Pathologic Mandibular Fracture Associated with Bilateral Dentigerous Cysts in a Dog

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Abstract

This report describes the management and computed tomographic (CT) follow-up of a pathologic fracture of the mandibular body associated with bilateral dentigerous cysts in a 16-month-old Boxer. Bilateral, rostral, mandibular lesions consistent with dentigerous cysts were identified by intraoral radiography and CT. The left cyst was associated with an open, mildly displaced mandibular fracture. Treatment of the cystic lesions consisted of surgical exposure, extraction of embedded teeth, curettage of the cyst lining, and placement of demineralized bone matrix. Reduction and stabilization of the fracture were achieved by interdental wiring combined with an intraoral splint. Follow-up examination and CT imaging were performed at 8, 18, and 85 weeks postoperatively. Complete fracture healing and resolution of both cystic lesions were confirmed at 18 weeks with no recurrence evident at 85 weeks. No complications were encountered. To the authors' knowledge, this is the first case report of a pathologic mandibular fracture secondary to a dentigerous cyst in a dog, documenting the healing of dentigerous cysts via CT with progressive replacement of demineralized bone matrix by new osseous growth. Surgical treatment of the pathologic mandibular fracture and the bilateral dentigerous cysts resulted in an excellent clinical outcome.

Keywords
- dentigerous cyst
- interdental wiring
- mandibular fracture
- dog

Introduction

Pathologic fractures of the mandible account for a relatively small proportion of oral fractures in dogs, most of which are attributable to severe periodontal disease or neoplasia.[1,2] Odontogenic cysts (OC) are epithelial-lined cavities derived from the odontogenic epithelium and are reportedly rare in dogs.[3,4] Subtypes of OC described in dogs include dentigerous cysts (DC), radicular cysts and odontogenic parakeratinized cysts.[5] Dentigerous cysts are the most reported subtype and are mainly described in small and brachycephalic breeds.[4–9] They are associated with unerupted teeth and arise from proliferation of tissue remnants of the enamel organ or reduced enamel epithelium.[10] Boxers are well-recognized as a breed with an increased risk of developing DC, which are almost-exclusively associated with the first premolar teeth.[9] Pathologic fracture has anecdotally been listed as a possible sequala to untreated OC in dogs[6–8,11] but, to the authors' knowledge, has not otherwise been described in the veterinary literature to date. The recommended treatment of DC consists of extraction of the unerupted tooth, complete enucleation of the cyst lining epithelium and osteoplasty before apposition of the overlying soft tissues.[10] Bone grafting has been recommended if the cyst is of sufficient size to compromise the mandibular bone support.[4,5,8] Autogenous cancellous bone grafts are considered

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to be the gold standard in reconstructive orthopaedic surgery, but their acquisition is associated with increased patient morbidity.[12] Bone allografts are increasingly used in small animal orthopaedic surgery and have shown promising results in promoting osseous healing and specifically in restoring the integrity of mandibular defects.[8,13–15] Demineralized bone matrix (DBM) is an allograft consisting of bone which has been acid-treated to remove the mineral matrix while preserving the organic, collagen matrix and growth factors including bone morphogenic proteins, insulin-like-, transforming- and fibroblast growth factors.[16] The collagen matrix provides an osteoconductive scaffold, while the growth factors facilitate osteoinduction.[12] In humans, there is histologic evidence that DBM supports periodontal regeneration and promotes osseous healing compared with open-flap debridement alone.[13,17]

The objectives of this report were to (1) describe the diagnosis and treatment of a pathologic fracture associated with bilateral DCs in a dog; (2) report the short- and long-term clinical and computed tomographic (CT) follow-up; and (3) use CT-derived density assessment to evaluate osseous healing of the cystic cavities and mandibular fracture following placement of DBM.

Case Report

A 16-month-old, 29-kg, male Boxer was referred for evaluation and treatment of a fracture of the left mandibular body. There was no known history of trauma; the patient had been found in a kennel 48 hours earlier bleeding from the left side of the mouth. At admission, general clinical examination was largely unremarkable. Conscious and sedated oral examination revealed mild, breed-associated, dental overcrowding and a class III malocclusion (maxillary brachygnathia).[18] Both mandibular first premolar teeth appeared to be absent. An open fracture of the left mandible was observed, with exposure of the mesial root of the second premolar tooth and surrounding alveolar bone.

Intraoral radiography and CT of the head confirmed an open, acute, mildly displaced, fracture of the left mandibular body immediately mesial to the second premolar tooth (►**Fig. 1**). The first mandibular premolar teeth were present bilaterally, albeit unerupted, and the existence of an unerupted, supernumerary, left, first premolar tooth was discovered. Bilaterally, the embedded teeth were surrounded by a geographic, hypoattenuating, lytic region. In the right mandible, the lytic region was well-defined and ovoid, enclosing the entirety of the unerupted first premolar tooth, the distal aspect of the root of the canine tooth and the mesial root of the second premolar tooth. There was associated disruption of the lateral, medial and dorsal mandibular cortices with a thin, linear, soft tissue rim visible at its dorsal periphery. In the left mandible, the lesion was more difficult to define due to association with the fracture. Similarly, it enclosed the entirety of the two unerupted first premolar teeth, as well as the distal aspect of the root of the canine tooth and the mesial root of the second premolar tooth. These lesions were consistent with OC, with DC considered most likely due to the presence of unerupted teeth. Based on the clinical and radiographic findings, a pathologic fracture of the left mandibular body, secondary to a DC was diagnosed.

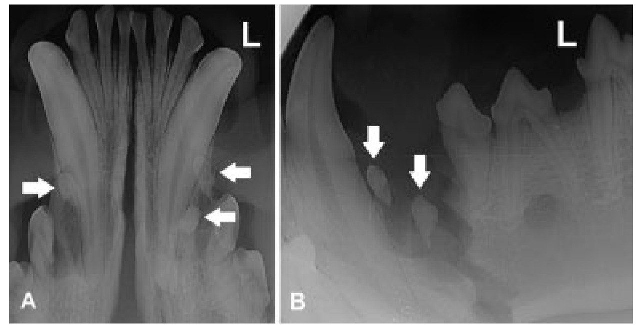

Fig. 1 (**A**) Intraoral radiograph of the rostral mandible. The three unerupted first mandibular premolar teeth can be appreciated (*arrows*) and are associated with well-defined, roughly ovoid, radiolucent lesions in the surrounding alveolar bone. The fracture of the left mandibular body is not readily apparent on this view due to the superimposition of structures, but the radiolucent lesion is less well-defined than in the contralateral mandible as a result of the fracture. (**B**) Intraoral radiograph of the left rostral mandible. The fracture distal to the left mandibular canine tooth is readily apparent and the unerupted first premolar teeth are evident (*arrows*) within a cystic lesion immediately rostral to the fracture gap.

Surgical treatment of the DCs and stabilization of the mandibular fracture were recommended. Premedication was achieved with methadone (0.2 mg/kg intravenously [IV]) and dexmedetomidine hydrochloride (0.3 µg/kg IV) prior to co-induction of anaesthesia with midazolam (0.2 mg/kg IV) and propofol (2–4 mg/kg IV to effect). A sterile, 10.5 mm, cuffed, armoured, endotracheal tube was placed, and anaesthesia was maintained on a mixture of 100% oxygen and isoflurane. Bilateral mandibular nerve blocks were performed using 0.5% bupivacaine and meloxicam (0.2 mg/kg IV) was administered. The dog was positioned in sternal recumbency and the head was secured in an open-mouthed position by a hinging system at the end of the table. A throat pack was placed and the mouth was prepared with a 0.2% chlorhexidine solution. Antibiotic medications (cefuroxime 20 mg/kg IV) were administered every 90 minutes throughout surgery. The right OC was treated first. A longitudinal incision was made along the mucogingival junction from the level of the right mandibular canine tooth to the right mandibular second premolar tooth. A periosteal elevator was used to elevate a mucoperiosteal flap to expose the underlying alveolar bone and lateral wall of the cyst, which was easily opened using a spoon curette. The embedded right mandibular first premolar tooth was extracted and the cyst lining was removed by accurate curettage. Alveoloplasty was performed using a small bone rongeur, followed by thorough flushing of the cyst cavity with sterile saline. The cyst cavity was then packed with a DBM allograft (DBM putty, Veterinary Tissue Bank, Chirk, United Kingdom) prior to closure of the mucoperiosteal flap with a simple interrupted suture pattern (3–0 poliglecaprone 25). This procedure was repeated for the fractured cyst cavity of the left mandible (►**Fig. 2**), with extraction of both embedded left mandibular first

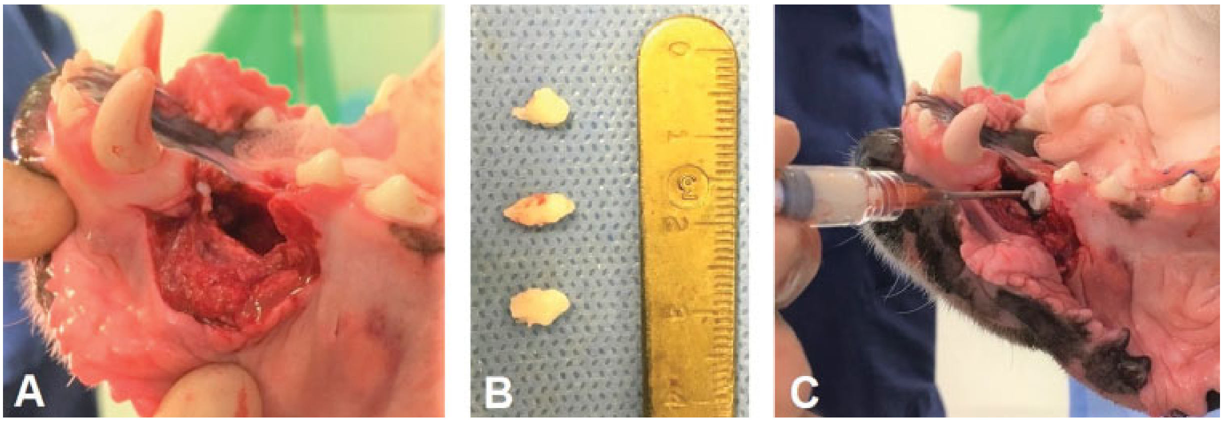

Fig. 2 (A) Appearance of the left dentigerous cyst with the associated open mandibular fracture following approach by mucogingival incision, elevation of the mucoperiosteal flap and opening of the lateral cyst wall using a spoon curette. One of the unerupted first premolar teeth is visible at the rostral border of the cyst. The supernumerary first premolar tooth is not visible as it is contained deeper within the cyst cavity. (B) The three extracted first premolar teeth. (C) Placement of demineralized bone matrix into the fractured left dentigerous cyst cavity following extraction of the embedded first premolar teeth and curettage of the cyst lining.

premolar teeth. The fracture was then reduced and stabilized using 0.6mm orthopaedic wire by means of the Stout multiple loop interdental wiring technique.[19] An intraoral splint composed of photopolymerisable composite (Suprafil Microhybrid, R&S Ashford, United Kingdom) was also applied, extending from the right first mandibular molar tooth to the left first mandibular molar tooth.[10,20,21] Stability and breed-appropriate occlusion were achieved. Postoperative radiographs showed satisfactory alignment and apposition of the fracture with suitable intraoral splint placement. The dog had an uneventful anaesthetic recovery and methadone (0.2 mg/kg, IV q4h) and cefuroxime (20 mg/kg IV q8h) were continued overnight. It was discharged the following day with 10-day course of meloxicam (0.1 mg/kg, per os, q24h) and a 28-day course of cefalexin (20 mg/kg, per os, q12h). The owners were instructed to remove all chew toys and to provide a soft diet until implant removal. Samples of the excised cyst lining epithelium from both lesions were submitted for histological analysis, the results of which were inconclusive due to poor preservation of the submitted sample.

Clinical follow-up was performed at 4, 8, 18, and 85 weeks postoperatively and repeat CT examination was included at 8, 18, and 85 weeks (►Fig. 3). All CT images were evaluated using DICOM viewing software (OsiriX v4.1.2, Geneva, Switzerland) in a bone-window and multiplanar reconstruction images were generated in the sagittal, dorsal and transverse planes. The size and bone density (Hounsfield units, HU) of both cystic cavities were quantified at each examination. Regions of interest (ROI) were defined in all three planes for each DC that were centred on the cystic cavities and avoided the mandibular cortices and roots of adjacent teeth (►Fig. 4). The mean HU values across both ROI were recorded at each examination (►Table 1). The bone density (HU) of "normal mandible" was calculated by defining a similar ROI in approximately the same location in a CT of another young, adult Boxer without any mandibular pathology. To obtain a base reference value of the biomaterial used

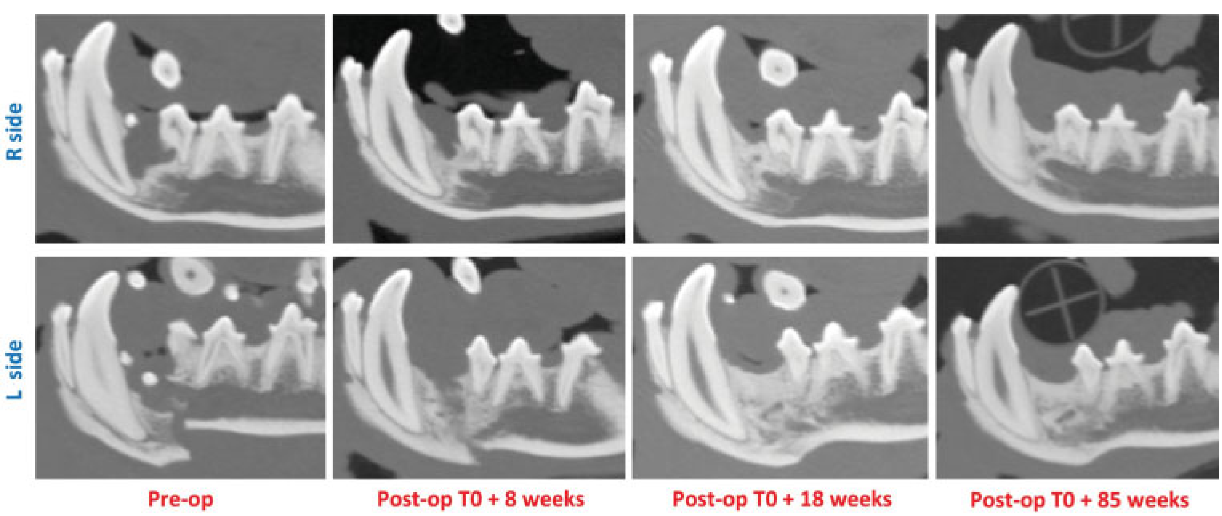

Fig. 3 Sagittal computed tomographic images demonstrating the progression of healing of both dentigerous cysts and the pathologic left mandibular fracture. Note the presence of the three unerupted mandibular first premolar teeth associated with the cysts on the preoperative images.

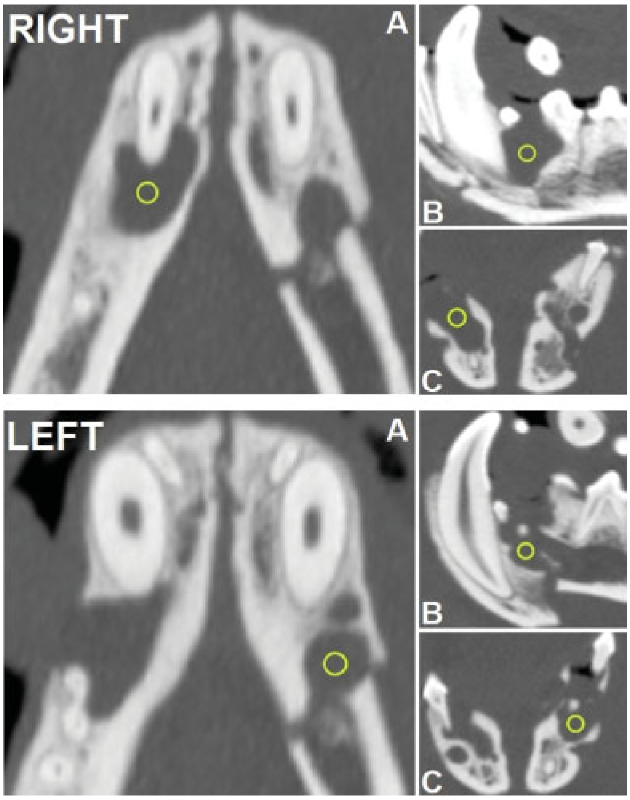

Fig. 4 Location of the regions of interest used to calculate bone density (green circle) in the right and left mandibles. These were defined in the dorsal (**A**), sagittal (**B**), and transverse (**C**) planes and used in all subsequent computed tomography studies of the dog to quantify bone healing.

in this case at the time of implantation, a sample of pure DBM allograft was scanned and its mean HU value was similarly calculated. At 4 weeks postoperatively, complete healing of the gingival incisions and preservation of the intraoral splint were confirmed. The mandible remained stable, and the patient showed no signs of discomfort. At 8 weeks postoperatively, the splint and interdental wiring were removed under general anaesthesia and all teeth were scaled and polished. The previous fracture site was stable immediately following explantation and remained so at all subsequent follow-up appointments. On CT, both cystic lesions were reduced in size and largely filled with heterogeneous new bone, which had a more amorphous appearance on the left side where the fracture line remained visible. At 18 weeks postoperatively, both lesions were completely filled with mineralized new bone and the fracture line on the left side was no longer visible. Some residual, solid, mineralized callus with smooth margins remained at the previous fracture site. At 85 weeks postoperatively, the previous cystic lesions could no longer be identified and the gross appearance of bone in each ROI was comparable to the "normal mandibular bone" used as a reference.

Discussion

In the described case, a combination of intraoral radiography and CT was used for the diagnosis of the bilateral DCs and a left-sided pathologic mandibular fracture. The diagnostic yield of CT is greater than that of radiography for the identification of fracture morphology in the craniomaxillofacial region that is particularly useful for surgical planning.[22] This is especially true for cases with breed-associated, dental overcrowding and a class III malocclusion,[23] such as the subject of this report. Furthermore, CT allowed for easier identification of the three unerupted first premolar teeth and examination of the fracture ends for underlying pathology.

Treatment of the DCs was performed in-line with published recommendations:[24] the cystic cavities were accessed surgically, the unerupted teeth extracted and the cyst lining carefully curetted to prevent recurrence. The residual defects were packed with DBM to encourage bone healing as both were of sufficient size to compromise the integrity of the mandible, as evidenced by the presence of a pathologic fracture. Bone grafting techniques are used in both human and veterinary dental surgery to enhance alveolar bone repair[15,25] and the use of DBM has been advocated for the treatment of large DC in dogs to preserve alveolar ridge height and provide jaw stability during early healing.[8,11] A combination of interdental wiring and acrylic splinting was chosen as the most appropriate fracture fixation option considering the location of the fracture and the patient's brachycephalic anatomy. This technique is minimally invasive, well-tolerated, and provides sufficient

Table 1 Bone density (Hounsfield Units [HU]) of both dentigerous cysts over time

	Bone density (HU)									
	Preoperative		DBM (t0)[a]	t0 + 8 weeks		t0 + 18 weeks		t0 + 85 weeks		Normal mandible[b]
	Right	Left		Right	Left	Right	Left	Right	Left	
Dorsal plane	47	74	187	96	82	701	839	490	747	396
Sagittal plane	38	63	191	120	285	748	1,035	866	826	383
Transverse plane	43	76	192	123	154	773	1,015	478	703	392
Mean	42	71	190	113	173	740	960	611	797	390

[a]In the absence of immediate postoperative imaging, computed tomography of a syringe of unopened demineralized bone matrix (DBM) was performed to represent t0.
[b]As the dog in this case had bilateral rostral mandibular pathology, the bone density in approximately the same location was measured in a different young, adult Boxer without any mandibular pathology.

stability for a fracture in this location.[21] Extension of the splint between the right and left first mandibular molar teeth was elected to provide sufficient biomechanical support to both sides of the mandible.

Computed tomographic follow-up allowed for more accurate quantification of the progressive reduction in cyst-cavity size and replacement of the DBM graft with ingrowing bone than plain radiography would permit. Both DCs were visibly reduced in size at 8 weeks postoperatively and were no longer visible at 18 weeks. This was reflected in the changes in HU values. As expected, preoperative measurements were the lowest, as the cystic cavities measured their largest and predominantly contained fluid. Predictably, the density of the DBM allograft was also lower than that of normal mandibular bone due to the absence of mineralized material. Postoperatively, both lesions behaved similarly with an initial marked increase in bone density to approximately twice that of normal mandibular bone, followed by a steady reduction toward the "normal" value. This likely reflected the process of secondary bone healing, with initial rapid deposition of woven bone, followed by gradual Haversian remodelling. The bone density of the fractured left DC was greater than the intact right DC throughout healing and approached that of cortical bone at 18 weeks postoperatively. This is likely because the pathologic fracture resulted in a larger defect which was inherently less stable, leading to the formation of callus.

The absence of histologic diagnosis of DC due to poor tissue preservation represents a significant limitation of this case report. However, the radiographic features of DC may be considered as near-pathognomonic[10] and the absence of recurrence on long-term clinical and CT follow-up further supports the diagnosis.

In summary, this report documents the surgical management of bilateral DCs and an associated unilateral pathologic mandibular fracture in an adult dog. Progressive replacement of DBM with new osseous growth was confirmed by repeat CT and complete healing of all lesions was demonstrated by CT at 18 weeks postoperatively. An excellent clinical outcome was achieved.

Conflict of Interests
The authors report no conflicts of interest.

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