An osteoma is a benign bone tumor composed of mature compact or cancellous bone that generally grows continuously and usually at a slow rate. It occasionally occurs in the oral and maxillofacial regions. Osteomas arising on the surface of bone are referred to as periosteal osteomas, those that develop centrally within bone are termed endosteal osteomas, and those that develop in the soft tissue are termed extraskeletal osteomas. The etiology is unknown, although trauma, infection, and developmental abnormalities have been suggested as contributing factors.

The diagnosis is usually made by clinical evaluation, diagnostic imaging, and histologic testing. In affected human patients, the tumor is usually not painful on palpation but may produce swelling, malocclusion, and pain secondary to compression of neurovascular structures. The etiology is unknown, although trauma, infection, and developmental abnormalities have been suggested as contributing factors.

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Osteoma occurs in all domestic animals but has been reported more frequently in horses and cattle. There are few reports of osteoma of the oral and maxillofacial regions of cats, with minimal information on treatment and outcome. Therefore, the purpose of this article was to describe the clinical features of oral and maxillofacial osteoma in a series of cats.

**Materials and Methods**

**Criteria for selection of cases**—Medical records of cats with a diagnosis of oral osteoma, maxillofacial osteoma, or both examined at the William R. Pritchard Veterinary Medical Teaching Hospital, University of California-Davis, between January 1999 and July 2009 were evaluated. Cats were included in the study if a diagnosis of osteoma was confirmed by histologic testing and a complete medical record was available.

**Procedures**—Information obtained from the medical records included signalment, body weight, history, clinical signs, diagnostic imaging results, histologic analysis, treatment, and outcome. Long-term follow-up information was obtained through examination of the medical records.

**Results**—Seven cats examined during the study period met the criteria for inclusion in the study. There were 4 do-
mestic shorthair, 2 medium-hair, and 1 longhair cat. No 
purebred cats were identified. The median age at the 
time of initial examination was 9 years (range, 1 to 23 
years). The median weight was 5.8 kg (12.8 lb; range, 
4.1 to 7.9 kg [9 to 17.4 lb]). Six cats were neutered 
males, and 1 was a spayed female.

Clinical signs—One cat was examined for difficulty 
eating and dropping food from the mouth. In addition, it 
had slight mandibular drift away from the side of the mass. 
Two cats did not appear to have clinical signs associated 
with the masses and were examined after the masses were 
noticed on routine physical examination by the referring 
veterinarian. Another cat did not appear to have clinical 
signs associated with the osteoma, but had an additional 
diagnosis of adenocarcinoma of the paranasal sinuses. 
One patient had difficulty finding food and water and was 
lethargic at the time of initial examination. Results of com-
plete neurologic and ophthalmic examinations were un-
remarkable. Another cat had difficulty breathing and had 
unilateral mucopurulent nasal discharge, and another was 
examined for mandibular swelling, fever, and epiphora 
and exophthalmos of the right eye.

Clinicopathologic findings—Complete blood count, 
serum biochemical analyses, and urinalyses were per-
formed on all patients. One cat had anemia (PCV, 26.5%; 
reference range, 30% to 50%). Two cats had leukocytosis 
(17.7 X 10^9 cells/L and 23.9 X 10^9 cells/L; reference range, 
4.5 X 10^9 cells/L to 14.8 X 10^9 cells/L) and neutrophilia 
(reference range, 14.3 X 10^9 cells/L to 16.7 X 10^9 cells/L; 
reference range, 2.0 to 9.0 X 10^9 cells/L). One of these cats 
also had thrombocytopenia (167 X 10^9 platelets/L; refer-
ence range, 180 X 10^9 platelets/L to 500 X 10^9 platelets/L). 
The remaining 4 cats did not have hematologic abnormal-
ities. In addition, high serum activities of alkaline phos-
phatase (reference range, 80 to 650 U/L; reference range, 
14 to 71 U/L) were detected in 3 cats, 1 of which also had 
hematologic abnormalities. This cat also had high serum 
alanine aminotransferase activity (549 U/L; reference range, 
27 to 101 U/L), aspartate aminotransferase activity 
(147 U/L; reference range, 17 to 98 U/L), and glutamate 
dehydrogenase activity (102 U/L; reference range, 0 to 4 
U/L). Low thyroxine concentration (0.3 µg/dL; reference range, 
1.1 to 3.9 µg/dL) was detected in another cat. The 
remaining cats did not have serum biochemical abnormal-
ities. Urinalysis results were within reference limits for all 
cats except for the cat with multiple abnormalities on he-
matologic and serum biochemical analyses, in which mild 
proteinuria (2+ on reagent strip) was noted.

Diagnostic imaging—Full-mouth dental radiographs 
had been obtained for 3 of the cats. In 1 cat, there 
was permissive bone loss in a 15-mm-diameter area 
overlying the left maxillary fourth premolar tooth with- 
out evidence of tooth displacement. In another cat, all 
teeth except the maxillary incisor teeth were deciduous 
with permanent teeth buds visible. In addition, a radi-
opaque granular material at the caudal aspect of the right 
mandible was noted. A circular, well-defined mineral 
opacity measuring 17 to 20 mm in diameter at the rostral 
aspect of the right mandible was observed in 1 patient. 
All 7 cats underwent general anesthesia, and com-
puted tomographic images of the head were obtained 
with a computed tomographic scanner with the cats po-
sitioned in ventral recumbency. Biopsy specimens were 
obtained following diagnostic imaging. The locations of 
the osteomas were variable but included the mandible, 
nasal cavity, and maxilla. The most commonly affected 
bone was the mandible (5/7 cats). The caudal portion of 
the mandible was affected in 4 cats (Figure 1) and the 
rostral portion in 1 cat (Figure 2). Two cats had osteoma 
failing the nasal cavity. One cat had a tumor involving 
multiple bones of the nasal cavity, including the incisive, 
palatine, vomer, maxillary, presphenoid, lacrimal, and 
turbinate bones with extension of the tumor into the ret-
robulbar space (Figure 3). One cat had a tumor associ-
ated with only the left maxillary bone.

Two distinct patterns of osteoma were identified— 
compact (or cortical) and cancellous. The compact os-
teoma was productive in pattern with a globular shape. 
Moreover, the compact osteoma was markedly hyperai-
tenuating, well marginated, and smooth along its outer 
borders. Cancellous osteoma was characterized by a pre-
dominately productive pattern with some destruction of 
adjacent bone. It was less hyperattenuating than compact 
osteoma and loosely resembled cancellous bone. Cancell-
ous osteoma had a more expansile appearance and was 
less well marginated, with irregular, sometimes palisading 
surrounding osseous proliferative tissue. Hounsfield unit 
values for 3 of 4 cortical-type osteomas and 1 of 3 cancell-
ous osteomas were measured for multiple regions of in-
terest on a dedicated computed tomography workstation. 
The median HU value for the compact-type osteoma was 
1,940 HUs (range, 1,870 to 2,070 HUs). The single can-
cellous osteoma had a value of 1,310 HUs.

Biopsy sample collection—Biopsies were performed 
on all cats after acquisition of the computed 
tomographic images. Six cats had incisional biopsies 
performed, and 1 cat had an excisional biopsy per-
formed. Three cats had biopsy samples collected with a 
Michele trephine, a biopsy sample was obtained from 
1 cat by use of a 6-mm osteotome and 100-g mallet,
2 cats had biopsy samples collected with both of the previous methods, and biopsy samples from 1 cat were collected with a bone curette. The decision to perform an excisional biopsy on 1 cat was based on the shape of the tumor. In this cat, the tumor was pedunculated and easily removed without extensive surgery (Figure 4).

**Histopathologic findings**—The 6 incisional biopsy specimens had a smoothly contoured outer surface consisting primarily of dense sheets of compact lamellar bone. The osseous tissue was comprised of irregular islands of mature, dense, eosinophilic, lamellar bone organized around central neurovascular groups (osteonal bone). Intervening sheets of more amphophilic to basophilic woven bone interconnected the islands of osteonal bone. In many sections, connective tissue separating the sheets and spicules of bone was sparse. Cells within osseous lacunae were indistinguishable from normal osteocytes.

Gross sectioning of the mandible from the 1 cat in which an excisional biopsy was performed demonstrated concentrically lamellar bone surrounding the mandibular bone (Figure 5). The mandibular cross-
Sectional profile was markedly thickened by concentrically arranged, proliferative, interanastomosing osseous trabeculae (Figure 6). Centrally, the mandibular canal containing the inferior alveolar artery, vein, and nerve was surrounded by a remnant mandibular cortex comprised of dense lamellar bone. Thin, anastomosing trabeculae of intermixed lamellar and woven bone radiated out perpendicularly from the entrapped and centralized cortical bone. At the lesion periphery, the trabeculae compacted into a smoothly contoured outer cortex of both lamellar and interstitial bone. A layer of dense connective tissue lined by a row of polygonal cells was present at the outermost edge of mandibular bone (periosteum). Throughout the section, the bony trabeculae were lined by 1 or more layers of plump to flattened polygonal cells (osteoblasts). Osteoclasts were rarely identified. The spicules of woven bone had a high density of osteocytes within lacunae, whereas in the adjacent lamellar bone, the osteocytes were more widely separated. Mitotic figures were not observed within the populations of osteocytes and osteoblasts. Osseous trabeculae were separated by loose connective tissue with small numbers of intermixed hematopoietic cells. At the lesion periphery, the intertrabecular connective tissue was sparse where the cortical bone was most compact and dense.

**Microbial testing**—Aerobic and anaerobic bacterial testing and fungal culture testing of specimens obtained at the time of biopsy were performed on 3 of 7 cats. In 2 cats, no growth was detected. In the other cat, *Enterobacter cloacae* was detected but considered a contaminant rather than a true infectious agent.

**Treatment and follow-up**—Three of 7 cats were euthanatized. The owners of 2 cats elected euthanasia because surgical excision of the mass may have resulted in an unacceptable quality of life and because of financial constraints. The third cat was euthanatized because of concurrent progressive nasal adenocarcinoma. One cat had a left caudal mandibulectomy, and another had a left maxillectomy. The cat that had the mandibulectomy developed a mild nontraumatic malocclusion that did not require further treatment, and both cats had no other complications. Debulking surgery was performed on 1 cat without complications, and the tumor was pedunculated in another and was excised at the level of the left mandibular canine tooth at the time of biopsy without complications.

Follow-up information on the cat that underwent the debulking surgery was available 1 year postoperatively. The owner reported that the cat was doing well, breathing better, and eating and drinking well with an acceptable quality of life. Follow-up information on each of the cats that had the mandibulectomy, maxillectomy, and excision of the pedunculated tumor was available at 9, 8, and 1 year after treatment, respectively. The owners reported that these cats were doing well, with a good quality of life and no gross signs of recurrence.

**Discussion**

Few case reports exist of osteoma affecting cats, especially those involving the maxillofacial region. Oral and maxillofacial osteomas in humans are relatively rare but well documented. There is much debate with regard to etiology and pathogenesis of the tumor. Some suggest that it is a true neoplasm, whereas others classify it as a developmental anomaly triggered by infection or trauma and exacerbated by muscle traction. As far as the authors are aware, there was no history of obvious trauma sustained by any of the cats in the present study. Of the 3 samples that were cul-
tured, 1 grew *E. cloacae*. This bacterium was thought to be a contaminant in this instance rather than a true infectious agent.

Osteomas of the maxillofacial region are clearly classified in the human literature. Most (93.5%) are reported as peripheral (periosteal, cortical, or compact) osteoma, whereas the remaining 6.5% are central (endosteal or cancellous) osteoma. Once the mass is histologically confirmed as an osteoma, the classification is made on the basis of clinical appearance. No such classification exists yet in the veterinary literature. However, in the present report, we used the computed tomographic findings to identify 2 distinctive patterns that parallel the peripheral and central variations reported in people. Unlike the case in people, in which osteomas are most often peripheral, the distribution of osteomas in the cats in the present case series was almost 1:1 (4 peripheral and 3 central).

In humans, peripheral osteomas are most often identified in the frontal bone (28.6%), followed by the mandible (22.9%) and finally the maxilla (14.3%). Central osteoma has been reported to more frequently affect the mandible (70%) versus the maxilla (30%). In the cats in the present report, 5 osteomas were located in the mandible, 1 involved the nasal cavity, and 1 affected the maxilla. Although it appears that there may be some predilection for the mandible in cats, no conclusion can be drawn because of the small size of the study. There is also 1 report of an osteoma affecting the zygomatic arch of a cat.

In humans, osteomas have been reported in patients ranging from 12 to 79 years of age. This was similar to the cats in the present report, which ranged from 1 to 23 years of age with a median of 9 years. It is important to point out that these lesions are often slow growing and may not be noted until advanced.

Humans with osteoma of the maxillofacial region generally present with a unilateral, pedunculated mass. The osteoma is typically located on the ventral border or buccal aspect of the mandible, a site that is suggested to be more susceptible to trauma than the lingual aspect. The size and shape of the osteomas in the cats in the present report were highly variable. It is difficult to draw any conclusions with regard to this observation; however, it is likely that this tumor is often diagnosed when more advanced in cats than in humans.

It is interesting to note that 6 of the 7 patients in the present study were castrated males. In human patients, the reported ratio of males to females affected by osteoma is 1.9:1. Also of note is that none of the cats in this study were purebred. These observations are interesting and may warrant further study.

In the present study, the youngest patient (1 year old) had numerous deciduous teeth, with impaction of most of the permanent dentition. Gardner syndrome associated with human osteoma was first described in 1953 by Gardner and Richards and is now well recognized in human patients as 3 distinct entities: familial adenomatosis (intestinal polyps), surface tumors of soft or hard tissues (pedunculated osteomas), and abnormal dental findings (tooth impaction, abnormal dental growth, supernumerary teeth, and odontomas). It has been demonstrated that 62% to 80% of patients with Gardner syndrome have multiple osteomatous lesions. Because the intestinal polypsis of Gardner syndrome is associated with an extremely high malignancy rate (50% to 100%) if not treated early, human patients evaluated for symptoms associated with intestinal polyps, multiple impacted or supernumerary teeth, and osteomas are treated with a high index of suspicion for Gardner syndrome. There are no reports in the veterinary literature of a similar syndrome associated with osteomas in cats; however, because the patient in our series was noted to have an osteoma, persistent deciduous dentition, and unerupted permanent dentition, this is an interesting parallel observation that may warrant investigation if observed in additional cats.

Early intervention is recommended for patients with osteomas, and in human patients, treatment usually involves debulking and recontouring of the affected area. When patients are examined at a more advanced stage of disease, a more invasive surgical approach may be required, as for several of the cats in the present series. There are no reports of osteoma undergoing malignant transformation, although recurrence at the surgical site has been reported. Therefore, regular reexamination or follow-up is recommended for patients that undergo surgery.

In the present report, 4 of 7 cats with osteoma of the oral or maxillofacial region survived at least 1 year after diagnosis. However, when cats are examined at a relatively advanced stage of disease, treatment options may be limited. The anatomic location presents unique challenges such that although osteoma is a benign tumor, clinical evaluation and a complete diagnostic workup should be performed as early as possible in the disease process. Clinical evaluation, diagnostic imaging including computed tomography, and biopsy will help guide the most appropriate surgical intervention.

References


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**From this month’s AJVR**

**Evaluation of four drugs for inhibition of paracentesis-induced blood-aqueous humor barrier breakdown in cats**

Amy J. Rankin et al

**Objective**—To compare inhibitory effects of topically applied 1% prednisolone acetate suspension, 0.03% flurbiprofen solution, 0.1% dexamethasone suspension, and 0.1% diclofenac on paracentesis-induced blood-aqueous humor barrier breakdown in cats.

**Animals**—9 healthy cats.

**Procedures**—Paracentesis of the anterior chamber was performed in both eyes of each cat. One eye of each cat was treated with a topically administered anti-inflammatory medication (1% prednisolone [n = 7 cats], 0.03% flurbiprofen [7], 0.1% dexamethasone [9], or 0.1% diclofenac [8]) immediately following paracentesis and at 6, 10, and 24 hours after paracentesis. The contralateral untreated eye served as the control eye. Each cat had a 6-day washout period between experimental drugs. Breakdown of the blood-aqueous humor barrier was quantified by use of laser flaremetry.

**Results**—Topical administration of 1% prednisolone significantly reduced aqueous humor flare at 4, 8, and 26 hours after paracentesis. Topical administration of 0.1% diclofenac significantly reduced aqueous humor flare at 8 and 26 hours after paracentesis. Topical administration of 0.1% dexamethasone and 0.03% flurbiprofen did not significantly decrease flare at any time point. There were significant differences in intraocular pressures between NSAID-treated eyes and untreated contralateral eyes.

**Conclusions and Clinical Relevance**—Topical administration of 1% prednisolone and 0.1% diclofenac significantly reduced intraocular inflammation in cats with paracentesis-induced uveitis. Topical administration of 1% prednisolone or 0.1% diclofenac may be appropriate choices when treating cats with anterior uveitis. Topical administration of diclofenac and flurbiprofen should be used with caution in cats with a history of ocular hypertension. (Am J Vet Res 2011;72:828–832)