Diagnostic Imaging in Veterinary Dental Practice

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Figure 1—Parallel intraoral radiographic view of the left mandibular third and fourth premolar teeth and first, second, supernumerary second, and third molar teeth of an 11-year-old Labrador Retriever that was evaluated because of persistence of an odontogenic cyst.

History and Physical Examination Findings

An 11-year-old 40-kg (88-lb) spayed female Labrador Retriever was referred to a veterinary dental specialty practice for evaluation of a suspected cyst affecting the caudal aspect of the left mandible. Two months earlier, the dog's owner had noticed a large swelling at that location. The primary care veterinarian had obtained radiographs of the affected area and collected multiple bone and soft tissue biopsy samples. Histopathologic findings included the presence of fibrosis and reactive bone as well as a squamous epithelial lining. The described swelling was diagnosed as an odontogenic cyst. Within a few weeks, the swelling worsened, and the dog was referred for further care.

On oral examination, there was a 40-mm, round, firm swelling in the area of the left mandibular fourth premolar and first molar teeth. The associated teeth were not mobile, but palpation of this area elicited signs of pain. Results of a CBC and serum biochemical analysis were within the respective reference ranges.

The dog was anesthetized, and intraoral dental radiography was performed. A selected radiographic view is provided **(Figure 1)**.

Determine whether additional studies are required, or make your diagnosis, then turn the page→

This report was submitted by Kristina Feigin, DVM; Cindy M. Bell, DVM; Mauricio Solano, MV; and Randy J. Boudrieau, DVM; from Veterinary Dental Services, Boxborough, MA 01719 (Feigin); Specialty Oral Pathology for Animals, Geneseo, IL 61254 (Bell); and the Department of Clinical Sciences, Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA 01536 (Solano, Boudrieau).

Address correspondence to Dr. Feigin (kfeigin@veterinarydental.com).

Diagnostic Imaging Findings and Interpretation

Evaluation of the dental radiographs revealed a large, multiloculated area of mandibular alveolar bone geographic lysis in the area of the left mandibular fourth premolar and first molar teeth **(Figure 2)**. The lesion extended from just distal to the mesial root of the left mandibular fourth premolar tooth to the distal root of the left mandibular first molar tooth. Apically, the lesion extended to the ventral margin with visible expansion and endosteal scalloping of the cortices.

To better evaluate the size, extent, and character of the lesion, cone-beam CT (CBCT)[a] was performed. Contiguous 0.2-mm-thick images of the skull were obtained (90 kV; 8 mA; field of view, 16 X 16 cm; **Figure 3**). All digital images were evaluated by use of commercially available software.[b] The images revealed a large expansile mass with thinning of the lateral mandibular cortex in the area of the left mandibular fourth premolar and first molar teeth. The expanded medial mandibular cortex was smoothly thickened. Interruption of the cortices at the affected site, indicating additional lysis, was also noted. The tissues filling this lesion appeared homogeneous and had soft tissue attenuation.

During the same anesthetic episode, multiple bone and soft tissue samples were obtained. There was no obvious evidence of a cystic lining or fluid accumulation in the affected area. The samples were submitted for histologic analysis.

Microscopic evaluation of samples from the mandibular mass revealed an epithelial neoplasm with squamous differentiation but indicated limited nuclear atypia and a low mitotic rate. The histologic differential diagnoses included primary intraosseous squamous cell carcinoma, conventional ameloblastoma, and amyloid-producing odontogenic tumor.

The 3-D CBCT images provided substantially better information to allow spatial evaluation of the intraosseous lesion and aid in treatment planning, compared with the intraoral dental radiographs. Segmental mandibulectomy with immediate mandibular bone reconstruction was advised and scheduled.

Treatment and Outcome

The dog was returned 4 weeks later and underwent segmental mandibulectomy with a mandibular bone reconstruction procedure. The immediate goals of this treatment were complete excision of the neoplastic mass with plate[c] stabilization of the mandible to maintain function and restore appropriate occlusion. The long-term goal was to induce bone regeneration at the defect by placement of recombinant human bone morphogenic protein-2 (rhBMP-2)[d] delivered in a compression-resistant matrix carrier.[1,2,e] Segmental mandibulectomy and immediate mandibular reconstruction was performed as previously described.[1,2]

An antimicrobial (clindamycin hydrochloride, 10 mg/kg [4.5 mg/lb], SC) and analgesic medications (hydromorphone hydrochloride, 0.1 mg/kg [0.05 mg/lb], IV; carprofen, 4.4 mg/kg [2 mg/lb], SC) were administered intraoperatively. That night, the dog was discharged from the hospital and the owner was instructed to administer carprofen (2.1 mg/kg [1 mg/lb], PO, q 12 h), gabapentin (11 mg/kg [5 mg/lb], PO, q 8 to 12 h), and clindamycin hydrochloride (7 mg/kg [3.2 mg/lb], PO, q 12 h) for 2 weeks. The owner was also instructed to feed a soft diet for 3 weeks.

The histologic diagnosis of the left mandibular mass was eventually refined to conventional ameloblastoma with keratinization and dentinoid. The tumor had an expansile growth pattern and was excised with complete histologic margins **(Figure 4)**.

The dog was reevaluated 3 and 14 days after surgery and was doing well. The oral examination con-

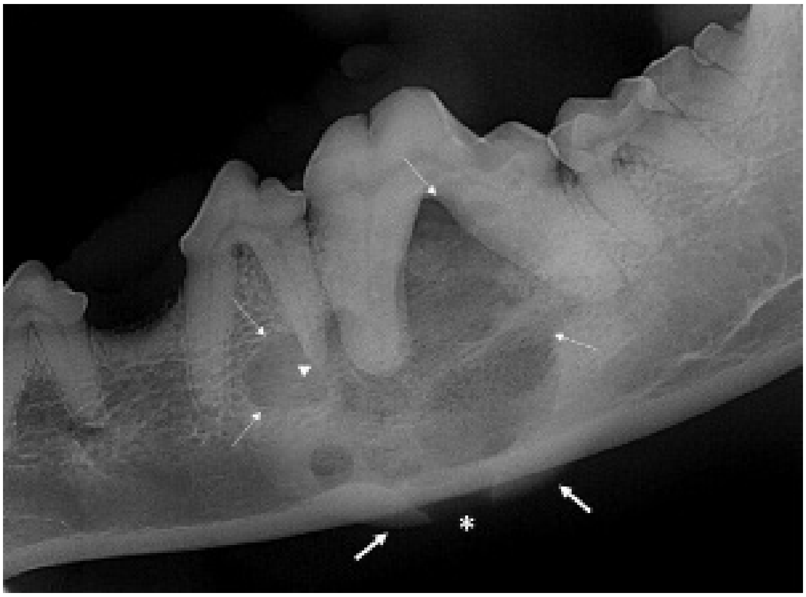

Figure 2—Same radiographic image as in Figure 1. A large area of geographic bone lysis is present, affecting the radicular areas of the left mandibular fourth premolar (distal root) and first molar teeth. The lesion is multilocular (thin arrows) and of an expansile nature (thick arrows). Mandibular alveolar bone lysis with ill-defined borders affecting the radicular areas of the left mandibular fourth premolar tooth (distal root) is evident (arrowhead). A large bone defect (cloaca) along the ventral cortex of the lesion is also present (asterisk).

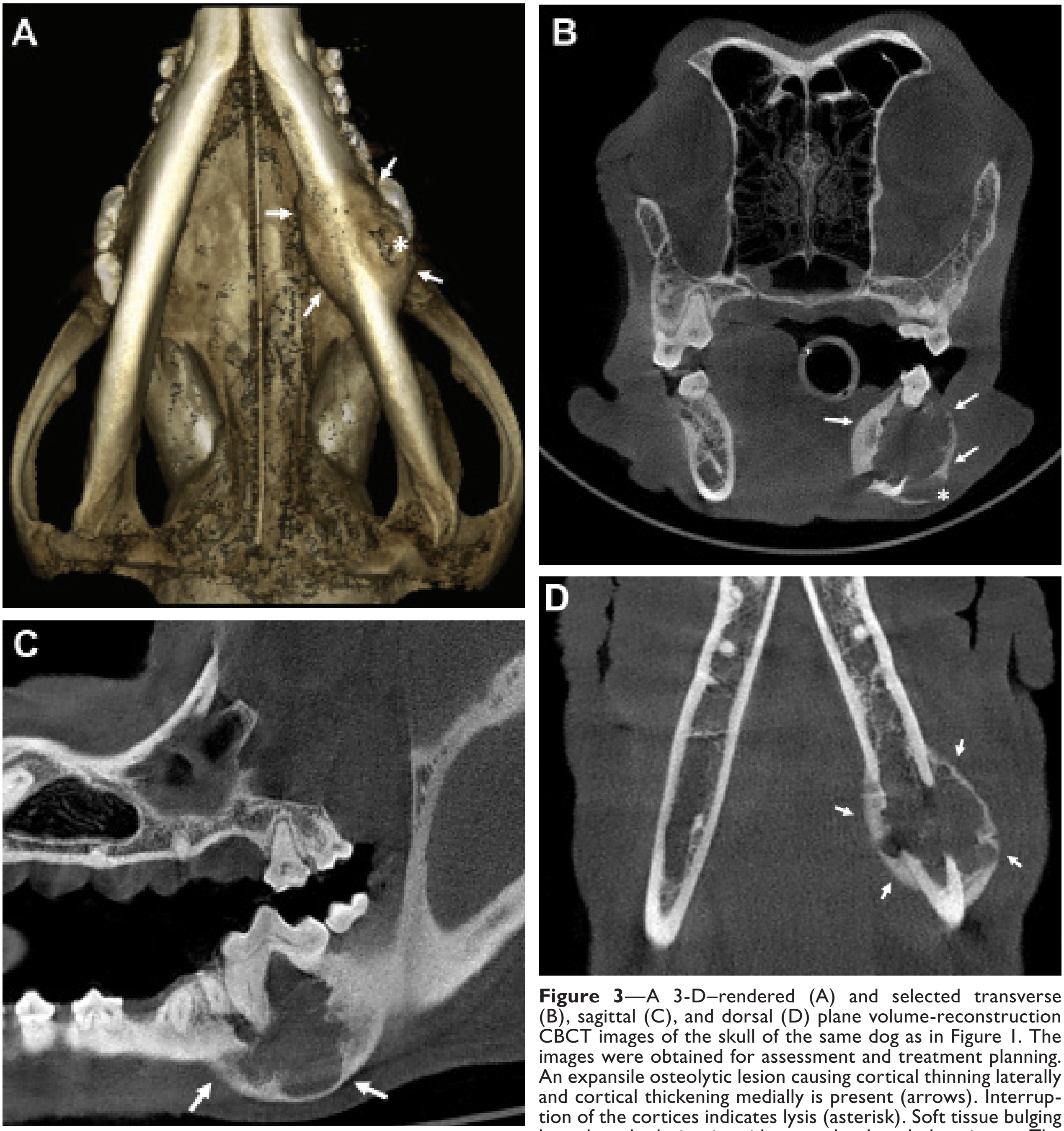

Figure 3—A 3-D–rendered (A) and selected transverse (B), sagittal (C), and dorsal (D) plane volume-reconstruction CBCT images of the skull of the same dog as in Figure 1. The images were obtained for assessment and treatment planning. An expansile osteolytic lesion causing cortical thinning laterally and cortical thickening medially is present (arrows). Interruption of the cortices indicates lysis (asterisk). Soft tissue bulging lateral to the lesion is evident on the dorsal plane image. The right side of the images in panels A, B, and D corresponds to the dog's left side.

firmed intact surgical areas with some expected postoperative firm swelling in the left mandibular region as a result of the vasoactive properties of the rhBMP-2.[1]

The dog continued to do well, and 2 months after surgery, the left mandible was reevaluated by gross examination and dental radiography with the dog under general anesthesia. There was new bone formation in the area of the previous mandibular defect, evidenced by continuous mineralization and replacement of the compression-resistant matrix carrier. The dorsal (alveolar) plate was removed at this time because of partial exposure through the gingiva. Additional CBCT images obtained 3 months after surgery showed continued new bone remodeling within the left mandibular defect. At a follow-up examination 32 months after surgery, CBCT imaging showed new bone formation and complete osseointegration with the native bone **(Figure 5)**. There was no evidence of tumor regrowth.

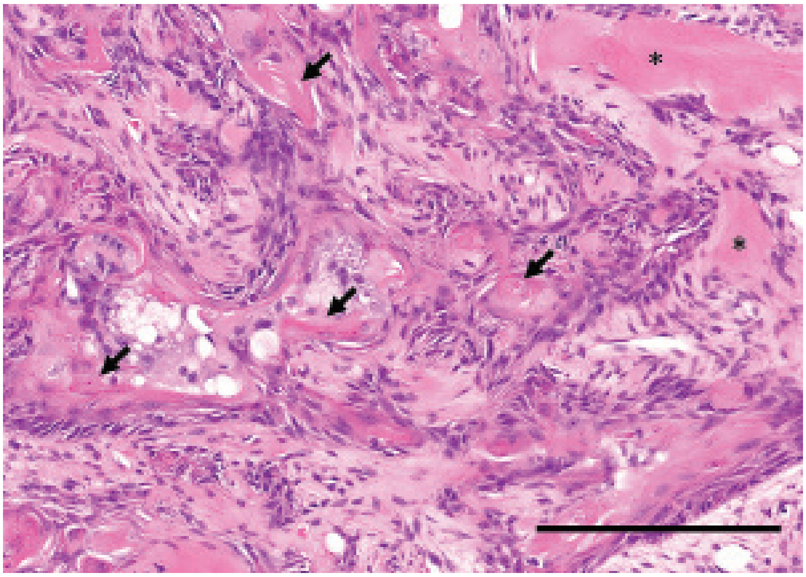

Figure 4—Photomicrograph of a solid area of the tumor excised from the left mandible. Irregular cords of odontogenic epithelium abruptly differentiate to keratin-producing squamous cells (arrows). Islands of eosinophilic matrix, consistent with dentinoid, are present within the supporting fibrovascular stroma (asterisks). H&E stain; bar = 200 μm.

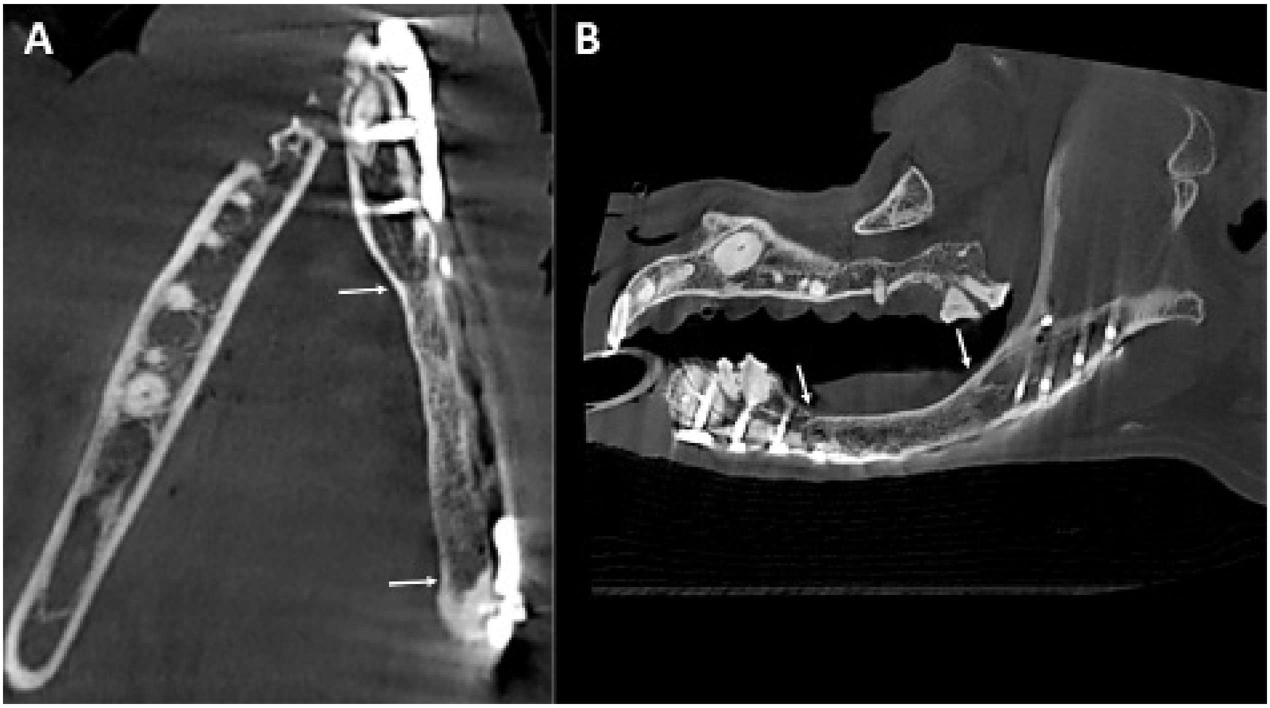

Figure 5—Dorsal (A) and sagittal (B) plane volume-reconstruction CBCT images of the left mandible 32 months after segmental mandibulectomy and mandibular reconstruction. There is complete bridging of new bone, with smooth margins, within the previous ostectomy site (arrows). The native bone and new nonnative bone have merged, indicating complete bony remodeling along the affected portion of the mandible. Linear streaks arising from the metallic implants are CT artifacts commonly seen in conventional CT and CBCT. The right side of the dorsal plane image corresponds to the dog's left side.

Comments

Preoperative radiologic evaluation of odontogenic lesions provides greater information on the morphology and extent of lesions than does gross evaluation. Conventional analog and digital radiography, which rely on large detectors, are less effective in depicting with accuracy the full extent of bone changes and tumor invasion of adjacent structures,[3] whereas dental radiographs allow better appreciation of mass-associated tooth destruction in dogs but are not intended to assess extraoral tumor extension owing to the narrowed field of view.[4] Advantages of CT imaging technologies such as conventional or CBCT include the lack of superimposition of complex anatomic structures of the skull and mandible and the user's ability to assess a lesion in various anatomic planes. Depending on the image postprocessing software, some of these units can provide volume reconstructions, including panoramic reconstructions and 3-D projections of the area of interest.[5-7]

Advantages of CBCT include its low cost and low radiation dose, compared with conventional CT.[5] The footprint of the unit is smaller than that of a standard CT unit, and this allows for its use in smaller building spaces. Results of a study[7] performed to evaluate preoperative radiologic assessment of odontogenic cysts and tumors reveal that CBCT was comparable with CT in linear measurements but more accurate in identification of tooth displacement and buccal bone defects. Cone-beam CT might be the modality of choice for evaluation of bone invasion in cases involving oral and maxillofacial pathology.[8]

Whereas CBCT provides better-quality dentoalveolar and osseous images,[9] conventional CT is considered a better choice for depicting differences in soft tissues.[7,8] The 2 modalities have comparable spatial resolution and high-speed scanning capability; however, soft tissue contrast resolution is greater with conventional CT.[8,10] Soft tissue masses, which can be composed of different types of soft tissues with or without fluid accumulation, may have a uniform density with nonreliable density differentiation on a CBCT scan.[10] Owing to the capabilities of associated image postprocessing software, conventional CT is useful for vascular studies in which contrast medium can be used to depict, with a high degree of accuracy, the neovascularization associated with a neoplastic process.[7,8] Both CT and MRI are useful for lymph node staging and detection of soft tissue tumor involvement.[8]

For the dog of the present report, the CBCT images permitted examination of not only the lesion size and margins, but also the adjacent structures. These images allowed a detailed evaluation of the position of the mandibular canal and its relationship to the lesion. The left mandibular mass in this dog was quite large, occupying and distorting a large portion of the left mandible and important neighboring anatomic structures. All of the gathered information aided the surgical planning.

Clinical staging of patients with oral malignant neoplasms includes assessment of the extent of the primary tumor, involvement of regional lymph nodes, and absence or presence of distant metastasis by means of thoracic radiography or CT, abdominal ultrasonography, and local lymph node aspiration or biopsy.[11] The owner of the dog described here wanted to proceed with surgery as soon as possible and consider staging later, if needed, after receiving the biopsy results.

In dogs, ameloblastoma is divided into acanthomatous and conventional types.[12] Canine acanthomatous ameloblastoma is common; it is specific to dogs and has a predictable histologic morphology.[13] Conventional ameloblastoma is less common, and the histologic features are highly variable.[12] Squamous differentiation and keratinization are frequently observed and can complicate the diagnosis.[12] Conventional ameloblastoma has been reported in young and old dogs and is clinically characterized by focal swelling and expansion within the jaw.[12,13] Radiographic features of this neoplasm include intraosseous loculation with mixed lytic and proliferative changes. A multicystic or multilocular pattern is more commonly seen than a unicystic or unilocular pattern. A multicystic pattern with cortical bone expansion has been described in dogs evaluated with CT.[12] External root resorption was reported in 5 of 14 dogs with conventional ameloblastoma evaluated with this method, and contrast enhancement of the lesion was reported in all 14 dogs with CT.[12] Large conventional ameloblastomas can erode through the cortex into the adjacent soft tissues. These tumors are typically treated by complete surgical excision.[9,11]

Segmental mandibulectomy results in instability and malocclusion resulting from mandibular drift. Elastic training, extractions, and crown reduction with vital pulp therapy can be used to help mitigate this surgical consequence, albeit with limited success.[14] Mandibular reconstruction allows immediate jaw stability and return to function.[1,2] The rhBMPs are potent molecules capable of inducing new bone formation, and as such, they should be used judiciously. One review[15] published in 2017 focused on the potential for both tumor suppression and tumor promotion by bone morphogenic proteins (BMPs). Therefore, the potential for tumor induction must at least be considered with the use of BMPs in any patient with malignant neoplasia.[15] In a situation with an aggressive tumor type, use of BMPs may be contraindicated, whereas with benign growths, their use may be well tolerated.[16]

The dog of the present report experienced 1 postoperative complication (plate exposure), which has been previously reported[1] and was treated with plate removal. The lesion in this dog was initially diagnosed as an odontogenic cyst; however, subsequent diagnostic imaging showed a more aggressive lesion, which was later histologically confirmed to be a conventional ameloblastoma. Cone-beam CT was performed in addition to dental radiography and was useful in evaluating the extent of the lesion and in surgical planning for the reconstruction; all of these factors contributed to the successful treatment and favorable prognosis of the dog of this report.

Footnotes

a. Planmeca USA Inc, Hoffman Estates, Ill.
b. Planmeca Romexis, Hoffman Estates, Ill.
c. Advanced Locking Plate System, KYON Veterinary Surgical Products, Boston, Mass.
d. Bioventus LLC, Boston, Mass.
e. Mastergraf Matrix, Medtronic Sofamor Danek, Memphis, Tenn.

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