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ORIGINAL RESEARCH ARTICLE

A Limited, Lower-Cost Dental Procedure Can Improve Owner-Reported Canine Health and Welfare for Dogs With Severe Dental Disease

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Abstract

***Introduction*:** Dental disease is nearly ubiquitous in dogs, with small breeds being particularly afflicted. Dogs with any degree of dental disease require evaluation and treatment under general anesthesia, which is financially out of reach for many pet owners. The objective of this study was to document the impact of a lower-cost dental procedure on dog health and quality of life (QoL) among a population of small breed dogs with severe dental disease who lacked access to dental care.

***Methods*:** Client-owned small breed dogs received a dental examination and cleaning under anesthesia. Full-mouth radiographs were taken and repeated after extractions. The veterinarian performing the procedure was blinded to the radiographs, which were reviewed by a general practitioner with a special interest in dentistry. The actions of the procedure veterinarian were compared with the recommendations from the radiographs. Owners completed questionnaires measuring dog health and QoL before the procedure, 1 month, 3 months and 6 months post-dental procedure. Dental exams and radiographs were repeated for each dog after at least 6 months.

***Results*:** 56 dogs were enrolled, and 40 completed all parts of the study. Most owners had been waiting more than 1 year for the dental procedure to be scheduled due to cost concerns. Owner-reported health and QoL were higher 1 month and 6 months post-procedure. The procedure veterinarian performed the recommended action (as suggested by dental radiograph review) 85% of the time.

***Conclusions*:** In small breed dogs with severe dental disease, radiographs were minimally helpful in determining treatment decisions. An abbreviated dental procedure improved dog health and QoL as assessed by the owner. Given that many owners delay or never schedule dental procedures due to the cost, making them more affordable is essential to improve access.

Keywords: *dogs*; *dental disease*; *quality of life*; *spectrum of care*; *accessible veterinary care*; *general practitioner*

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Oral health is a critical component of overall well-being in companion animals, yet periodontal disease remains one of the most prevalent – and often under-addressed – health conditions in dogs.[1,2] Approximately 80–90% of dogs develop periodontal disease between 3 and 10 years of age, with especially high prevalence among small breeds and brachycephalic dogs.[1–3] A study conducted across 1,000 Banfield Pet Hospitals encompassing data from 3 million pets in 2023 reported that 73% of dogs and 64% of cats were diagnosed with dental-related issues.[3] In addition to causing symptoms such as pain, drooling and reluctance to eat or drink, periodontal disease has been associated with an increased risk for chronic kidney and heart disease.[3]

Affordability remains one of the most significant barriers to accessing veterinary dental care. The cost of canine dental care—which often includes procedures with full-mouth radiographs and extractions under general anesthesia[4] is a significant obstacle for pet owners seeking dental treatment for their pets.[5] Many pet insurance

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policies exclude coverage for routine or preventive dental care, placing the financial burden squarely on pet owners, and as a result, some owners are forced to forgo necessary treatment even if their pets are insured.[5] In fact, nearly 52% of American pet owners have declined recommended veterinary care, and 71% of those owners said it was because they could not afford it or it was too expensive.[6] Even in clinics that advertise 'low-cost' services, affordability often remains a substantial concern.[7] Financial limitations can prevent timely interventions, leading to more advanced disease progression and further increasing the cost and complexity of care.

Community-based veterinary medicine models aim to reduce access barriers, yet they often struggle to include dental procedures due to resource constraints. These clinics typically provide subsidized or sliding-scale services to underserved populations, but dental care, particularly procedures requiring anesthesia or specialized equipment, can be challenging to provide for all of the animals who need it. Financial limitations are the most commonly cited barrier to veterinary access, and nationwide, 80% of pet owners who were unable to obtain veterinary care cited cost as the primary reason.[7–9] In addition, pet owners are often surprised at the cost of veterinary care, and about 59% agree or strongly agree that routine veterinary visits cost more than expected.[10,11] These challenges can affect pet owners across income levels and may contribute to emotional and family stress.[7,12] Expanding accessibility of dental services by lowering the cost of the procedure could play a critical role in reducing health disparities in companion animals.

Despite growing interest in developing more accessible models of veterinary dental care, there remains a significant lack of research on the outcomes and effectiveness of lower-cost procedures. While at home interventions such as daily tooth brushing, dental chews[5] or advanced therapies like platelet-rich plasma injections have shown promise in managing periodontal disease[13] these options are often financially or logistically out of reach for many pet owners, particularly those facing economic hardship or systemic barriers to accessing veterinary care. Low-cost preventive measures such as home care are also of limited value once periodontal disease is already established. Moreover, in addition to issues that owners may have in being able to pay for needed care, in many parts of the world community clinics, animal shelters, and low-cost veterinary programs operate without access to diagnostic tools such as dental radiography.

In addition, there are often very long waiting lists for dental services for shelter pets and private clients alike in many communities. All of these challenges underscore the pressing need for practical, scalable, and evidence-based dental care approaches that are more efficient yet safe and effective, even in resource-limited settings. Expanding research in this area could support the development of protocols tailored for diverse practice environments, ultimately improving health outcomes for a broader population of companion animals.

To explore the health and welfare impacts of limited dental procedures on dogs, we conducted a prospective, nonrandomized clinical trial evaluating the effects of a lower-cost dental procedure in a sample of 56 dogs. The study aimed to assess both clinical outcomes and owner-reported measures of quality of life (QoL) in the months following a lower-cost dental procedure in which veterinarians were blinded to radiographic diagnostics prior to performing a dental procedure. By documenting the effects of dental procedures based on observable clinical signs rather than radiographic diagnostics, this research seeks to inform the feasibility, safety, and effectiveness of more accessible models of veterinary dentistry. Anecdotally, we are aware of veterinarians and programs that sometimes forgo dental radiography due to resource constraints despite its inclusion being the current standard of care. Given such circumstances where dental procedures might be performed without the benefit of imaging, we wanted to answer the question as to what impact forgoing this diagnostic step would have on a canine patient with advanced periodontal disease. In other words, did performing a dental procedure without radiographs cause actual harm to the patient, and if so, could the risk of harm be quantified in order to better guide caregivers to make decisions regarding dental procedures.

Methods

In order to understand canine health and QoL after a lower-cost dental procedure, we conducted a prospective, nonrandomized dental clinical trial of 56 dogs from September 2019 through March of 2023. Dogs were eligible if they were under 25 pounds, had been advised to have a dental cleaning, and were reasonable anesthetic candidates as assessed by a board-certified veterinary anesthesiologist (EM). Dogs at high anesthetic risk (ASA IV or higher) or dogs with only mild periodontal disease were excluded from this study. Owner consent was obtained prior to enrollment, and participants could withdraw from the study at any time. The study was reviewed by Tufts University's IACUC (Protocol #006-19) and excluded from review by the institutional review board (IRB) as nonhuman subject research.

Procedure

Participants in this clinical trial were referred by local veterinarians from community clinics. Owners were asked to complete a survey questionnaire at the time of enrollment and schedule their dog for a dental appointment. After the dental procedure, owners were contacted within 1 week to check in on the dog's health and well-being.

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Next, owners were asked to fill out a survey questionnaire post-dental procedure. Dogs were then re-checked by a veterinarian 6–12 months after the original dental procedure. Scheduling variability for this 6-month recheck procedure was impacted by COVID-19 veterinary clinic shutdowns. Additional dental work and cleanings were performed at this re-check appointment if needed. Dogs were lost to follow-up if we were unable to contact owners after three attempts. Finally, we attempted to call all of the dog owners 2 years after completion of the study to check on the dog's condition.

Clinical procedure

Enrolled dogs received a screening physical exam and baseline laboratory profile (complete blood count [CBC] and chemistry panel). Dogs were pre-medicated with acepromazine (0.01–0.02 mg/kg) and butorphanol (0.1–0.4 mg/kg), and an intravenous catheter was placed into a cephalic vein.

Induction was with propofol (4 mg/kg given to effect), and anesthesia was maintained with isoflurane in 100% oxygen. Dogs were monitored using a multiparametric veterinary anesthesia monitor and Doppler detection of arterial pulse and were maintained on heat support using a HotDog® warming blanket and Bair Hugger™). Endotracheal cuffs were inflated until there was no audible leak at 10 cm H_2O, and cuff patency was checked frequently. Dogs who needed extractions were given a dose of buprenorphine at 0.01 mg/kg and dental blocks with bupivacaine at a maximum dosage of 2 mg/kg. Dogs received an injection of meloxicam (0.1 mg/kg) or carprofen (2 mg/kg) and were discharged with 2–3 days of the same nonsteroidal anti-inflammatory drug (NSAID). at the same dose at an appropriate dosing interval, depending on what was most convenient by weight. Ampicillin and additional analgesics were given if the clinician felt indicated.

Immediately after induction and monitor placement, complete full-mouth digital radiographs were obtained using a standard digital image capture system for veterinary dentistry and Progeny software. The radiographs were obtained by a licensed veterinary technician (LVT) who was not involved in treatment decisions (LK). The primary clinician (ER), who was a highly experienced community veterinarian, was blinded to the radiographs and performed the dental procedure based on clinical symptomology; essentially, teeth that were mobile in the mouth or teeth that were cracked or otherwise had root or pulp exposure were removed. After any extractions, all remaining teeth were cleaned using an ultrasonic scaler and then polished. If any extractions were performed, a full set of dental radiographs was then obtained. Before and after photographs of teeth were also taken. Dogs were discharged after anesthetic recovery.

Radiograph review

Both sets of dental radiographs (pre- and post-procedure) were sent to a highly experienced general practice veterinarian with a special interest in dentistry. This veterinarian made a recommendation for each tooth based solely on the radiographic findings. Options for each tooth included: healthy (no action), extract, extract if mobile/clinical significance, and not applicable (missing tooth or nondiagnostic radiograph). The veterinarian reviewed the post-procedure films and scored each tooth based on whether their recommendation had been followed by the clinician who was blinded to the x-rays. Based on the radiographs, the veterinarian was asked to rate the dog's periodontal disease on a scale of 0 (normal) to 4 (severe).

Recheck examination

Dogs were re-anesthetized 6–12 months after the initial dental procedure, and an additional set of full-mouth radiographs was obtained. Dental cleaning was repeated, and additional extractions were performed if indicated on the radiographs.

Measures

Quality of life

Questionnaires about dog demographics, health, lifestyle, and QoL were collected from owners at four time points (enrollment, 1, 3, and 6 months post-dental procedure). Participants were asked at enrollment how long the dog had needed a dental cleaning, and response options included less than a year, 1–2 years, 2–3 years, 3–4 years, and 5+ years. Participants were asked if the dog had previously had a dental procedure (yes/no/not sure), and if they felt like their dog was in pain (yes/no/not sure). Owners were also asked to rate their pets' overall health (*1 = fair, 2 = good, 3 = very good, and 4 = excellent*). The QoL Instrument used was modified from one used in a recent study of cats.[14] QoL was measured by asking owners to think back over the last week and rate their dog's QoL where 0 is a life not worth living and 10 is the best life possible. In addition, owners were asked about their dog's behavior and if they noticed any changes in the way their dog plays or eats since the dental procedure.

Data analysis

Data were analyzed using SPSS Version 27. Descriptive statistics were used to understand dog demographic variables within our sample (age, sex, breed, etc.). For each dog, the number of extractions recommended by the radiograph review was compared with the number of extractions performed at the original dental procedure and at the recheck. Additionally, the number of retained roots from the dental procedure was recorded. For owner survey questionnaires, we compared the mean scores of dog pain, health,

and QoL at enrollment and 1 and 6 months post-dental procedure using paired-sample *t*-tests (α = 0.05). Prior to conducting *t*-tests, assumptions of normality and homogeneity of variances were evaluated. We did not use a repeated-measures, multilevel regression model to analyze these data because of the limited sample size for each point due to high attrition. Qualitative data were limited, as open-text fields were optional, resulting in substantial missing data and a small sample size insufficient for meaningful thematic analysis. Accordingly, we did not conduct a robust content analysis; instead, we applied simple coding (positive vs. negative/neutral responses) and used selected quotes to illustrate interpretation of survey items.

Results

Dental procedures were performed on 56 dogs. Dogs ranged in age from 4.5 to 16 years with a mean age of 9.4 years (SD = 2.56). Most dogs were small, ranging in size from 1.9 to 14.5 kg with a mean weight of 6.8 kg (SD = 2.18). Dogs were a variety of small breeds, with 13 (24%) being Chihuahuas, 13 (24%) were Yorkshire Terriers or Shih Tzus and the remainder a variety of small and mixed breed dogs. The sex distribution was equal with 28 females and 28 males, and the majority of the dogs were spayed or neutered.

Owner perception of dental pain and health

When owners were asked how long they had known that their dog needed a dental cleaning, 10 (20%) reported less than 1 year, 14 (27%) said 1–2 years, 17 (33%) 2–3 years, 7 (14%) 3–4 years, and 3 (5.9%) said 5 years or longer. When asked whether the dog had previously had a dental cleaning, 32 out of 51 owners (63%) said *no* and 19 owners (37%) said *yes.* At the time of enrollment and at each follow-up assessment, owners were asked if they thought their dog was in pain; results are shown in Table 1. Additionally, owners were asked to rate their pet's overall health, and results are in Table 2. Dogs at 1 month (d = –0.61, M = 3.36, $t(43) = -4.07$, $p < 0.001$) and 6 months (d = –0.62, M = 3.35, $t(38) = -3.88$, $p < 0.001$) post-procedure had significantly higher overall health ratings when compared to ratings at study enrollment (M = 2.77, SD = 0.73). Dogs did not have statistically different health scores from 1 to 6 months (Table 3) post-procedure.

Owner-reported QoL data

Owners were also asked to evaluate their dog's QoL at the time of enrollment and at 1 and 6 months after the procedure. To assess global QoL, owners were asked to give their dogs a global QoL score from 0 to 10 where 0 is a life not worth living and 10 is the best life possible. Dogs had significantly higher QoL ratings at both 1 month post-procedure (d = –0.41) and 6 months post-procedure (d = –0.34) than they did at enrollment; however, no significant differences were found between scores at 1 and 6 months (Table 3). Owners were also asked after the procedure if they had noticed any differences with how their pet was eating (such as noisy chewing, dropping food, etc.). The total number of qualitative responses available for simple coding was 45. Of 47 owners who responded to the question about how their pet was eating at the 1-month follow-up, 33 (70%) owners reported no changes in the way that their pet ate, whereas 14 (30%) said they had noted changes. Of the 30% of owners who noted changes with the way that their dog was eating, 12 out of 14 reported changes in a positive way,

Table 1. Owner assessment of presence of pain at enrollment, 1 month and 6 months after procedure

Dog feeling pain	Time of enrollment	1-month follow-up	6-month follow-up
Yes	19 (36.54%)	2 (4.35%)	3 (6.98%)
No	33 (63.46%)	44 (95.65%)	40 (93.02%)
Total (*n*)	52	46	43

Table 2. Owner assessment of pet's overall health at enrollment compared to 1 and 6 months post-procedure

Health score	*N*	Min score	Max score	Mean	SD	*P*
Enrollment	52	1	4	2.77	0.73	-
1 month post	47	2	4	3.36	0.67	< 0.001*
6 months post	43	1	4	3.35	0.75	< 0.001**

*1 month compared to enrollment, **6 months compared to enrollment.

Table 3. Owner-reported global quality of life (QoL) scores at enrollment compared to 1 and 6 months post-dental procedure

QoL score	*N*	Min score	Max score	Mean	SD	*P*
Enrollment	49	4	10	8.57	1.46	-
1 month post	46	6	10	9.12	1.50	0.01*
6 months post	42	4	10	9.08	1.33	0.02**

*1 month compared to enrollment, **6 months compared to enrollment.

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meaning that their dog's eating was improved compared to how they were eating at enrollment. These results were supported by owner qualitative comments such as: 'I think he is doing better than before', 'She is eating much more comfortably and does not shift her head from side to side while eating', 'He will now readily eat raw carrots and other crunchy vegetables again and was once again interested in his Greenie', and 'No longer taking food and running away to drop it on the floor. Eating VERY well'.

Dental radiographs

At the time of the original dental procedure, 53.6% of dogs (30) had periodontal disease scores of 3 or 4. The distribution of periodontal disease scores for dogs is given in Table 4. In contrast, at the 6-month recheck, only 12.5% of dogs (5) had ratings of 3 or 4 for periodontal disease, whereas 78% of dogs (31) were rated a 0 or 1. Based on pre-procedure radiographs, each dog had on average 13 healthy teeth (SD = 10.20), 9 missing teeth (SD = 6.41), 11 teeth that were recommended for extraction (SD = 9.2), an average of 5 teeth (SD = 4.28) that were recommended to extract if clinical signs or visual observation (i.e. mobility present), and about 4 teeth (SD = 3.77) where a recommendation was not possible (due to either radiograph quality or a missing tooth). Among cases with matching pre- and post-procedure radiographs, a sample of 2,104 teeth were included in this section of analysis after excluding 248 teeth due to missing radiographic data or missing documentation of the recommended action performed. Seven hundred and thirty-six (736) teeth had "no recommendation applicable", which indicated that a recommendation could not be assigned for a given tooth. The reason was not always documented for each individual tooth, but commonly included missing teeth in the mouth or radiographic issues that prevented assessment. As a result, recommendations were possible for 1,368 teeth in total. Each dog had an average of 20 teeth (SD = 8.61) for which the outcome (what was done by the procedure veterinarian) matched what was recommended by radiographic review. There was an average of 4 teeth (SD = 5.00) per dog for which the outcome did not match the recommendation made by the veterinarian looking at the radiographs. An average of 13 teeth per dog (SD = 6.71) were 'no recommendation applicable' and could not be evaluated for a recommendation. If looking at only the 1368 teeth that had a possible recommendation, 1,164 (85%) were a match, meaning the clinician performed the recommended action and 204 (15%) were not a match. Of 53 dogs who had extractions performed during the dental procedure, 25 dogs (47.2%) were found to have at least one root remaining on the post procedure radiographs.

Table 4. Assessment of periodontal disease among study subjects

Periodontal disease score	Number of dogs with score at enrollment (n = 56)	Number of dogs with score at 6-month re-check (n = 40)
0	2 (3.6%)	11 (27.5%)
1	12 (21.4%)	20 (50.0%)
2	12 (21.4%)	4 (10.0%)
3	6 (10.7%)	3 (7.5%)
4	24 (42.9%)	2 (5.0%)

Re-check dental evaluation

In order to assess longer-term outcomes from the dental procedure, we performed a follow-up dental recheck of 40 dogs (71%). Sixteen dogs were lost to follow-up. While each dog had about 11 teeth on the initial exam that were recommended for extraction, at the time of the recheck exam, this number had decreased to an average of 2.5 teeth (SD = 2.60) per dog (with a range of 0–10). The average number of teeth per dog recommended to do nothing (healthy) at 6-month recheck was 15.52 (SD = 10.9, min = 0, max = 34), and the average number of teeth per dog recommended to extract if questionable at 6-month recheck was 3.7 (SD = 3.55, min = 0, max = 17). As previously mentioned, 25 dogs were found to have retained roots after the initial dental procedure. Of these, 18 dogs returned for the 6-month follow-up procedure, but no problems with retained roots were found by clinicians. One additional dog was seen at the clinic after the procedure for pain from a retained root, which was then extracted. Finally, we attempted to call the dog owners 2 years after completion of the study and were able to reach the owners of all but six dogs. All dogs were reportedly doing well, and owners had no concerns about the teeth.

Discussion

In this study of 56 dogs with severe dental disease, we were able to demonstrate that a dental cleaning increased owner-reported health and QoL assessments on average for the dogs in our study. Importantly, the improvements in dog health and welfare were maintained at the time of recheck. Many of the dogs in our study had waited years for dental cleaning because the owners were unable to afford recommended care, and multiple owners had reached out to the study team directly seeking help for their dogs because they could not afford dental care procedures. Dog owners often expressed considerable moral distress that they were unable to follow through with a recommended treatment plan. An important issue that needs to be addressed in veterinary medicine concerns the obvious and inescapable fact that if clients cannot comply with the recommended treatment plan because of cost or other barriers to care, then the animal does not receive needed care. In our study, this reality was evident by the amount of time that clients had been waiting to get

a dental procedure. Lack of veterinary care is clearly an animal welfare problem for the patient, but there are other impacted parties, including the bonded pet parent who feels guilt and shame, as well as the veterinary caregiver who may also experience moral distress at being unable to provide care.[15,16] One approach to address the challenge of accessible veterinary care that has gained popularity over the last 5 years is the idea of providing a spectrum of care.[17] Critical to a spectrum of care approach is the idea that there are treatment options for most price points, and rather than centering the treatment plan on the veterinarian's desire to offer a gold standard treatment option,[18] the pet's caretaker should be supported by the veterinary care team to choose the treatment option that best suits their circumstances. As long as basic welfare needs are met (i.e. the patient is not suffering), there should be many approaches that are medically appropriate for most conditions, with euthanasia being an option when cases are not easily treatable and the prognosis is poor.

Accordingly, in order to be able to provide a spectrum of care approach for canine dental disease, it is essential to either develop less expensive care plans or additional ways for clients to pay. or both. One of the ways we believe that we can lower the cost of care is by increasing the efficiency of care. For dentistry, one of the more time-consuming steps can be obtaining and reviewing dental radiographs, although that time can be greatly decreased with well-trained staff. Another barrier to being able to perform a high standard of dental care can be the availability of equipment. While many state practice acts currently require dental radiographs to be taken, that is not the case for all states, and moreover there are many practice settings where radiographs are not available. The results here demonstrated that radiographs added limited value for this population of severely affected dogs, as 85% of the time the veterinarian performed the recommended action and was able to determine the 'correct' action based on the appearance of the teeth in the mouth. However, the risk of retained roots among extracted teeth was high, with nearly 50% of dogs undergoing extractions had at least one retained root. Importantly, many of the dogs already had evidence of retained roots prior to the extractions we performed, and there was little evidence of these retained roots causing any problems. In the dogs that had retained roots after the extractions that we performed, we were only able to document subsequent clinical signs in one dog. We believe that while it is optimal to take radiographs after every extraction, in order to document the presence or preferably absence of retained roots, that in situations where teeth are removed and radiographs are not taken, owners should be warned that there is potentially up to a 50% risk of their dog having a retained tooth root and informed about what clinical signs to look out for. In our experience, owners were understanding when they were told future procedures may be needed but valued having that explained to them in advance. Whenever clients choose a treatment plan that deviates from the accepted standard of care, it is critical that likely risks are explained and informed consent is documented.

Limitations

This project had several important limitations. Some data were incomplete, and recommendations had to be extrapolated for teeth that were missing or were healthy and for which the dental expert had no comment. We studied only dogs with severe dental disease, and so our results may not be generalizable beyond this population. Only 56 dogs were able to be enrolled, and many were lost to follow-up before the 6-month recheck. Community medicine clients often have many barriers to care, and despite our efforts to be as accommodating as possible with the study participants, some of these barriers impacted our clients' ability to comply with requested follow-up. Additionally, the length of the study period ended up being 12–18 months for most of the dogs, rather than the 6 months we had planned. Some of the difficulties we had completing the study procedures in 6 months were due to the COVID-19 pandemic, which paused all research activities at our institution for 3 months, just as we had begun to enroll patients. We initially had planned to do the recheck evaluations at 6 months because we thought of that as a time far enough away from the original procedure that improvements to the dog's teeth would remain present, but new pathology may not have emerged, making it easier to distinguish problems that may have arisen from the abbreviated procedure from new disease. Many of the dogs required additional extractions at the time of the recheck. In a population of older small breed dogs who have already developed periodontal disease, it is likely that these dogs would benefit from annual dental examinations and cleanings. While this reality made it difficult for our study to demonstrate a long-lasting impact from the intervention, because the expected duration of any benefit would, of course, be somewhat limited, it is another reason why it is imperative that we find less expensive ways to provide dental procedures if we want clients to comply with our recommendations. Since we asked only a limited number of optional open-response questions, we did not have enough qualitative data for a meaningful thematic analysis and recommend that future studies include robust, required open-ended fields to support rigorous qualitative analysis. Finally, our results are based on owner evaluation of their own dog's QoL and are applicable only to dogs with end-stage periodontal disease.

Conclusion

We found that an abbreviated dental procedure improved owner-observed dog QoL. We were able to demonstrate

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persistent improvements in dog oral health and QoL post-procedure and those benefits persisted for at least 6 months. Treatment decisions based on symptomatology for these dogs were relatively accurate, although nearly 50% of dogs had at least one retained root. While the clinical significance of the retained roots remains unknown, we were unable to document that they caused harm in the vast majority of patients. In our experience, the retained roots caused minimal to no impact on the patient's welfare. Making dentistry more affordable would increase the number of dog owners who are able to provide this service for their pet.

Author contributions

McCobb: conceptualization, data curation, funding acquisition, investigation, methodology, project administration, supervision, writing. King: data curation, methodology, formal analysis, writing. Knight: data curation, investigation, resources. Clifton: data curation, investigation, writing. Rozanski: conceptualization, investigation, methodology, writing.

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Author notes

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