Oral Examination Results in Rescued Ferrets: Clinical Findings

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Summary:

Ferrets have increased in popularity as pets, and a growing number are seen in companion animal practice. Domestic ferrets are commonly used as animal models for research of human oral conditions. The present study evaluated the prevalence of oral pathology in rescued ferrets which – to the authors' knowledge – has not yet been described in the scientific literature. Conscious oral examination was performed on 63 ferrets, of which 49 underwent general anesthesia for further examination. The most common clinical findings included malocclusion of mandibular second incisor teeth (95.2 %); extrusion of canine teeth (93.7 %); and abrasion and attrition of teeth (76.2 %). Tooth fractures were exclusively associated with canine teeth and found in 31.7 % of ferrets. Pulp exposure was confirmed in 60.0 % of fractured teeth. The normal gingival sulcus depth measured < 0.5-mm in 87.8 % of anesthetized ferrets. Clinical evidence of periodontal disease was present in 65.3 % of anesthetized ferrets (gingivitis or probing depths > 0.5-mm), however, advanced periodontal disease (i.e. periodontal pockets > 2-mm or stage 3 furcation exposure) was not found upon clinical examination. There was no evidence of tooth resorption, dental caries, stomatitis, or oral tumors in the examined group of ferrets. ***J Vet Dent 28(1); 8 - 15, 2011***

Introduction

Based on the California State Bird and Mammal Conservation Program Report,[1] the total pet population of domestic ferrets in the United States in 1996 was approximately 800,000, and the popularity of pet ferrets seems to be increasing. While numerous studies show the prevalence of oral disease in cats, dogs, humans and other species with brachyodont dentition, objective information regarding ferret oral health is lacking. The prevalence of ferret oral disease is often considered to be similar to that seen in cats and dogs.[2,3] Veterinary dentists and exotic animal veterinarians acknowledge that ferrets are affected by periodontal and endodontic disease, but accurate information about the type and prevalence of oral diseases is unknown.[2,3]

The domestic ferret (*Mustela furo*) belongs to the family *Mustelidae*, one of the largest families of carnivorous mammals. Like most mammals, ferrets have deciduous and permanent dentitions. Eruption of permanent teeth is normally completed between 42 to 77-days after birth.[4,5] Adult ferrets have 34 teeth, with the permanent dental formula being I 3/3; C 1/1; P 3/3; M 1/2 = 34.[2,3,5,6]

Carnivores are characterized by having a highly specialized brachyodont dentition. In ferrets, the maxillary fourth premolar and mandibular first molar teeth are sectorial and move in a scissor-like fashion. Ferrets have long, thin canine teeth that form a tight dental interlock when the mouth is closed. Large, hourglass-shaped maxillary first molar teeth are one of the taxonomic characteristics of the family Mustelidae.[5,6] The relatively small size of the teeth and oral cavity, coupled with the animal's active nature, makes it difficult to thoroughly assess oral health in conscious ferrets, and this can result in oral pathology being overlooked. Additionally, some clinicians feel that ferrets rarely develop clinical signs of oral disease or simply do not live long enough to develop oral pathology that could result in oral discomfort and decreased quality of life.

The domestic ferret is a commonly used animal model for research of many human oral diseases (*e.g.* periodontitis,[7] orthodontic conditions,[8] endodontic disease[8-11]). There are at least two studies describing skulls and teeth in large numbers of wild and pet ferret specimens.[5,12] However, references providing a detailed description of the oral anatomy in domestic ferrets are scarce.[5,13] The description of oral diseases in ferrets is largely limited to experimentally induced endodontic and periodontal lesions in research animals,[7-11] individual reports of ferret dental disease,[2,3] and results of archeological studies on ferret skulls and teeth.[5,6,12] To the authors' knowledge, the prevalence of naturally occurring oral pathology, and particularly that in shelter ferrets, has not been described in the scientific literature. The goal of the present study was to improve understanding of oral biology and oral pathology of the ferret while providing treatment to a group of rescued ferrets that ultimately optimized their adoption status.

Materials and Methods

Clinicians of the Dentistry and Oral Surgery Service and the Section of Special Species Medicine and Surgery of the Matthew J. Ryan Veterinary Hospital of the University of Pennsylvania (MJR-VHUP) conducted a prospective clinical study to examine a large number of rescued ferrets from the Greater Chicago Ferret Association at the Ness Exotic Wellness Center. This study was evaluated by an Institutional Animal Care and Use Committee (IACUC), and all ferrets were examined in accordance with guidelines established by the IACUC-approved protocol. Diagnosis of oral disease was accomplished by conscious and anesthetized oral examination. Special Species Medicine and Surgery clinicians provided anesthetic protocols and perioperative care. Dentistry and Oral Surgery clinicians performed diagnosis and treatment of oral disease.

Ferrets were selected randomly for the study regardless of their oral or general health status. A conscious oral examination was performed in 63 adult ferrets. All ferrets were evaluated for the presence of dental plaque, calculus, gingivitis, stomatitis, oral tumors, malocclusion, tooth extrusion, missing or supernumerary teeth, abrasion or attrition of teeth, tooth

Figure 1

Photograph showing marked paleness of the nasal planum indicative of anemia in the ferret on the right as compared to a healthy ferret on the left. Fourteen ferrets were excluded from anesthesia due to anemia, elevated liver enzymes, dehydration, poor body and skin condition, abdominal masses, insulinoma, or adrenal disease.

Figure 3

Photograph showing linguoversion of the mandibular second incisor teeth (*) in a ferret.

Figure 2

A PDT sensor probe type US (Williams) was used for the periodontal examination of anesthetized ferrets.

fractures, tooth resorption, and dental caries; and, the results were recorded using a modified ferret dental chart[a]. Tooth extrusion was defined as supragingival positioning of the suspected cementoenamel junction [CEJ] (junction of the conical and cylindrical portions of the tooth) with exposure of up to 3-mm of the cylindrical portion of the tooth in the absence of gingival recession. Extraoral examination evaluated facial symmetry, mandibular lymph nodes, salivary glands, ears, eyes, and nares.

A complete physical examination and blood tests including serum chemistry screen and hematocrit were performed on each animal in preparation for general anesthesia. Fourteen ferrets were excluded from anesthesia due to marked anemia, elevated liver enzymes, severe dehydration, poor body condition, palpable abdominal masses, uncontrolled insulinoma, or ongoing treatment of adrenal disease (Fig. 1). One ferret was excluded due to difficulties in placing a venous catheter as a result of a severe dermatologic condition. Forty-nine ferrets were placed under general anesthesia to allow for detailed oral examination, full-mouth dental radiography, and appropriate treatment. Ferrets were premedicated with butorphanol[b] (0.3 mg/kg IM) and midazolam[c] (0.5 mg/kg IM) 20-minutes prior to induction. Induction (isoflurane[d] at 5 %; oxygen flow rate of 2 L/min) was accomplished using a face mask. Patients with significant oral disease were intubated using a cuffed endotracheal tube with a 2.5-mm inner diameter[e]. Anesthesia was maintained with isoflurane at 2 % and an oxygen flow rate of 1 L/min.

A periodontal probe[f] was used to measure gingival index, tooth mobility, furcation exposure, gingival recession, and the depth of the gingival sulcus at 4 locations around each tooth (Fig. 2). An ODU 11/12 dental explorer was utilized to assess teeth for the presence of coronal surface defects and pulp exposure. Radiographic examination was performed using a portable hand-held X-ray unit[g] and a digital radiography system[h]. Intraoral and extraoral radiographic techniques were utilized. Full-mouth dental radiography and histopathology results of extracted teeth will be reported in another publication. A professional dental cleaning was performed on all anesthetized ferrets, which included supra- and subgingival ultrasonic scaling and polishing of teeth. When teeth required extraction, regional anesthesia was provided with a mixture of bupivacaine[i] (1.0 mg/kg) and lidocaine[j] (1.0 mg/kg).

Results

Based on available medical records, the age range of the 63 evaluated ferrets was 1 to 6 -years, with a mean age of 4-years. Bilateral linguoversion of mandibular second incisor teeth was the most common finding on conscious oral examination in 60 of 63 (95.2 %) ferrets (Fig. 3). Skeletal malocclusion was not observed in any of the ferrets. One or more extruded canine teeth were found in 59 of 63 (93.7 %) ferrets. Extrusion was present in mandibular (57 of 63 ferrets) and maxillary (51 of

Figure 4

Photograph showing extruded left maxillary and mandibular canine teeth in a ferret. Note the junction between the crown and root (arrow) is positioned about 3-mm coronal to the gingival margin in the absence of obvious gingival recession.

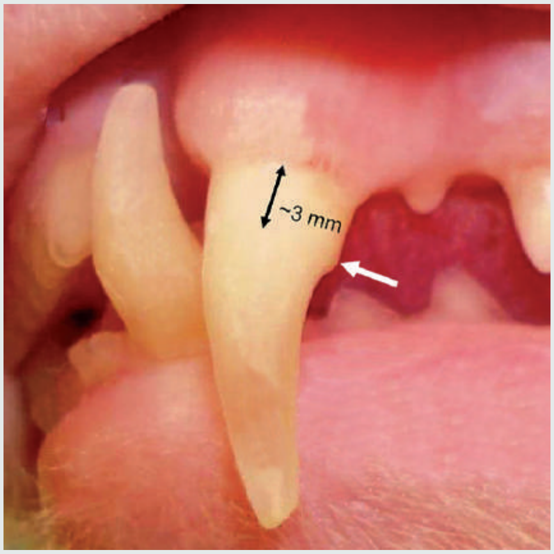


Figure 5

Photograph showing tooth wear of the left maxillary and mandibular teeth in a ferret. The third premolar tooth was most commonly affected by abrasion or attrition in both the maxilla and mandible (*).

63 ferrets) canine teeth, and only canine teeth showed evidence of extrusion (Fig. 4). Supernumerary teeth were not found in the examined ferret population.

Tooth wear due to abrasion or attrition was found in 48 of 63 (76.2 %) ferrets, with the mandibular and maxillary third premolar teeth being most commonly affected (Table 1 and Fig. 5). Tooth fractures were present in 20 of 63 (31.7 %) ferrets. Pulp exposure was evident in 9 of 15 (60 %) fractured teeth and confirmed in 6 of 11 (54.5 %) fractured teeth during the anesthetized oral examination (Table 2). Tooth fractures were associated exclusively with canine teeth (24 maxillary, one mandibular).

Clinical evidence of periodontal disease was present in 32 of 49 (65.3 %) ferrets. Advanced periodontal disease (*i.e.* periodontal pockets > 2-mm or stage 3 furcation exposure) was not found upon clinical examination of anesthetized ferrets. Missing teeth were rarely observed. One of 63 ferrets was found to be missing a right mandibular third incisor

Table 1

Distribution of dental attrition and abrasion seen in 63 ferrets.

	Number of Ferrets Affected	Percentage (%) of Ferrets Affected
Maxillary Teeth		
Incisor	10	15.9
Canine	22	34.9
Premolar 2	13	20.6
Premolar 3	32	50.8
Premolar 4	21	33.3
Molar	12	19.0
Mandible Teeth		
Incisor	25	39.7
Canine	24	38.0
Premolar 2	20	31.7
Premolar 3	31	49.2
Premolar 4	27	42.8
Molar 1	16	25.4
Molar 2	12	19.0
Total:	48	76.2

Table 2

Summary of dental fractures found during oral examination of ferrets.

	Number of Teeth Affected	Number of Ferrets Affected	Percentage (%) of Ferrets Affected
Examination-conscious dental fractures (63 ferrets)	25	20	31.7
Examination-anesthetized dental fractures (49 ferrets)	15	11	22.4**
Complicated fractures*	9	6	12.2**
Percentage (%) with confirmed complicated fractures	60	54.5	

* Pulp exposure confirmed under anesthesia with explorer
** Unrepresentative subpopulation

Table 3

Summary of oral pathology found during oral examination of rescued ferrets.

	Number of Teeth Affected	Number of Ferrets Affected	Percentage (%) of Ferrets Affected
Malocclusion	63	60	95.2
Canine tooth extrusion	63	59	93.7
Dental abrasion and attrition	63	48	76.2
Tooth fracture	63	20	31.7
Periodontal disease *	49	32	65.3

* confirmed under general anesthesia

tooth. No evidence was found of tooth resorption, dental caries, stomatitis, or oral tumors in the examined ferrets (Table 3).

Teeth that required extraction were exclusively maxillary canine teeth with complicated crown fractures. Flaps were raised using a # 15C scalpel blade[k] and a periosteal elevator[l]. Partial alveolectomy was performed using a # ½ round carbide bur on a multiplying handpiece attached to an electric-driven dental unit with external cooling[m] using sterile saline (Fig. 6). Teeth were extracted using a winged dental elevator[n], and the alveolar sockets were debrided with a bone curette. Sharp bone edges were removed with a # 16 diamond-coated round bur. The periosteum was bluntly dissected using Ragnell scissors[o], and a tension-free flap was sutured using 5-0 poliglecaprone 25[p] in a simple interrupted pattern (Fig. 6). Odontoplasty was performed on ipsilateral mandibular canine teeth (minimal shortening and rounding of their coronal tips) to minimize lip trauma after extraction of maxillary canine teeth. Ferrets undergoing dental extractions were provided with a subcutaneous injection of meloxicam[q] (0.01 mg/kg) and were reexamined 48-hours after surgery. Despite odontoplasty of ipsilateral mandibular canine teeth, all ferrets that underwent maxillary canine tooth extraction developed minor complications associated with upper lip irritation (Fig. 7).

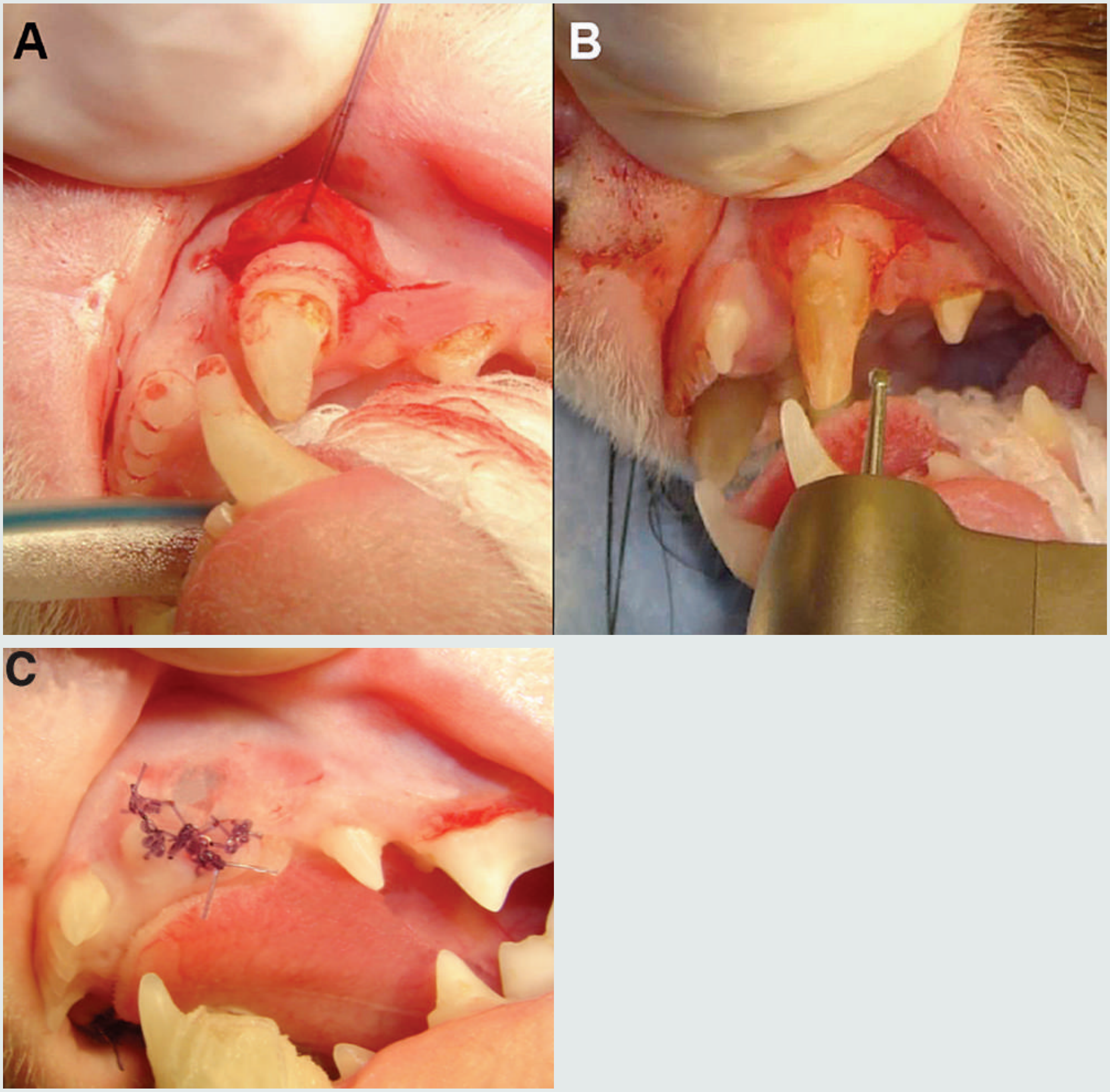
Discussion

Malocclusion associated with the mandibular incisor teeth has been reported as a commonly observed condition in members of the family *Mustelidae*. In one study that evaluated 613 skulls of different species of the genus *Mustela*, lingually displaced mandibular second incisor teeth were found in 64 % of specimens.[12] Several authors have mentioned malocclusion of these teeth in ferrets.[3,5,12,13] The present study demonstrated linguoversion of the mandibular second incisor teeth in 95.2 % of the ferrets examined. The position of both mandibular second incisor teeth followed the same pattern in all examined ferrets and was not associated with clinical discomfort. Therefore, linguoversion of the mandibular second incisor teeth in this population of ferrets may be a normal anatomic variation rather than a pathologic condition. A possible explanation of the high prevalence of incisor malocclusion is the sharing of a common gene pool since most of the ferrets came from the same breeding farm[r] based on the identification tattoo.

The normal gingival sulcus depth in ferrets has not been reported previously. The present study showed that the gingival sulcus depth measured < 0.5-mm in 87.8 % of anesthetized ferrets, and those ferrets with sulcus depths < 0.5-mm had no clinical or radiographic evidence of attachment loss. Therefore, in the

Figure 6

Photographs showing maxillary canine tooth extraction in a ferret. A mucoperiosteal flap was raised, and a stay suture was placed in the flap to avoid trauma from handling with thumb forceps (A). Removal of alveolar bone facilitated the extraction of the firmly rooted tooth (B). The flap of the maxillary canine tooth extraction site was apposed using 5-0 absorbable monofilament suture in a simple interrupted pattern (C).



present study, periodontal disease was documented in ferrets with clinical evidence of gingivitis, probing depths > 0.5-mm, gingival recession, and radiographic evidence of alveolar bone loss. Alveolar bone loss has been described previously in domestic ferret skull specimens at a prevalence rate of 62 %.[5] The normal gingival sulcus depth and, in cases of pathology, the periodontal pocket depth together with gingival recession are important clinical parameters for evaluation of periodontal attachment.[14] Use of periodontal probes designed for human dental evaluation limits the ability to detect subtle changes in sulcus and pocket depth. Clinical evidence of periodontal disease was present in 65.3 % of ferrets. However, advanced periodontal disease (*i.e.* periodontal pockets > 2-mm) was not found upon clinical examination of anesthetized ferrets.

One reason for the relative paucity of clinical evidence of periodontal disease may be due to the population of animals studied. Although the medical records were available for every animal, the age was sometimes estimated at the time of arrival at the shelter. The mean age of ferrets in this study was 4.0-years. The authors have seen clinical cases of ferrets affected by severe periodontal disease resulting in periapical disease and facial swelling (Fig. 8). However, most ferrets with severe periodontal disease are usually older than 4-years of age. It has been reported that 46.5 % of domestic ferrets were missing at least one tooth, and it was proposed that severe periodontal disease secondary to the diet contributes to tooth mobility and loss.[5] However, only 1 of 63 ferrets in the present study had a missing tooth. This ferret had not undergone an anesthetized oral examination due to its poor health condition, but it had noticeable root exposure of premolar teeth associated with advanced periodontal disease.

The CEJ has been routinely used as a radiographic reference mark for assessment of alveolar bone height in humans[14] and dogs.[15] In ferrets, the location of the CEJ is difficult to determine on dental radiographs due to the small size of the teeth. To the authors' knowledge, the area where the conical crown meets the cylindrical root has not been definitively determined as the location of the CEJ in ferrets. The present study showed that one or more canine teeth in 93.7 % of conscious ferrets appeared to be extruded as evidenced by exposure of up to 3-mm of the cylindrical portion of the tooth in the absence of gingival recession. This may be explained either by idiopathic tooth extrusion similar to that seen in domestic cats,[16] or this peculiarity may present a normal anatomic variation in ferrets. A histological study to determine the location and morphology of the CEJ in the context of clinical observations is currently in progress.

The prevalence of tooth fractures has been reported in necropsy specimens of pet ferrets of North America and feral ferrets

Figure 7

Photograph showing bilateral upper lip irritation (arrows) due to trauma from opposing mandibular canine teeth after extraction of maxillary canine teeth in a ferret.

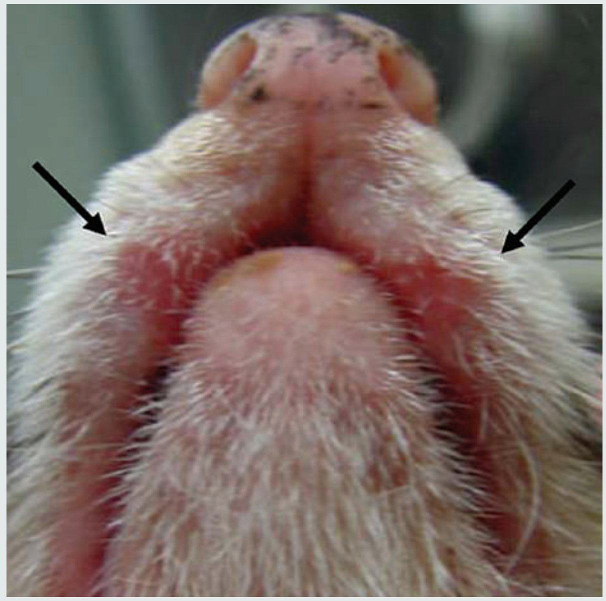
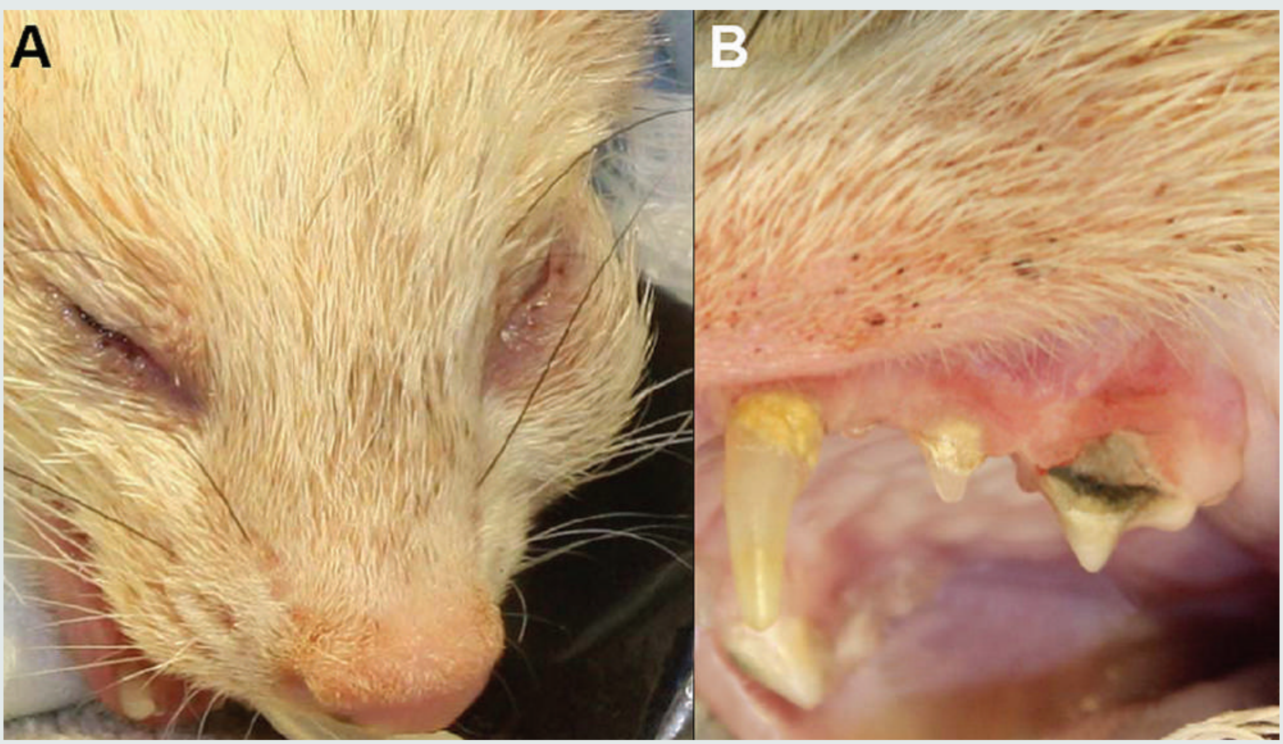


Figure 8

Photographs showing a ferret with left facial swelling (A) due to advanced focal periodontitis of the left maxillary fourth premolar tooth (B) that resulted in periapical infection and abscessation.



of New Zealand.[5] Fractured teeth were present in 30 % of pet ferrets but only in 4.5 % of feral ferrets. Although shelter ferrets represent a different population, animals included in the present study were exclusively pet ferrets. The prevalence of tooth fractures was 32 %. The high prevalence of tooth fractures in pet ferrets was thought to be due to cage confinement, environmental trauma, and human abuse.[5] Changes in biomechanics of the masticatory apparatus and cranial changes have been documented in captive animals.[17] These changes associated with domestication, including unnatural environment and artificial diets, may lead to abnormal chewing behavior that could result in an increased prevalence rate of tooth fracture in pet ferrets. It is important to create a domestic environment that minimizes the likelihood of dental trauma, such as considering confinement alternatives to wire mesh cages.

Similar to cats and dogs, complicated tooth fractures in ferrets can lead to pulpitis and pulp necrosis with possible periapical infection. Studies in experimental ferrets showed that pulp exposure led to infection, inflammation, and necrosis of the pulp followed by formation of radiographically detectable periapical lesions as early as 4-weeks after pulp exposure.[9] In the present study, more than 50 % (9 of 15) of all fractured teeth were confirmed to have resulted in exposure of the pulp chamber. Worn and fractured teeth without pulp exposure may also be at risk of endodontic disease. Concussive dental trauma may also lead to pulpitis and pulp necrosis with associated pain, even in the absence of endodontic infection.[18] One study evaluated the effects of pulpal inflammation induced by bacterial lipopolysacharide (LPS) and showed significant behavioral changes in affected ferrets (face-wash strokes, headshakes, forelimb flails, paw-licks, ear grasps, tongue protrusion, and chin rub) compared to the control group.[19]

The treatment of choice for complicated crown fractures is endodontic treatment or extraction. In the present study, extraction was chosen over endodontic treatment due to limited funds, remote location of the shelter in relation to the care providers, and necessity for long-term follow-up after endodontic treatment. Although the open extraction procedures (*i.e.* mucoperiosteal flap creation, partial alveolectomy, elevation of the tooth, and closure of the extraction site) were uneventful, it is worth mentioning that ferret oral mucosa is very thin, requiring extremely gentle handling of the flap tissue that is used to close the extraction site. Firmly rooted canine teeth require removal of alveolar bone to facilitate the extraction procedure. Closure of the flap with absorbable sutures in a simple interrupted fashion prevents food and debris from accumulating in the alveolus and may prevent clot disruption and alveolar osteitis ("dry socket"). In addition to their primary penetration and prehending functions, maxillary canine teeth deflect the upper lips away from the line of occlusion. The minor odontoplasty performed on the ipsilateral mandibular canine teeth in the hope of avoiding development of postoperative lip irritation due to self-trauma following maxillary canine tooth extraction failed to prevent this minor complication. Though this complication was minor, it may be avoided by treating fractured maxillary canine teeth with root canal therapy rather than extraction. Endodontic treatment may be considered as a preferred option for fractured canine teeth in pet ferrets, although each case should be evaluated individually.

Tooth resorption and dental caries have been widely reported and studied in different species. Tooth resorption represents the most common dental disease in cats with a reported prevalence in one study of 72.5 %.[20] Dental caries is very rare in cats and uncommon in dogs, with a prevalence of up to 5.3 % seen in dogs.[21] Diet has been implicated as a possible cause of both tooth resorption and dental caries.[20,21] Pet ferrets are often fed commercial cat food. The examined ferrets in the present study were fed a commercial ferret diet while in the shelter, however, their feeding management is largely unknown prior to entering the shelter. No evidence was found of tooth resorption, dental caries, stomatitis, or oral tumors in the examined ferret population.

A major limitation of the present study is that it reflects the prevalence of oral disease in a shelter environment of ferrets with largely similar genetic background, which may be different than the prevalence in the larger general pet ferret population. Ferrets of the present study were mostly surrendered or abandoned by the previous owners for various reasons including disease of the animal, allergy of the owner, and unwillingness or inability to take care of the animal. It may be justified to assume that the prevalence of oral disease is higher in rescued ferrets than in pet ferrets due to lack of disease prevention, presence of concurrent disease, and suboptimal diet and housing situations. Further, the results of this study were likely affected by the mean age of the population. For example, the prevalence of dental fractures found during conscious oral examination was higher than in the group that was anesthetized (Table 2). This correlates with the age of the examined animals. The mean age of ferrets examined without anesthesia was 4.0-years, whereas the mean age of ferrets that underwent anesthesia was 3.5-years because some older ferrets were considered unfit for and excluded from anesthesia. Some ferrets of unknown age were also included in the study.

Further studies are warranted to evaluate orofacial anatomy and assess the prevalence of oral disease in other ferret populations including geriatric pet ferrets, captive wild ferrets, and domestic pet ferrets from non-shelter environments.

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[a] http://vetdent.eu/cpd/cpddownloads/chart-ferret.pdf (modified from Dr. David Crossley)
[b] ButorJet, Phoenix Pharmaceutical, Inc., St. Joseph, MO
[c] Midazolam Hydrochloride Injection, Hospira, Inc., Lake Forest, IL
IsoFlo, Abbott Laboratories, Chicago, IL
[e] Mila International, Inc., Erlanger, KY
PDT Sensor Probe type US (Williams), Zila, Inc., Scottsdale, AZ
[g] Nomad, Aribex, Inc., Orem, UT
[h] Schick Technologies, Inc., Long Island City, NY
[i] Marcaine, Abbott Laboratories, Chicago, IL
[j] Lidocaine Hydrochloride Injection 2%, APP Pharmaceuticals, Schaumburg, Ilk
[k] Miltex Instrument Company, Inc., Bethpage, NY
[l] Cislak EX-19, Cislak Manufacturing, Inc., Niles, IL
[m] Ti-Max Ti 95 EX, NSK Nakanishi, Inc., Japan
[n] Cislak EX-W3, Cislak Manufacturing, Inc., Niles, IL
[o] Miltex Instrument Company, Inc., Bethpage, NY
[p] Monocryl, Ethicon, Somerville, NJ
[q] Metacam, Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO
[r] Marshall Farms Group, North Rose, NY

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