Clinical signs and histologic findings in dogs with odontogenic cysts: 41 cases (1995–2010)

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Objective—To characterize clinical signs and histologic findings in dogs with odontogenic cysts and determine whether histologic findings were associated with clinical features.

Design—Retrospective case series.

Animals—41 dogs.

Procedures—Medical records were reviewed to obtain clinical data, including breed, age, sex, and lesion location. Microscopic sections and results of diagnostic imaging were reviewed.

Results—Odontogenic cysts were identified in 41 dogs between 1995 and 2010. There were 29 dogs with dentigerous cysts, 1 with a radicular cyst, 1 with a lateral periodontal cyst, and 1 with a gingival inclusion cyst. In addition, 9 dogs with odontogenic cysts that had clinical and histologic features suggestive of, but not diagnostic for, odontogenic keratoctys seen in people were identified. In all 9 dogs, these cysts were located in the maxilla and surrounded the roots of normally erupted teeth. Of the 29 dogs with dentigerous cysts, 23 had a single cyst, 5 had 2 cysts, and 1 had 3 cysts. Six cysts were associated with an unerupted canine tooth, and 30 were associated with an unerupted first premolar tooth (1 cyst was associated both with an unerupted canine tooth and with an unerupted first premolar tooth). Dentigerous cysts were identified in a variety of breeds, but several brachycephalic breeds were overrepresented, compared with the hospital population during the study period.

Conclusions and Clinical Relevance—Results suggested that a variety of odontogenic cysts can occur in dogs. In addition, cysts that resembled odontogenic keratocysts reported in people were identified. We propose the term canine odontogenic parakeratinized cyst for this condition. (J Am Vet Med Assoc 2011;239:1470–1476)

Cysts are pathological, epithelial-lined cavities containing fluid or semifluid material. Odontogenic cysts are derived from odontogenic epithelium and can be developmental or the result of an inflammatory process. A number of subtypes have been recognized in humans, including radicular (periapical) cysts, dentigerous (follicular) cysts, and lateral periodontal cysts. Odontogenic keratocysts are developmental cysts with an unusual propensity for recurrence; because of this propensity, the World Health Organization recently proposed that the name of these lesions be changed to keratocystic odontogenic tumor to more accurately reflect their neoplastic nature.

Odontogenic keratocysts, dentigerous cysts, and radicular cysts have been reported in dogs but are apparently uncommon. In a comprehensive review of the veterinary literature, we identified only a single case series and several case reports describing these lesions in dogs. In the case series, 5 odontogenic cysts were identified among 3,395 biopsy specimens from oral masses in dogs. However, these odontogenic cysts did not fit into the human classification of odontogenic cysts because they were lined by what was described as ameloblastic epithelium and were not associated with teeth. In addition to this case series, 6 case reports describing dentigerous cysts in 7 dogs have been published. These cysts were associated with unerupted maxillary canine teeth, a mandibular first premolar tooth, both mandibular canine teeth, a single mandibular canine tooth, and a supernumerary maxillary premolar tooth. A single dog with a radicular cyst has been reported; the cyst was associated with nonvital maxillary second and third incisor teeth. An additional case report described a dog with a cyst in the rostral aspect of the maxilla and reported that the cyst was a radicular cyst; however, no evidence was given that the cyst was associated with a nonvital tooth, which is an important criterion for identifying radicular cysts. Three reports describing dogs purported to have OKCs have been published. One described a cyst extending from the mandibular first premolar tooth to the symphysis in...
a 10-year-old dog, and 2 described cysts involving the maxilla in a 4-year-old dog and a 9-year-old dog. In 2 case reports, cystic changes were described for dogs with ameloblastic fibro-odontomas. However, because cystic changes are common with many odontogenic tumors, these lesions should not be classified as odontogenic cysts but as odontogenic tumors.

Much confusion has arisen regarding the nomenclature of odontogenic cysts in animals. Although proper identification and understanding of odontogenic cysts are important in veterinary medicine, few studies exist because of the rarity of these cysts. Despite past attempts to classify cysts on the basis of clinical features, some odontogenic cysts are difficult to classify, particularly when trying to use human odontogenic cyst nomenclature. Some previous studies have identified dogs of various ages and breeds and either sex with odontogenic cysts. To our knowledge, however, a large, comprehensive analysis of clinical and histologic findings in dogs with odontogenic cysts has not been published. The purpose of the study reported here, therefore, was to characterize clinical signs and histologic findings in dogs with odontogenic cysts and determine whether histologic findings were associated with clinical features.

Materials and Methods

Criteria for selection of cases—The medical records database of the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California-Davis was searched to identify dogs examined between January 1, 1995, and April 1, 2010 (15 years inclusive) in which 1 or more odontogenic cysts had been diagnosed. The following keywords were used for the search: odontogenic, dentigerous, radicular, keratocyst, and cyst. Dogs were included in the study if the preoperative diagnosis had been made on the basis of results of diagnostic imaging and had been confirmed postoperatively on the basis of results of histologic examination of biopsy specimens, with the exception of small, typical dentigerous cysts. In addition, dogs were included only if full-mouth radiographs obtained at the time of diagnosis were available for review, along with a complete medical record, including a record of the lesion location within the oral cavity; information on the patient’s breed, sex, and age; and a description of any treatments given. Dogs were excluded from the study if the medical record was incomplete or if, on review, a cystic odontogenic tumor was found.

Medical records review—Medical records of dogs included in the study were reviewed to obtain information on breed, sex, age, lesion location, and treatment. Full-mouth radiographs and, when available, computed tomographic images were reviewed to identify the location and span of the lesion. Microscopic sections that had been prepared from tissue samples fixed in neutral-buffered 10% formalin, embedded in paraffin, and stained with H&E were reviewed, and cysts were classified according to criteria used for classification of odontogenic cysts in people. Follow-up examinations and telephone calls were performed to document recurrence.

Histologic examination—Histologic criteria used to classify odontogenic cysts in human patients as dentigerous (follicular) cysts, OKCs, radicular (periapical) cysts, and lateral periodontal cysts were used. A dentigerous (follicular) cyst was identified as a cyst that enclosed the crown of an unerupted tooth, was attached to the cemento-enamel junction, and had a wall consisting of a thin layer of connective tissue and a nonkeratinized stratified squamous epithelial lining 2 to 6 cells layers thick. An OKC was identified as a unilocular or multilocular cyst that typically was not associated with the teeth and had a cyst wall that was 8 to 10 cell layers thick with hyperchromasia and palisading of the basal cells, luminal epithelial cells that were typically parakeratinized, and an irregularly folded cyst lumen possibly filled with keratin. A radicular (periapical) cyst was identified, in accordance with criteria defined by the World Health Organization, as a cyst at the apex of a nonvital tooth that was inflammatory in origin and derived from the cell rests of Malassez of the periodontal ligament and that was lined by stratified squamous, nonkeratinized epithelium with a cyst wall that contained a mixed inflammatory cell infiltrate. Finally, a lateral periodontal cyst was identified as a cyst arising from odontogenic epithelial rests of the dental lamina with a thin lining (1 to 5 cell layers thick) of nonkeratinizing squamous or cuboidal epithelial cells with small, pyknotic nuclei and focal thickened areas of epithelium containing clear cells (plaques) and typically located between the roots of vital teeth.

Data analysis—χ² Tests of homogeneity were used to compare age, sex, and breed distributions between dogs with odontogenic cysts and distributions for the total hospital population of dogs examined during the 15-year period. For dentigerous cysts, the following breeds were examined: Tibetan Spaniel, Maltese, Pug, Belgian Malinois, Newfoundland, mixed, Shih Tzu, Chihuahua, Schnauzer, Boxer, Labrador Retriever, Papillon, Boston Terrier, Japanese Chin, American Pit Bull Terrier, American Staffordshire Terrier, and Lhasa Apso. Remaining breeds were combined for purposes of comparing these breeds with the hospital distribution. Ages were divided into the following categories: < 1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and ≥ 11 years. For sex, dogs were categorized as sexually intact males, castrated males, sexually intact females, and spayed females. For COPCs, the following breeds were examined: Chihuahua, English Springer Spaniel, Siberian Husky, Boxer, Miniature Schnauzer, mixed, Pug, and Lhasa Apso. Remaining breeds were combined for purposes of comparing these breeds with the hospital distribution. Age and sex categories were the same as for dentigerous cysts. All analyses were 2 tailed and were performed with standard software. Values of $P < 0.05$ were considered significant.

Results

Between January 1, 1995, and April 1, 2010, 3,023 dogs underwent a complete oral examination, including full-mouth radiography, at the William R. Pritchard Veterinary Medical Teaching Hospital. In 41 (1.4%) of these dogs, 1 or more odontogenic cysts were identified on the basis of clinical, radiographic, and microscopic findings.
Dentigerous cysts—Dentigerous cysts were identified in 29 of the 41 (71%) dogs with odontogenic cysts. Fifteen of these dogs were examined because of the cyst; in the remaining 14 dogs, the cyst was an incidental finding. Radiographic findings included a well-defined, unilocular, radiolucent area originating from the cemento-enamel junction and enclosing the crown of an unerupted tooth (Figure 1). Histologically, the cyst wall consisted of a thin layer of stratified squamous epithelium with a few inflammatory cells (Figure 2). Of the 29 dogs with dentigerous cysts, 23 had a single cyst, 5 had 2 cysts, and 1 had 3 cysts. Thus, 36 cysts were identified. Six cysts were associated with an unerupted canine tooth (left maxillary canine tooth, 3; left mandibular canine tooth, 2; and right mandibular canine tooth, 1), and 30 were associated with an unerupted first premolar tooth (right mandibular first premolar tooth, 14; left mandibular first premolar tooth, 12; left maxillary first premolar tooth, 2; and right maxillary first premolar tooth, 2) (1 cyst was associated both with an unerupted canine tooth and with an unerupted first premolar tooth). The involved first premolar teeth were frequently found to lie in an abnormal horizontal position, and all 3 involved maxillary canine teeth were malformed. Four dogs had a supernumerary mandibular first premolar tooth associated with the dentigerous cyst. Size of the cysts varied from small, just encompassing the crown of the unerupted first premolar tooth, to large, causing displacement and resorption of adjacent teeth, particularly the adjacent second premolar tooth. The larger cysts appeared expansile and were associated with severe cortical thinning. Treatment consisted of surgical extraction of the unerupted tooth, enucleation of the cyst wall, curettage, osteoplasty, and primary closure. In 4 dogs with large lesions, an autogenous cancellous bone graft was implanted at the site. Mean follow-up time was 29 months (range, 4 to 84 months). One of the 29 dogs had 2 recurrences of a dentigerous cyst associated with a mandibular first premolar tooth 3 and 6 months after the initial diagnosis and treatment.

Age of the dogs at which cysts were first diagnosed ranged from 6 months to 10 years. Age distribution of the 29 dogs with dentigerous cysts was significantly different from age distribution for the total hospital population of dogs examined during the study period, with dogs 2 to < 3 years old overrepresented in the cyst group, compared with the hospital population, and dogs ≥ 11 years old underrepresented. Of the 29 dogs with dentigerous cysts, 16 were female and 13 were male. Sex distribution for dogs in the cyst group did not differ significantly from sex distribution for the total hospital population. Of the 16 female dogs, 15 were spayed, and of the 13 male dogs, 2 were castrated. Neuter status (neutered vs sexually intact) for dogs in the...
cyst group did not differ significantly from neuter status for dogs in the total hospital population.

The 29 dogs with dentigerous cysts consisted of 6 Boxers, 5 Pugs, 2 Shih Tzus, and 16 other dogs representing 16 other breeds. When breed distribution for dogs with dentigerous cysts was compared with breed distribution for the total hospital population, Tibetan Spaniels, Pugs, Belgian Malinois, Shih Tzus, Schnauzers, Boxers, Papillons, Japanese Chins, and Staffordshire Bull Terriers were significantly ($P < 0.001$) over-represented in the cyst group.

**Canine odontogenic parakeratinized cyst**—Nine of the 41 (22%) dogs with odontogenic cysts had a cyst with some, but not all, of the clinical and histologic features required to make a diagnosis of OKC in humans (Figures 3 and 4). Histologic features consistent with a diagnosis of OKC were a cyst wall consisting of nonkeratinizing stratified squamous epithelium of uniform thickness but with a parakeratotic surface and a flat epithelial-connective tissue interface. These cysts, however, typically lacked the hyperchromatic, palisading basal cell layer and keratinaceous debris in the cyst lumen characteristic of OKCs in humans. Thus, these cysts were classified as COPCs.

In all 9 dogs, cysts were identified in the maxilla and surrounded the roots of fully erupted, normally
developed teeth (Figure 5). None of the associated teeth were nonvital. Diagnostic imaging revealed extensive interradicular expansion, cortical thinning, and, in most cases, displacement of adjacent teeth. The size and span of the lesions varied greatly. Computed tomography was performed in 6 of the 9 dogs and proved superior to radiography in determining the extent of the lesion.

Six dogs were examined because of the COPC; in the remaining 3, it was an incidental finding. Age of the dogs at which cysts were first diagnosed ranged from 8 months to 11 years. There was no significant ($P = 0.45$) difference in age distribution between dogs with COPCs and age distribution for the total hospital population of dogs. Five of the dogs were female (all spayed), and 4 were male (all castrated). Sex distribution of dogs with COPCs did not differ significantly ($P = 0.42$) from sex distribution for the total hospital population. Five of the dogs were female (all spayed), and 4 were male (all castrated). Sex distribution of dogs with COPCs did not differ significantly from neuter status for dogs in the total hospital population. The 9 dogs with COPCs consisted of 2 Miniature Schnauzers, 2 English Springer Spaniels, 1 Chihuahua, 1 Siberian Husky, 1 Boxer, 1 Pug, and 1 Lhasa Apso. When breed distribution for dogs with COPCs was compared with breed distribution for the total hospital population, all affected breeds were significantly ($P < 0.001$) overrepresented in the group with COPC.

Treatment for dogs with COPCs was identical to that described for dogs with dentigerous cysts, except that mobile teeth embedded in the cyst wall were removed as part of the enucleation procedure. Mean follow-up time was 36 months (range, 1 to 84 months). None of the dogs reportedly had a recurrence.

Other odontogenic cysts—The remaining 3 dogs had 3 distinct types of odontogenic cysts. One dog was examined because of signs of oral pain, and a traumatic gingival inclusion cyst located at the site of a previously extracted right maxillary fourth premolar tooth was diagnosed. Histologic examination revealed a cyst lined by keratinized epithelium similar to gingival epithelium. The cyst was treated by means of enucleation, curettage, and osteoplasty.

The second dog was also examined because of signs of oral pain, and a radicular cyst associated with a nonvital maxillary first incisor tooth was diagnosed. The cyst was treated by means of enucleation, curettage, and osteoplasty in addition to extraction of the nonvital tooth. Finally, a lateral periodontal cyst was an incidental finding in a dog that underwent en bloc resection for treatment of squamous cell carcinoma of the mandible (Figure 6).
Discussion

Results of the present study suggested that a variety of odontogenic cysts can occur in dogs, although they are rare. In addition, we were able to identify cysts that resembled in some, but not all, aspects the OKCs that have been reported in people, and we propose the term COPC for these lesions.

In 18 of the 41 dogs in the present study, odontogenic cysts were an incidental finding. This suggests that many odontogenic cysts may go unnoticed by pet owners because they fail to generate sufficient clinical signs to prompt an oral examination. More importantly, this finding stresses the importance of frequent oral examinations and the routine use of full-mouth radiography in dogs undergoing dental treatment.21

Twenty-four of the 41 (59%) dogs in the present study were brachycephalic. Boxers (n = 7) and Pugs (6) were the most common breeds with odontogenic cysts. However, it is difficult to conclude that odontogenic cysts are most common in Pugs and Boxers, given that these are 2 of the most popular brachycephalic breeds among pet owners. The exact reasons for the apparent high frequency of odontogenic cysts in brachycephalic dogs are unknown, but crowding of teeth as a result of cephalic conformation may be an underlying factor.21

In the present study, sexually intact dogs were no more or less likely to have odontogenic cysts than were spayed or castrated dogs, suggesting that sex hormones do not have an important role in the pathogenesis of odontogenic cysts. Radicular cysts are more common in men than in women, and this may be related to differences in oral hygiene and greater susceptibility to periodontal disease.22,24 Establishing whether a similar association between radicular cysts and periodontal disease exists in male versus female dogs is problematic because oral hygiene in most dogs is not maintained the same way as with humans.24,25

Dentigerous cysts were the most common type of odontogenic cysts in the present study (29/41 [71%] dogs). We also found that, similar to the case in humans,24 the most common site of dentigerous cysts in these dogs was the mandible. In humans, dentigerous cysts are most commonly associated with the mandibular third molar teeth, the most commonly impacted teeth in the arches. It was remarkable, therefore, that dentigerous cysts found in the dogs in the present study were only associated with the canine and first premolar teeth. Other reports5,11,17,23,26–29 of dogs with dentigerous cysts also indicated that the cysts were associated with the canine and first premolar teeth, and to our knowledge, there have been no published reports of dogs with dentigerous cysts occurring elsewhere. Importantly, 30 of the 36 (83%) cysts that were identified in the present study were associated with the first premolar tooth.

Although dentigerous cysts were identified in dogs of a wide age range (6 months to 10 years) in the present study, dogs ≥ 2 to < 3 years old were overrepresented. The fact that several cysts were diagnosed in older dogs suggested that these cysts may go unnoticed for a considerable period of time.

Cysts that resembled OKCs in humans were the second most common type of odontogenic cysts in the present study. We propose the term COPC for this entity because although it resembles the human counterpart, it also lacks several of the hallmark microscopic features of OKCs. As was the case for dentigerous cysts, COPCs were identified in dogs of a wide age range, and no sex predilection was identified. Unlike dentigerous cysts, the COPCs were not associated with unerupted teeth and spanned the roots of several fully erupted teeth.

In humans, OKCs are characterized by locally infiltrative growth,4 a feature that was evident in the dogs with COPCs in the present study. However, in contrast to humans with OKCs,5,11 there were no recurrences of COPCs in the present study. Another important difference between OKCs in humans and COPCs in dogs is that in humans, OKCs occur more often in the mandible,4 but in the present study, all of the COPCs were identified in the maxilla. There has been a single report15 of a dog with a purported OKC associated with the mandible. In addition, the survey of odontogenic tumors and cysts by Poulet et al16 described a single case suggestive of OKC, but an incomplete histopathologic description was provided. The cyst wall was lined by squamous epithelial cells that had prominent keratinization. Similar histopathologic findings were described in a case report of a dog by Watanabe et al.11 However, the cyst wall consisted of keratinizing stratified squamous epithelium; thus, the diagnosis of OKC was not convincing. A case report by Nicoll et al12 described a dog with a possible OKC, but a histopathologic description of the cyst was not provided. The paucity of cases in the veterinary literature of this previously poorly characterized entity suggests that further reporting and study of COPCs are important.

Radicular cysts do not have a specific histologic appearance and have no remarkable features, compared with other odontogenic cysts.22 However, the association with a nonvital tooth clearly differentiates a radicular cyst from a dentigerous cyst.20,21 Given the fact that radicular cysts are the most common type of odontogenic cyst in humans,2 it is noteworthy that only
I was identified in the present study. It is not certain why radicular cysts appear to be so uncommon in dogs, compared with humans. It is possible that some small radicular cysts in dogs may be misdiagnosed as periapical lesions because during root canal therapy, they are not consistently submitted for histologic examination. A clinically unremarkable gingival inclusion cyst was identified in 1 dog in the present study. The cyst likely formed after prior removal of a right maxillary fourth premolar tooth. A single lateral periodontal cyst was diagnosed involving the right mandibular canine tooth of a dog. This was in agreement with findings in humans that the most common location of lateral periodontal cysts is the mandible. This cyst was an incidental finding, which is consistent with findings in people that lateral periodontal cysts are typically asymptomatic. Lateral periodontal cysts normally do not affect neighboring teeth and are typically diagnosed only during regular radiographic examinations.

Although the scheme used for classification of odontogenic cysts in humans may be appropriate for most odontogenic cysts in dogs, some defy classification. For example, the COPCs identified in the present study share some features of OKCs in humans but lack some of the important histologic criteria. Because treatment of these lesions in dogs may differ from treatment of other odontogenic cysts, uniformity in nomenclature likely will prove useful for diagnosis and management of odontogenic cysts in veterinary medicine.

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