gingivostomatitis

FCV: feline calicivirus

FeLV: feline leukemia virus

FHV: feline herpes virus

FPV: feline panleukopenia virus

I: incisor

M: Molar

N: sample size

P: probability level

PD: periodontal disease

PG: plaque grade

PM: premolar

ρ: Spearman´s rank correlation coefficient

TR: tooth resorption

Introduction

In cats, the three most common oral diseases are periodontal disease (PD), tooth resorption (TR) and feline chronic gingivostomatitis (FCGS). As described by Wiggs and Lobprise [1], PD is commonly found in cats: 70% of 2-year–old cats show some PD form. O´Neill et al. [2] found that PD was the most prevalent disorder (13.9%) on primary-care veterinary clinical data from Scotland; only cases with recommendations for surgical or medical therapy were recorded. More recent data showed that approximately 96% of 5-year-old cats show gingival inflammation [3]. The prevalence rate for the FCGS was 0.7%–3% [4,5]. Van Wessum et al. [6] reported that TR was present in 62% of the Dutch cats and the 67% of the USA cats. Lund et al. [7] found TR lesions in 48% of cats older than 1 year submitted to anesthesia for various procedures. Lommer and Verstraete [8] identified TR lesions in 60.8% of feline dental patients in a retrospective study about the 1995- 1998 period.

Using both clinical and radiographic diagnosis, Ingham et al. [9] (2001) found a prevalence of 29% for TR in a clinically healthy population of cats in England (mean age 4.9 years). In a revision by Gorrel [10], the TR prevalence ranged from 28.5% to 67%.

Tooth resorption results from the destruction of the dental hard tissues (cementum, dentin and enamel) by odontoclastic action; radiolucent defects of affected teeth are the main criteria for TR diagnosis [11]. Pain due to TR is controversial. When dentine tubules become exposed and dental pulp is affected, TR causes pain; however, the effects on the pulp occur late in TR and when lesions affect only the root surfaces without communication with the oral cavity they are likely to be asymptomatic [12]. Okuda and Harvey [13] pointed to inflammatory cytokines as being responsible for odontoclastic activity. Alternatively, hematopoietic stem cells would be attracted to the periodontal ligament space where they can become osteoclasts responsible for dental hard tissue resorption [14].

Several causal factors that may lead to development of TR lesion have been investigated; however, no causal agent has ever been identified. Rather numerous associated lifestyle factors have been identified. The most widely documented association in the literature is increasing age [15, 9]. Other associations that have been investigated include the presence of occlusal stress which can cause cementum surface microfractures ; these microfractures could prompt inflammation in the cementum or periodontal ligament and attraction of odontoclasts, leading to TR [14, 16]. Localized gingivitis is associated with clinical evidence of TR, even if gingiva inflammation could be a result of TR rather than a cause [17]. Affected cats showed Ca or Mg deficiency in blood serum [14]. Results regarding vitamin D are contradictory; Reiter et al. [17] found higher serum concentrations of 25-hydroxy vitamin D in TR cats, but Girard et al. [16] and Zhang [18] detected lower levels. Bacteria in dental plaque could initiate non-inflammatory TR or even transform it into inflammatory TR [19]. Recently, Thomas et al. [20] found that feline calicivirus (FVC) was associated with FCGS, but not with TR.

In the authors´ knowledge there are no studies regarding prevalence of tooth resorption in cats in Spain. Due to the high prevalence of Tr identified in other countries, the aim of the present study is to show preliminary data about global TR prevalence in Spain from the cats treated at our Odontology Service, in a University Veterinary Hospital, with specific emphasis on TR distribution per tooth.

Materials and methods

The sample size was determined by the number of cases presented in our Odontology Service during the study period (September 2016 - June 2018). This cross-sectional study included a total of 59 adult cats of both sexes (27 females, 32 males) that showed appetite suppression, food refusal, food falling from the mouth or oral pain as primary clinical signs and were treated at our Odontology Service as primary care patients. Individuals with tumours and jaw fractures were excluded from the study; also, individuals with dental fractures were excluded when these fractures were undoubtedly of traumatic origin.

The authors certify that all relevant legal and ethical requirements regarding the humane treatment of animals have been observed. This study also complied with Spanish legislation for animal protection in non-experimental veterinary procedures (RD 53/2013) and with the UK Veterinary Surgeons Act. All cat owners gave voluntary informed consent for the inclusion of their animals in the study.

The diagnostic protocol was performed on anesthetized cats. Oral health was evaluated by a combination of visual and tactile inspection, thorough oral examination with a sharp dental explorer and a series of intraoral dental radiographs. For the correct detection of plaque grade (PG), a plaque-revealing solution (IC Plaque Indicators PK 2b4025, Patterson

Veterinary , St. Paul, MN,USA) was used. The Silness-Löe plaque and gingival classic indexes were applied to the evaluation of PG and gingival inflammation. In accordance with American Veterinary Dental College (AVDC) recommendations, periodontal probing was performed to detect periodontal pockets (gingival sulcus >1mm), furcation exposure, dental mobility and gingivitis degrees. Diagnosis of FCGS was made based on visual evaluation of gingiva and mucosa (FCGS was identified as alveolar mucositis and/or presence of caudal mucositis in the region of the palatoglossal arches), probing and full-mouth dental radiographs [21], but no biopsy was carried out for confirmed diagnosis. The severe chronic inflammation and ulceration of the caudal and buccal oral mucosa are the visual signs required for diagnosis of FCGS vs PD. TR diagnoses were also made according to the AVDC recommendations by oral examination and dental radiographs. Diagnosis was based on TR presence/absence; TR types or stages were not assessed. To assess TR presence/absence on an individual basis, every cat received a full-mouth radiographic examination using a high-frequency X-ray tube (Toshiba, DG-073-B, 70kv, 8 mA) and an imaging plate scanner (Planmeca ProScanner). For missing teeth, the radiological study allowed differentiation of those lost due to TR or other causes: when only the dental crown was missing, loss due to TR was assumed (TR grade 3-5). Data were recorded on individual dental charts. All the evaluations were performed by the same veterinary dentist in charge of our Odontology Service who has more than 30 years' experience (AW). Every cat was weighed and owners provided information about age, vaccination status and the presence of spontaneous bleeding (reddish saliva) and excessive drooling.

Statistical analysis was carried out using the SPSS software v.22 (IBM). Median was calculated for weight, age and number of TR-affected teeth per individual due to non-normal distributions. The degree of association between age and number of TR-affected teeth per individual was evaluated using Spearman's rank correlation coefficient (ρ).

Results

The median of the weight was 4.35 kg (minimum: 1.95 kg; maximum: 8.30kg). The ages of the studied individuals ranged from 1 to 16 years and the median was 8.00 years. Three age groups were created: 1-4 years (16/59; 27.1%); 5-9 years (21/59; 35.6%) and 10-16 years (22/59, 37.3%). All cats received commercial feed and were kept indoors; home oral hygiene or professional dental cleaning had not been performed previously. With respect to their vaccination status, 43/59 cats (72.9%) were not vaccinated at all; one individual (1/59; 1.7%) only received trivalent vaccine [against feline panleukopenia virus (FPV), feline herpesvirus (FHV), and feline calicivirus (FCV)] and 15/59 individuals (25.4%) received both trivalent and FeLV (feline leukemia virus) vaccines. Cats are usually vaccinated as kittens and re-vaccinations are rare. These individuals were mainly Domestic Short Hair cats (39/59; 66.1%) but Persian (7/59; 11.8%) , Siamese (6/59; 10.2%), Norwegian Forest (2/59; 3.4%), British Shorthair (2/59; 3.4%), Maine Coon (1/59; 1.7%), Ragdoll (1/59, 1.7%) and Sphynx cats (1/59; 1.7%) were also represented.

TR was detected in 39/59 individuals (66.1%; 95% CI: 54.0% to 78.2%); 42/59 cats showed PD (71.2%; 95% CI: 59.6% to 82.8%) and FCGS was found in 24/59 animals (40.7%; 95% CI: 28.2% to 53.2%). Signs of TR, PD and FCGS were present in 11.9% (7/59; 95% CI: 3.7% to 20.1%) of individuals. TR and PD were present in 19/59 cats (32.2%; 95% CI: 20.3% to 44.1%); 6/59 cats (10.2%; 95% CI: 2.6% to 17.8%) showed TR and FCGS and PD and FCGS occurred in 10/59 cats (16.9%; 95% CI: 7.3% to 26.5%). Also, seven cats showed only TR (7/59; 11.9%; 95% CI: 3.7% to 20.1%), six individuals had only PD (6/59; 10.2%; 95% CI: 2.6% to 17.8%) and one individual suffered only from FCGS (1/59; 1.7%; 95% CI: 0% to 5.0%). No signs of TR, PD or FCGS were found in three cats (3/59; 5.1%; 95% CI: 0% to 11.0%).

Table 1 shows the individual characteristics of the cats in this study in relation to TR diagnoses. Table 2 shows TR distribution per tooth, according to the permanent feline dental formula: 2(incisor [I] 3/3, canine [C] 1/1, premolar [PM] 3/2, and molar [M] 1/1). TR was detected in 132/1770 teeth (7.5%, 95% CI: 6.3% to 8.7%). No TR cases were detected in incisors. The greatest TR occurrence corresponded to 307 (21/59; 35.6%; 95% CI: 23.4% to 47.8%) followed by 409 (17/59; 28.8%; 95% CI: 17.2% to 40.3%), 407 (16/59; 27.1%; 95% CI: 15.7% to 38.4%) and 309 (16/59; 27.1%; 95% CI: 15.7% to 38.4%). Table 3 shows the distribution of TR-affected teeth number. The median number of lesioned teeth per TR-affected animal was 3 (minimum: 1 affected tooth; maximum: 9 affected teeth). A highly significant but weak correlation was found for age and number of TR-affected teeth per individual (ρ=0.381, P=0.003, power= 0.853; N=59).

Discussion

As mentioned in Material and Methods, the type/stage of TR lesions was not determined; therefore, this is the major limitation of the present study. Even though TR diagnosis was carried out by oral examination and dental radiographs, we did not determine the type/stage of TR lesions because the main aim of this preliminary work was to obtain data about global TR incidence in Spanish cats. To the best of our knowledge, this is the first report on the prevalence of TR in Spanish domestic cats.

Previous studies showed a higher TR prevalence in cats seen at dental clinics (48%-67%) [6, 7] than in healthy cats (29.0%) [9]. As reviewed by Gorrel [10], the TR prevalence increased with age and when using radiological diagnosis. Therefore, the high TR prevalence (66.1% ; 95% CI: 54.0% to 78.2%) reported in the present study could be explained by the high median age of the studied animals studied and the suspicion of dental problems that led them to our Odontology Service where radiography was applied for TR diagnosis.

Ingham et al. [9] identified TR lesions in every tooth type except incisors with the most commonly affected teeth being 307 and 407. The condition was also frequently identified in the maxillary: third and fourth premolars (107, 207, 108 and 208). In the present study, TR lesions were absent in incisors, 106 (upper premolar), 109 (upper molar) and 209 (upper molar). On the other hand, the highest frequency of TR corresponded to 307, but 409, 407 and 309 also showed high TR frequencies; therefore, TR would develop symmetrically and not randomly. Similar results for 307, 407, 309 and 409 were observed by Mestrinho et al. [22].

The results of the present study did not confirm a relationship between TR and inflammatory processes such PD or FCGS. No correlation for periodontitis and TR was found by Gengler et al. [23]; Harley et al. [24] only found poor correlation for plaque/calculus accumulation, gingival inflammation and later development of TR. However, Arzi et al. [25] found an increased number of mast cells in the gingiva adjacent to affected teeth in cats affected with TR, FCGS or PD; also, a mild inflammatory reaction concurred in gingiva of TR cats. Therefore, mast cells may potentially participate in the TR pathogenesis. Mestrinho et al. [22] reported that gingivitis was significantly related to an increased TR risk.

Bleeding gums by probing has been described in TR stage 3 [26], but the occurrence of spontaneous bleeding gums was based only on owner information (presence of reddish saliva), not by probing. In the present study, all the animals with spontaneous bleeding (8/59; 13.5%; 95% CI: 4.9% to 22.1%) also showed PD and FCGS, while only 3/8 (37.5%; 95% CI: 4.0% to 71.0%) presented both spontaneous bleeding and TR. In our study, as expected, it was found that all cats with clinical evidence of FCGS had bleeding on probing.. Farcas et al. [27] suggested that FCGS was associated with a higher prevalence of type 1 root resorption and retained roots than other oral diseases. Spontaneous bleeding seems to be more associated with PD and FCGS than with TR. Unfortunately, as mentioned earlier, we did not determine TR type/stage and, therefore, the comparability of our results is limited.

Strong associations between age and TR were found in previous studies [9]. TR was detected in 60% of cats older than 6 years and TR increases with age [28, 29]. As mentioned earlier, this association could explain the high TR prevalence detected in the present work.

Girard et al. [16] demonstrated strong breed influence, purebred cats being affected by TR more often than mixed-breed cats. Mestrinho et al. [29] found a higher prevalence of TR (70%) in brachycephalic cats (Persian and Exotic cats). In the present study, most of the animals were domestic short hair cats, considered as crossbred animals. When only two groups of breeds were considered (domestic short hair cats and purebred cats) similar results were observed: TR was present in 24/39 (61.5%; 95% CI: 46.2% to 76.8%) domestic short hair cats and 15/20 (75.0%; 95% CI: 56.0% to 94.0%) purebred cats.

Conclusion

A significant age influence on TR was found. The greatest TR occurrence corresponded to 307 (21/59; 35.6%; 95% CI: 23.4% to 47.8%) followed by 409 (17/59; 28.8%; 95% CI: 17.2% to 40.3%), 407 (16/59; 27.1%; 95% CI: 15.7% to 38.4%) and 309 (16/59; 27.1%; 95% CI: 15.7% to 38.4%). These teeth would be considered as TR-sentinels in the studied population. Since TR prevalence varies widely according to the feline population considered, the reported findings would be relevant for veterinarians working in dental clinics, where the TR prevalence may be high especially in older cats.

Conflict of Interest

The authors declare neither conflict of interest nor funding.

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Authors' contribution:

-AW, SL, JW, LVM and MTT conceived and designed the study.

- AW performed dental evaluation.

- AW and SL collected the data.

- MTT analyzed the data.

All authors interpreted the data, draft the manuscript, critically revised the manuscript for important intellectual contents and approved the final version. All authors are in agreement with the content of the manuscript.

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Supporting information

The following supporting information is available for this article: Table S1: Individual data (excel file).

Table 1

Individual characteristics of the cats in this study. Data are reported as counts /N (%) except for weight and age, which are reported as median. 95% confidence intervals are reported in brackets.

Variable	TR unaffected cats 20/59 (33.9%; 54.0% to 78.2%)	TR affected cats 39/59 (66.1%54.0% to 78.2%)
Weight (kg)	5.05	4.15
Age (year)	4.50	9.00
Age group		
1 - 4 years	10/20 (50%)	6/39 (15.4%)
5 - 9 years	7/20 (35%)	14/39 (35.9%)
10 - 16 years	3/20 (15%)	19/39 (48.7%)
Breed		
Domestic short hair	15/20 (75%)	24/39 (61.5%)
Persian	2/20 (10%)	5/39 (12.8%)
Siamese	3/20 (15%)	3/39 (7.7%)
Norwegian Forest	0/20 (0%)	2/39 (5.1%)
British Shorthair	0/20 (0%)	2/39 (5.1%)
Maine Coon	0/20 (0%)	1/39(2.6%)
Ragdoll	0/20 (0%)	1/39(2.6%)
Sphynx	0/20 (0%)	1/39(2.6%)
Males	11/20 (55%)	21/39 (53.8%)
Excessive drooling	4/20 (20%)	5/39 (12.8%)
Spontaneous bleeding	5/20 (25%)	3/39 (7.7%)
PD	16/20 (80%; 62.6% to 97.4%)	26/39 (66.7%; 52.0% to 81.4%)
FCGS	11/20 (55%; 33.4% to 76.6%)	13/39 (33.3%; 18.6% to 48.0%)
Total vaccines		
None	16/20 (80%)	27/39 (69.2%)
Trivalent (FPV, FHV, FCV)	1/ 20 (5%)	0/39 (0%)
Trivalent+ FeLV	3/ 20 (15%)	12/39 (30.8%)

Table 2

TR distribution per tooth. Data are reported as counts /N (%).

Tooth	TR unaffected	TR affected present	TR affected missing	Missing
Incisors	622/708 (87.9%)	0/708 (0%)	0/708 (0%)	86/708 (12.1%)
Canines	210/236 (89.0%)	21/236 (8.9%)	0/236 (0%)	5/236 (2.1%)
104	55/59 (93.2%)	3/59 (5.1%)	0/59 (0%)	1/59 (1.7%)
204	53/59 (89.8%)	5/59 (8.5%)	0/59 (0%)	1/59 (1.7%)
304	51/59 (86.4%)	7/59 (11.9%)	0/59 (0%)	1/59 (1.7%)
404	51/59 (86.4%)	6/59 (10.2%)	0/59 (0%)	2/59 (3.4%)
Premolars	442/590 (74.9%)	63/590 (10.7%)	15/590 (2.5%)	70/590 (11.9%)
106	44/59 (74.6%)	0/59 (0%)	0/59 (0%)	15/59 (25.4%)
107	45/59 (76.3%)	7/59 (11.9%)	1/59 (1.7%)	6/59 (10.2%)
108	45/59 (76.3%)	9/59 (15.3%)	0/59 (0%)	5/59 (8.5%)
206	42/59 (71.2%)	1/59 (1.7%)	0/59 (0%)	16/59 (27.1%)
207	46/59 (78.0%)	7/59 (11.9%)	0/59 (0%)	6/59 (10.2%)
208	52/59 (88.1%)	6/59 (10.2%)	0/59 (0%)	1/59 (1.7%)
307	32/59 (54.2%)	14/59 (23.7%)	7/59 (11.9%)	6/59 (10.2%)
308	49/59 (83.1%)	5/59 (8.5%)	1/59 (1.7%)	4/59 (6.8%)
407	34/59 (57.6%)	11/59 (18.6%)	5/59 (8.5%)	9/59 (15.3%)
408	53/59 (89.8%)	3/59 (5.1%)	1/59 (1.7%)	2/59 (3.4%)
Molars	174/236 (73.7%)	27/236 (11.4%)	6/236 (2.5%)	29/236 (12.3%)
109	51/59 (86.4%)	0/59 (0%)	0/59 (0%)	8/59 (13.6%)
209	48/59 (81.4%)	0/59 (0%)	0/59 (0%)	11/59 (18.6%)
309	39/59 (66.1%)	13/59 (22.0%)	3/59 (5.1%)	4/59 (6.8%)
409	36/59 (61.0%)	14/59 (23.7%)	3/59 (5.1%)	6/59 (10.2%)
Total	1448/1770 (81.8%)	111/1770 (6.3%)	21/1770 (1.2%)	190/1770 (10.7%)

Table 3

Distribution of TR-affected teeth number.

TR affected teeth number	Counts /N (%)
1	9/39 (23.1%)
2	6/39 (15.4%)
3	6/39 (15.4%)
4	9/39 (23.1%)
5	1/39 (2.6%)
6	6/39 (15.4%)
7	1/39 (2.6%)
9	1/39 (2.6%)