Dental Pain in Cats: A Prospective 6-Month Study

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Abstract
Dental pathology is among the most ubiquitous diseases in cats of all ages. Dental pain is yet to be fully understood in cats and therefore its presence is often missed. To better understand feline dental disease as a pain trigger during routine examination and whether disease severity correlates to the degree of pain, a 6-month prospective study in a cats’ only veterinary hospital in Portugal was conducted. Sixty-four cats that randomly presented for different clinical procedures were evaluated. Dental and periodontal abnormalities (primary dental parameters, PDP), as well as clinical signs related to dental pain (secondary dental parameters, SDP), were assessed. All cats underwent an oral cavity examination, upon which, the Feline Acute Pain Scale from Colorado State University Veterinary Teaching Hospital (CPS), was used in order to assess pain. Six PDP (periodontal disease, gingival index, calculus index, tooth resorption, tooth fracture and missing teeth) and five SDP (mouth discomfort, halitosis, hypersalivation, difficulty in holding food and several attempts at prehension of food), were compared with CPS pain scores. All SDP were significantly associated to higher CPS pain scores (p < 0.05). The number of missing teeth was significantly associated to higher CPS pain scores (p < 0.0001). A trend was observed between higher CPS pain scores and tooth resorption (p = 0.08). This study concluded that cats with dental disease feel pain during clinical examination and the pain increases as the severity of the disease progresses.

Keywords
behavior observation, cats, dental disease, dental pain, pain assessment

Introduction
Dental pathology is extremely common in cats and can influence the health and welfare of affected animals. Cats’ teeth have extensive sensory innervation, supplied by branches of the maxillary and mandibular nerves. Cats are therefore expected to experience dental and orofacial pain with disease, as do humans. However, cats being natural prey as well as being predators, they often do not show obvious signs of pain and discomfort associated with dental disease, as they may for many other painful conditions. Tools to clinically assess this are thus well-needed.

In the present study, tooth pain is defined according to the behavioral reaction to that sensation. Behavioral changes associated with dental pain in cats can be very subtle. Managing pain effectively requires a systematic and methodical evaluation and classification of its clinical signs. It has been postulated that pain evaluation for patients with periodontal disease (PD) should include oral palpation of the affected tissues and behavioral observation using pain scales, which provide written documentation of pain behavior.
root cementum and alveolar bone. In the final stages of PD, one or more teeth may be absent due to exfoliation (Figures 1 A-D and 2 A-C).3,6

TR is characterized by the loss of hard dental tissues due to the action of odontoclasts.1,11 In advanced stages of TR, the crown may be lost and the tooth may appear clinically absent, although the root remnants can be observed radiographically (Figures 3 A-F).14,15

The pathogenesis of PD involves bone lysis and cementum destruction which lead to dentine surface exposure increasing pain sensation.1,10 Severe gingivitis is a potential cause of oral discomfort.13 Patients affected by TR may also show hypersalivation due to painful inflammation of surrounding soft tissues.13,16 TR can be difficult to detect, with cats often masking signs of oral discomfort or pain, but once dentin destruction has progressed to pulpal exposure, then discomfort or pain becomes evident.6,11 Hypersalivation is a commonly described symptom of endodontic pain, as it induces increased salivation.6,9 Halitosis is present in PD and TR, due to the presence of tissue inflammation.6 Also, eating behavior may be affected.17 Traumatic tooth fractures and dentoalveolar injuries are known to be a cause of pain, particularly when associated with acute pulpitis and secondary periapical lesions (Figures 4A and 4B).12

The behavior of patients is key to recognition and assessment of pain, considering as follows; the maintenance of normal behavior, loss of normal behavior and development of new behaviors.9 Different tools have been used to detect pain in cats.18 The main recommendations are: tools must include documented levels of validity (content, construct and criterion validity), reliability (internal consistency, intra rater, inter rater, test retest) and sensitivity; the acute and the chronic pain scales are not interchangeable; and feline pain scales are used only for cats.17,19

The American Animal Hospital Association/American Association of Feline Practitioners (AAHA/AAFP) pain management guidelines recommended two pain scales for cats. The Feline Acute Pain Scale from Colorado State University Veterinary Teaching Hospital (CPS), although not validated,

Figure 1. Periodontal disease. A/B) Clinical photograph and radiograph of right maxillary arcade showing missing canine, second and third premolar teeth, and calculus accumulation and gingival recession on fourth premolar tooth (108). C/D) Clinical photograph and radiograph of left mandibular arcade showing severe gingivitis, missing third premolar tooth (307), severe periodontitis, loss of alveolar bone height and tooth resorption of distal root of molar tooth (309).
and the Universidade Estadual Paulista (UNESP, Botucatu) pain scale. Behavior alterations are better assessed and scored using either a descriptive, numerical rating or visual analogue scale. CPS is a complex numerical rating scale that records the intensity of the pain using a score from zero to five (0 = no pain; 1 = weak pain; 2 = mild pain; 3 = moderate pain; 4 = strong pain) by evaluating psychological and behavioral pain indicators, adequate for daily clinic practice use. For these reasons, CPS was used in this study.

Despite its crucial importance to cats’ welfare, to the best of our knowledge, no methods to evaluate pain caused by oral examination of dental diseases have yet been validated or even proposed in clinical practice. This is the first study in the literature which correlates feline dental disease with pain.

The aims of this study were to evaluate whether dental disease is a cause of pain for cats in routine oral examination and if disease severity correlates to pain scores. To objectify this acute type of pain on dental examination, CPS was used.

**Materials and Methods**

**Animals**

Data collection was conducted between August 2015 and January 2016 in the Hospital do Gato (Lisbon, Portugal). A total of 64 patients were recruited with 53 meeting the selection criteria. Clinical data of all patients were collected. Fifty-three cats subjected to an oral examination at the Hospital do Gato (Lisbon, Portugal) were included in this study. Cat ages were between 4 months and 16 years (mean = 6.4, SD = 5.2 years). Twenty-seven of the 53 cats were female (51%) and 26 were male (49%). All cats undergoing anesthesia were not anesthetized solely for research purposes, but rather for necessary dental or elective reproductive clinical procedures after obtaining informed consent from the owners.

**Selection Criteria**

All cats which allowed examination were included in the study. Animals were excluded when we observed a pain score level 4 not due to severe dental disease; it was impossible to complete.

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**Figure 2.** Periodontal disease. A) Clinical photograph showing gingival enlargement (*) over supraeruption of maxillary right canine tooth (104). B) Radiograph of image A showing bony buccal expansion (*). C) Normal radiographic appearance of tooth 204.

**Figure 3.** Tooth resorption. A/B) Clinical photograph and radiograph of maxillary right canine tooth (104) showing stage 4c, type 2 TR (arrowheads). C/D) Clinical photograph and radiograph of missing crown of mandibular left third premolar tooth (307) showing stage 4a, type 3 TR (arrowheads). E) Clinical photograph of missing mandibular right canine tooth (404) (arrow). F) Radiograph showing missing 404 with osteitis and stage 4c, type 1 TR of image E (arrow).

**Figure 4.** Radiographic signs of chronic necrotic pulpitis. A) Normal healthy pulp canal. B) Wide pulp canal and periapical radiolucency observed in the maxillary left canine tooth (*)
the dental chart; it was impossible to assess the level of pain; and cats presented with known painful or otherwise serious systemic diseases. Those in which dental charts or pain data were lacking or not complete were not included.

**General and Dental Examination Protocol**

The study consisted of five steps. Review of patient dental history, type of food, gender, age, owner perspective about dental pain and past dental procedures or current dental home care; general physical examination of all body systems, and extraoral examination of face symmetry, lymph node palpation and temporomandibular joint function; intraoral conscious examination of teeth, gingiva and oral mucosa; filling of the CPS in accordance with the cat’s response to mouth examination, recording the psychological and behavioral aspects, response to palpation and body tension degree; and dental charting under anesthesia, after evaluating gingival index with a periodontal probe, assessing calculus index and presence of periodontal disease, tooth resorption, tooth fractures and missing teeth.

The anesthesia protocol consisted of premedication with a combination of 0.2 mg/kg midazolam, 0.05 mg/kg medetomidine and 0.01 mg/kg buprenorphine, both via intramuscular route. After induction with propofol 2–4 mg/kg to effect, anesthesia was maintained with isoflurane mixed with oxygen.

**Studied Parameters Description**

History parameters: age, gender and type of food. Type of food was registered as wet food, dry food, or wet and dry food.

Primary dental parameters (PDP): six dental and periodontal abnormalities: periodontal disease, gingival index, calculus index, tooth resorption, tooth fracture and missing teeth based on the American Veterinary Dental College Nomenclature.15

Cats were allocated into the following three groups. 1 = healthy gingiva (PD0), 2 = gingivitis (PD1), 3 = periodontitis (mild (PD2); moderate (PD3) and severe (PD4)).1, 15 Gingival index (GI) and calculus index (CI) are described in Table 1.15 TR was clinically diagnosed when hyperplastic lesions were observed beneath gingiva adjacent to a surface enamel defect and further confirmed by intraoral radiography.11 Tooth fracture and missing teeth were also clinically diagnosed and classified as absent or present. SDP clinical signs related to dental pain were evaluated based on the owner’s report before the clinical examination. Studied SPS included: mouth discomfort, hypersalivation, difficulty in holding food, and several attempts to seize food and halitosis. These parameters were classified as absent or present.

Pain was assessed according to the CPS. Each response and behavior was observed and analyzed. As this scale was designed for acute pain, the response to manipulation was correlated with the disease severity at the time of examination.

**Statistical Analysis**

Results were analyzed using the 9.4 SAS Software to compare PDP and SDP with pain scores. When the dependent variable had more than two groups, the Glimmix and Genmod SAS procedures were employed. Post-hoc multiple means comparisons were carried out using the adjustment of Tukey-Kramer. Comparison between oral parameters and pain were carried out using the chi-square test, except when variables were continuous. In this case, data were analyzed with a logistic regression using the Logistic procedure of SAS 9.4 software. Dental parameters and pain scores were also compared to age, sex and type of food. Statistical significance was based on a 5% (p<0.05) significance level.

**Results**

**PDP**

Fifteen cats presented with PD0 (28%), 20 cats PD1 (38%) and 18 cats PD2 (34%). Sixteen cats presented with GI0 (30%), 15 cats GI1 (28%), 14 cats GI2 (27%) 8 cats GI3 (15%). Sixteen cats presented with CI0 (30%), 14 cats CI1 (26%), 11 cats CI2 (21%) and 12 cats CI3 (23%). The mean number of missing teeth was 3 (range 0-25). The prevalence of TR was 25% (13 cats), and the prevalence of tooth fracture was 23% (12 cats).
Table 2. Dental Parameters (Primary, PDP and Secondary, SPD) Comparison with Pain Scores Using the CPS.

| Dental parameter                                      | p-value       |
|-------------------------------------------------------|---------------|
| **Primary dental parameters (PDP)**                   |               |
| Periodontal disease                                   | 0.1140        |
| Gingival index                                        | 0.6545        |
| Calculus index                                        | 0.2440        |
| Tooth resorption                                      | 0.0844        |
| Fracture                                              | 0.2925        |
| Missing teeth                                         | <0.0001       |
| **Secondary dental parameters (SPD)**                 |               |
| Discomfort in the mouth                               | 0.0239        |
| Halitosis                                             | 0.0293        |
| Hypersalivation                                       | 0.0055        |
| Difficulty in holding food                            | 0.0013        |
| Several attempts in arresting food                    | 0.0013        |

SDP

Twenty-four cats (45%) presented with halitosis, 23 cats (43%) had difficulty in holding food and 23 cats (43%) exhibited several attempts to prehend food, 19 cats (36%) had mouth discomfort, 12 cats (23%) showed hypersalivation.

CPS

Twenty-two cats (41%) showed no pain (score 0), 11 cats (21%) showed weak pain (score 1), 11 cats (21%) showed mild pain (score 2), and 9 cats (17%) showed moderate pain (score 3). No cats showed severe pain (score 4). 31 out of 53 cats (59%) exhibited pain with differing CPS scores upon oral examination.

Dental Parameters and Pain Assessment

PDP and SDP statistical comparison scores are shown in Table 2. Concerning PDP, a statistically significant correlation was found between missing teeth and pain scores (p<0.0001) (Figure 5). Moreover, a statistical trend was observed between tooth resorption and pain score (p = 0.0844). Statistical correlations were not found between pain score groups and the remaining PDP: periodontal disease (p = 0.1140), tooth fracture (p = 0.2925), gingival index (p = 0.6545) and calculus index (p = 0.2440).

On the other hand, all SDP were statistically associated to pain scores. There was a statistical correlation between pain score groups and hypersalivation (p = 0.0055) (Figure 6), mouth discomfort (p = 0.0239), halitosis (p = 0.0293), difficulty holding food (p = 0.0013), and several attempts to prehend food (p = 0.0013).

Increasing age was statistically associated with periodontal disease (p = 0.0159), missing teeth (p<0.0001), mouth discomfort (p = 0.0156), halitosis (p = 0.0056), hypersalivation (p = 0.0083), difficulty in holding food (p = 0.0005) and several attempts to prehend food (p = 0.0005).

GI was statistically correlated with type of food (p<0.0001). Cats fed wet food showed higher GI scores (GI3, p = 0.0025) than those fed dry food (odds ratio = 0.067) as well as those fed a combination of dry and wet food (odds ratio = 0.022).

Cats fed dry or wet food alone presented a higher number of missing teeth than those fed a combination of the two (p<0.0001). Males more often showed difficulty holding (p = 0.0201) and prehending food (p = 0.0201) when compared with female cats.

Discussion

This study confirms that dental disease is a cause of pain in cats during oral cavity examination, likely due to the well-developed nervous system that innervates teeth and adjoining structures.3,4
Among PDP, the number of missing teeth was associated with increasing pain. The literature describes that the number of missing teeth is associated with late stage PD and advanced stages of TR. These underlying causes, PD and TR, could be a source of dental pain in cats with missing teeth. Our study also showed a statistical trend between the presence of TR and increasing pain.

All SDP were statistically associated with the presence of increasing dental pain. Among these, halitosis and hypersalivation are well-documented signs of dental disease. Moreover, patients affected by TR often show hypersalivation due to painful inflammation in surrounding soft tissues.

Our results showed that SDP are not only a sign of dental disease but are also associated with the presence of dental pain as a consequence of the underlying oral disorder.

Another interesting result is that an exclusive wet food diet seems to negatively influence cats’ dental health. In fact, wet food intake was correlated with a GI of 3 and with an increased number of missing teeth. Two possible hypotheses could explain this finding. Firstly, wet food has been described in the literature as not allowing the correct mechanical removal of dental plaques, increasing the risk of gingival inflammation. Secondly, cats suffering from moderate to severe GI may prefer wet food to reduce mouth discomfort, as previously proposed. It is likely that both may be contributing factors in this association. It has been previously described that dietary formulation and nutritional intake affect tooth, bone and mucosal integrity and tooth longevity.

The age of the cats was correlated with the presence of PD, due to the fact that PD is a progressive condition, which tends to be aggravated if the initial cause is not treated. Also the number of missing teeth was associated with increasing age, probably because the PD and TR which cause missing teeth are progressive and a certain amount of time is required for the final loss or destruction of the tooth. All SDP were correlated with age. The majority of dental diseases are progressive over time, so the behavioral manifestations of these are more common and detectable as the cat ages.

Globally, our study highlights the importance of dental health care in cats. This work adds a further insight that cats suffering from dental disease feel pain upon manipulation of the affected areas. Dental pain was found to be stronger in a disease severity-dependent manner. Even if cats can hide symptoms of pain, owners and practitioners may have some useful clues for suspicion. SDP, mouth discomfort, halitosis, hypersalivation, difficulty holding food and several attempts at prehension, appear to be closely related to a concerning state of dental pain.

Materials

a Midazolam, B. Braun Melsungen AG, Germany.
b Domitor, Pfizer Animal Health BV, Netherlands.
c Bupaq, Richter Pharma AG, Austria.
d Propofol Lipuro, B. Braun Melsungen AG, Germany.
e IsoFlo, Zoetis, Portugal.
f SAS Institute, North Carolina, USA.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

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