# Tooth Resorption in Cats

## Introduction

It has been a little over eight years since I wrote about tooth resorption in cats and while not a lot has changed, in a practical sense, I think it is time I update you on some more recent findings and thoughts. By the way, there is also a paper on tooth resorption in dogs which is something we are seeing with increasing frequency. I would encourage you to review that paper as well:

www.toothvet.ca/PDFfiles/TRs_in_Dogs.pdf

The nomenclature committee of the American Veterinary Dental College has decided we should abandon the old terms such as "neck lesions", "feline odontoclastic resorptive lesions" and such in favour of the very simple *tooth resorption* which is abbreviated as TR. For more on proper dental nomenclature, grades and stages of pathology, please visit the AVDC website:

http://www.avdc.org/Nomenclature/Nomen-Teeth.html#resorption

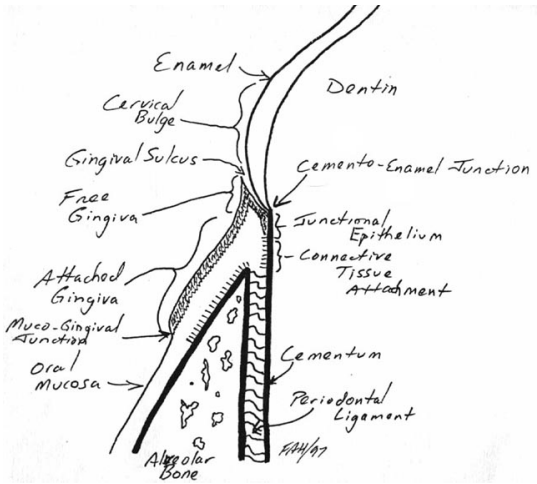
Over the past decade there have been a number of papers presented and published examining the problem of tooth resorption and though the body of knowledge has been growing, the pieces of the puzzle have not been adding up to a clear understanding of the condition. Around the beginning of this century there were a number of new studies presented that showed some promise of bringing the bits together so that a plausible picture almost came into focus.

## Anatomy Review

Before I embark on this discussion, we need to review a bit of anatomy to make sure we are all speaking the same language.

The crown of the tooth is that part covered by enamel and the root is covered by cementum. Where the crown and root meet is the neck, cervix or cementoenamel junction (CEJ). The bulk of the tooth is composed of dentin and inside the tooth is a hollow chamber containing the dental pulp.

Most of the root is situated in a depression in the bone known as the alveolus. The most coronal portion of the root extends above the margin of the alveolar bone. Gingiva is a tough tissue that lies against the tooth and alveolar bone. The free-gingival margin is above the CEJ, but gingiva does not attach to enamel, so the gingiva above the CEJ is known as the free gingiva (‘cause it ain’t attached) and the space between gingiva and enamel is known as the gingival sulcus. From the CEJ to the crest of the alveolar bone, the gingiva should be firmly attached to the root cementum in a tight collar completely encircling the tooth. It is this collar of gingival attachment that isolates the periodontal ligament space from oral bacteria and acts as the barrier to periodontal disease.



Line drawing of the periodontal tissues.

Within the alveolus, there is a space between the root and bone (the periodontal ligament space), occupied by the periodontal ligament, which attaches to the bone and cementum. The periodontal ligament space appears radiographically as a fine radiolucent line following the contour of the root.

I need to quote an axiom that must be kept in mind. *A little knowledge is a dangerous thing*. What follows will be a condensed review of some relatively recent papers. Much of this information needs further study before we can change our approach to treating tooth resorption. I do not want you going off half-cocked.

One more introductory note (which will be repeated because it is soooo important).

INTRA-ORAL DENTAL RADIOGRAPHY IS ESSENTIAL FOR THE ACCURATE ASSESSMENT AND PROPER TREATMENT OF TOOTH RESORPTION, REGARDLESS OF THE SPECIES.

I am not just saying this to encourage you to refer (though that would be nice) – it just makes sense. I doubt any of you would even consider treating a fractured limb without diagnostic radiographs. Nor would you do an exploratory laparotomy without radiographs. Without dental radiographs, you simply cannot know what you are getting into or when you have gotten out. So if you are not willing and able to do whole-mouth intra-oral dental radiographs on all of your dental patients, then you should stop offering dental services. *Diagnosis first...then treatment.*

## Types of Tooth Resorption

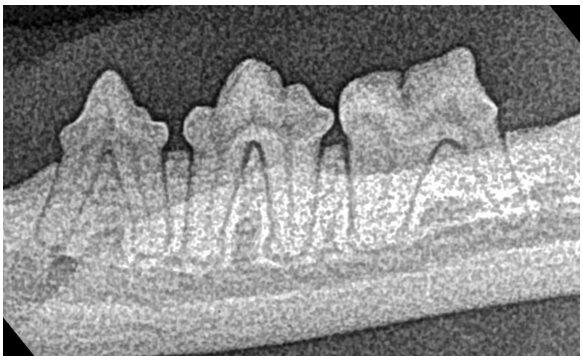
From the Nomenclature page at www.avdc.org:

*On a radiograph of a tooth with type 1 (T1) appearance, a focal or multifocal radiolucency is present in the tooth with otherwise normal radiopacity and normal periodontal ligament space.*

*On a radiograph of a tooth with type 2 (T2) appearance, there is narrowing or disappearance of the periodontal ligament space in at least some areas and decreased radiopacity of part of the tooth.*

*On a radiograph of a tooth with type 3 (T3) appearance, features of both type 1 and type 2 are present in the same tooth. A tooth with this appearance has areas of normal and narrow or lost periodontal ligament space, and there is focal or multifocal radiolucency in the tooth and decreased radiopacity in other areas of the tooth.*

Here is a normal digital radiograph of the left mandible of a cat with radiographically normal teeth and surrounding tissues.



We can see the uniform density of the roots, the pulp chamber within, the thin dark line of the periodontal ligament space and the normal variations in the density of the alveolar and mandibular bone, including the lucency associated with the mandibular canal.

Below is a digital photograph of an old analog radiograph of the left mandible of a cat with type 1 tooth resorption.

There is loss of bone and tooth structure, no new hard tissue is filling the defects and beyond the areas of tissue loss, the bone, roots and periodontal ligament space all look normal. The mesial root of the 4th premolar has been transected allowing bacteria into the endodontic system of this tooth resulting in septic pulp necrosis. The infection has then oozed out through the tip of the distal root resulting in apical periodontitis and bone loss (arrow).

Type 1 lesions are associated with moderate to severe gingivitis and/or periodontitis. They typically start at the CEJ and can extend in all directions from that starting point. The cause of these lesions might well be local inflammatory reaction due to gingivitis or periodontitis. It is

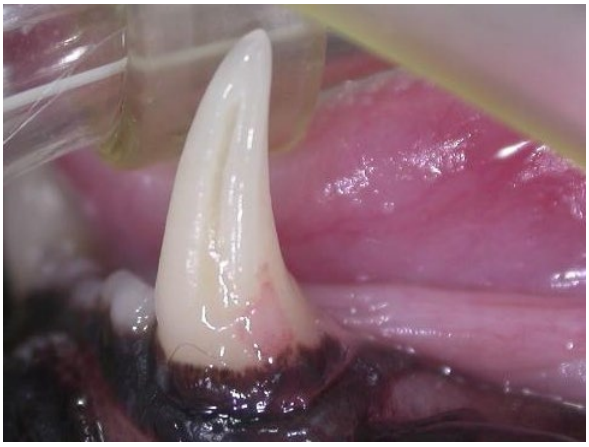
hard to say if the lesions are the cause of the periodontitis or the result of it.

As type 1 lesions are often associated with periodontitis and endodontic disease, these teeth must be entirely extracted. It is not permissible to leave any remnants of these roots behind. The good news is that the presence of a periodontal ligament (i.e., the lack of ankylosis) makes these roots fairly easy to extract. The bad news is that the resorptive process usually creates serious weak spots on the roots, so the roots break and then it is necessary to surgically remove the root remnants. Having a pre-operative dental x-ray lets you know where the weak spots are.

Type 2 lesions are more frustrating to deal with. These are the ones that we thought we might be getting closer to understanding.

Below is a radiograph of healthy, normal mandibular canine teeth.

Type 2 lesions are not generally associated with endodontic disease or periodontitis, though there may be localized gingivitis or granulation tissue in and around the lesion itself. These lesions seem to be able to arise at any location on the root and are associated with extensive root resorption, loss of periodontal ligament and ankylosis.



In the photo above, there is soft tissue creeping up the crown of the lower left canine tooth and this almost always indicates a resorptive lesion of some sort.

The radiograph shows advanced type 2 tooth resorption affecting both lower canine teeth. The right canine lesion (to your left) is all within the confines of the alveolus but the one affecting the left canine tooth has extended above the alveolus and onto the crown, as shown in the photograph.

## New(ish) Histologic Studies

Steinberg looked at 80 clinically normal teeth taken from cats that had at least one clinical TR and found that 100% of these teeth had microscopic evidence of resorption and these lesions were found primarily in the non-cervical

region of the root. This suggests that if these cats live long enough, every single tooth will eventually succumb to resorptive lesions. Taken further, it could be said that if they live long enough, every cat will develop type 2 TRs.

Gorrel and Larsson also did a study looking for microscopic lesions on the roots of cat teeth. They harvested 56 teeth that appeared clinically and radiographically free of TRs. Of these, 43 teeth (group A) were taken from cats that had a clinical TR on at least one tooth and 13 teeth (group B) were taken from cats with no clinical or radiographic evidence of TRs on any teeth. Twenty six teeth from group A and one tooth from group B showed microscopic evidence of external root resorption.

Among the salient observations of this study were the following:

The cervical cementum on the roots of teeth from TR cats was thicker and more irregular than that found on the roots of teeth taken from TR-free cats.

The periodontal ligament around non-ankylosed resorptive lesions was narrow and the fibers arranged vertically (rather than the normal horizontal or oblique arrangement). The ligament around ankylosed lesions was grossly abnormal with edematous vascularized tissue.

Teeth from TR cats were much more likely (60%) to have microscopic resorptive lesions than teeth from TR-free cats (8%). These microscopic lesions were all located at the mid root or apical portion of the root and were not associated with inflammation.

Healed cemental lesions covered by intact periodontal tissue was seen in some cases.

Ankylosis was associated with formation of reparative bone-cementum tissue filling in the space vacated by the disappearing root tissue.

These findings suggest that type 2 lesions start within the cementum of the root and in some cases they may heal spontaneously. The other big surprise was the finding that these early lesions are not associated with inflammation. It seems that as long as the lesion remains on the root below the level of gingival attachment and protected from oral bacterial contamination, there is no inflammation. Once the lesion extends through the gingival attachment and comes in contact with oral bacteria, inflammation develops as a result of the lesion, not its cause.

## New(ish) Biochemical Studies

Alex Reiter has done a study which looked like it might prove to be the key to unlocking the mystery. He looked at the serum concentration of calciotropic hormones in cats with TRs. What he found was that cats with TRs had significantly higher serum levels of 25 hydroxyvitamin D than cats without TRs.

As he points out, rather than asking "why do some cat teeth undergo resorption?", we should ask "why do some cat's teeth not undergo resorption?". After all, teeth are made of the same tissues as bone and it is constantly undergoing remodeling. Normally, the roots of permanent teeth are considered to be resistant to resorption because of a protective organic matrix. If this matrix is lost or becomes calcified, then odontoclasts (which are virtually identical in every way to osteotoclasts) can attack the root surface.

Reiter proposes that hypercementosis, osteoid production along the socket wall or gradual calcification of the periodontal ligament might be the trigger. He further postulates that this is caused by hypervitaminosis D. Another study found that excess administration of vitamin D or its metabolites to experimental animals resulted in dental and periodontal changes very similar to those seen around teeth affected by TRs. Since cats cannot manufacture vitamin D, they must take it in from dietary sources.

Looking at the vitamin D content in canned cat foods, Reiter found that 20 of 49 brands (41%) had in excess of 30 times the vitamin D requirements of 250IU/kg diet dry matter and 31% actually exceeded the AAFOO maximum level of 10 000 IU/kg diet dry matter.

Colin Harvey and others have done some work looking at a biphosphonate drug (alendronate) that is used in humans to prevent osteoporosis. One study found that the drug bound very heavily to alveolar bone and root cementum – that's good news as it means we can get this drug right where we want it.

The next study looked at the effect this drug might have on established type 2 lesions over time. Using colony cats at research facilities, he quantified the size of lesions found. The cats then received alendronate for a year and the lesions were re-measured. In the vast majority of cases, the lesions were no larger a year later and in some cases they were actually smaller. In the control cats, the lesions increased in size as predicted. These findings suggested that alendronate may someday be useful to prevent the progression of very early lesions and even in preventing them completely.

However, more recently there was this:

**Tooth Resorption and Vitamin D3 Status in Cats Fed Premium Dry Diets**

Nicolas Girard, DVM; Eric Servet, Food Ing; Philippe Hennet, DVM; Vincent Biourge, DVM, PhD

**Summary:** *It has been suggested that tooth resorption (TR) in cats is associated with vitamin D3 status. The purpose of this study was to evaluate any correlation between serum 25-OH-D concentrations and the prevalence of TR. The healthy adult domestic cats (n=64) of this study had been fed similar premium dry-expanded foods throughout their lives. Serum 25-OH-D was measured, and cats received a single, complete periodontal examination, with periodontal probing of each tooth and exploration of the tooth surface using a dental explorer. A complete set of 10 dental radiographs was taken for each cat. There were 168 TRs diagnosed in 40 of 64 cats (85 were Type 1 TR and 83 were Type 2). The mean serum 25-OH-D concentration was 187.7 ± 87.3 nmol/L. The mean serum 25-OH-D in cats with one or more TR was 164.2 ± 78.8 nmol/L, compared with 226.8 ± 88.2 nmol/L for those without TR ($p = 0.14$). The mean serum 25-OH-D in the 13 cats with >5 TR was 131.2 ± 49.5 nmol/L, which was significantly less than in cats with no TR ($p < 0.05$). There was no relationship between TR Type and serum 25-OH-D. There was no effect of age or sex on serum 25-OH-D. On the contrary, variations in serum 25-OH-D were observed according to the studied breeds. There was no relationship between TR Type and serum 25-OH-D. TR prevalence was greater in cats with lower serum 25-OH-D concentrations. In conclusion, the hypothesis that higher serum 25-OH-D concentrations are associated with a higher prevalence of TR is not supported by this study.* ***J Vet Dent 27 (3); 142-147, 2010***

And, there are serious concerns in human patients and warnings to veterinarians as well that bisphosphonates can cause a severe osteonecrosis of the mandible in some patients. So the use of these drugs in cats at this time cannot be justified.

*What does all this add up to?*

The two studies looking at Vitamin D and TR found opposite results so all we can say on that score is that more study is indicated.

Type 1 lesions are possibly the result of gingival and periodontal inflammation and arise at the cervical region of the tooth. From there, they may extend up the crown and/or down the root. Prevention would be based on maintaining good oral hygiene. Treatment of detectable lesions is complete extraction of the tooth and its roots (leave nothing behind). On the other hand, these may be caused by the same process as causes Type 2 lesions but they take on a different clinical presentation because their location allows them to be contaminated with oral bacteria very early in the process and so inflammatory changes dominate the situation (chicken or egg?).

Type 2 lesions are a non-inflammatory resorption that begins within the socket or at least below the level of gingival attachment and may be triggered by vitamin D toxicity or not. Only after the lesion enlarges sufficiently to break through the gingival attachment to become contaminated with oral bacteria does inflammation become a factor. Treatment is still extraction and in my view it should be complete removal of all dental tissues (more on this later).

**The only way to distinguish between a type 1 lesion and a type 2 lesion is with intra-oral dental radiography.**

For now, my feline discharge statement contains the following statement:

*While we do not know the causes of tooth resorption, we do know that cats that have had some are likely to develop more. There*

*is no way to predict which teeth will be affected next or when and we currently have no recommendations for prevention of new lesions. All we can do is monitor for new problems and deal with them as they arise.*

That is not a very comforting thought, but it is the best we have at the moment.

More on the treatment of Type 2 TRs. Here is an old reference that started a lot of problems.

**Crown amputation with intentional root retention for advanced feline resorptive lesions - A clinical study.**

Gregg DuPont, DVM

***Summary:*** *Whole tooth extraction is generally considered to be the treatment of choice for teeth with advanced feline external odontoclastic resorptive lesions. These teeth often have both a weakened, brittle crown and radicular ankylosis. These two factors cause frustration and sometimes complications during attempts at extraction. This study investigated the alternative of intentionally leaving part or all of non-pathologic tooth roots in situ to prevent iatrogenic trauma to the patient, loss of alveolar bone, and prolonged healing of surgical defects. Fifty one roots from 23 teeth were radiographed 5-36 months following elective root retention; continued resorption without surrounding bony reaction was seen in almost all cases. In one cat, the roots retained normal periodontal ligament one year later, and in another cat that developed severe stomatitis, the intentionally retained roots were extracted at the same time that the remaining molar teeth were extracted.* ***J Vet Dent 12 (1); 9- 14, 1995.***

This paper is now 17 years old. Sadly, some of the most important features of this paper have been lost on the general veterinary population. The paper suggested that **in very particular circumstances**, it might be permissible to leave some root remnants in place when extracting teeth with resorptive lesions. Unfortunately, this message got bastardized until the word on the street was that it was okay to just snap off the crowns and leave the rest to sort itself out. This gets back to the axiom about a little bit of knowledge being dangerous.

Here is the position statement from the American Veterinary Dental College:

*Feline tooth resorption typically originates in the cementum, may progress into root dentin, and then either progress through the root, into the crown, or both. Tooth resorption that can be identified on oral examination is an indication for radiographic evaluation and treatment. Intraoral radiography is required to properly evaluate this condition. Whole-mouth radiographs are recommended to evaluate other teeth in the mouth. Complete extraction is the treatment of choice for teeth that have detectable crown resorption but no radiographic evidence of root resorption. Teeth with crown resorption but radiographic signs of advanced root resorption (and no concurrent periodontal disease, periapical periodontitis or stomatitis) may be treated by subgingival amputation. Either form of treatment should be followed by gingival closure. If there is radiographic evidence of root resorption, but no clinical resorption can be detected on oral examination, the tooth can be "monitored" or preemptively extracted. Restoration of these teeth is not recommended. Semiannual dental examinations are recommended for all cats with previous diagnosis of tooth resorption. Radiography should be repeated annually or more frequently as dictated by the oral examination.*

*Adopted by the Board of Directors, April 2006, revised April 2007*

That statement is now five years old.

I will be the first to admit that veterinary dentists do not have all the answers with regard to TRs yet, however, we do always take dental radiographs as part of our evaluation of TRs and that is absolutely essential.

As I have stated, type 1 lesions should be completely extracted. Also, teeth with any radiographic or clinical evidence of deep periodontal or endodontic disease should be extracted completely. Teeth in cats who are positive for FeLV, FIV or who have a history of Feline Chronic GingivioStomatitis should be completely removed. Let me say that again. ***For***

***cats with FCGS, you must remove every scrap of every root of every tooth and you must confirm/document complete extraction with immediate post-operative radiographs.***

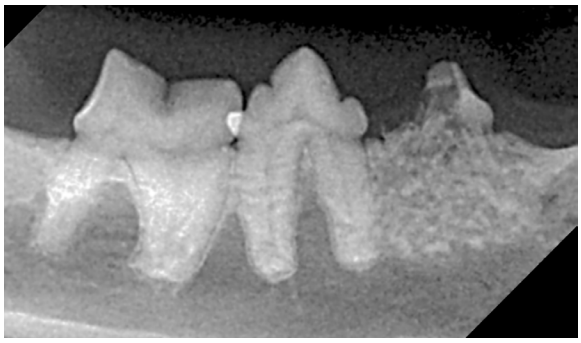
If a tooth has a type 2 lesion without periodontal or endodontic disease (as confirmed radiographically) and the root appears to have been largely replaced by new bone-cementum tissue, then it might be permissible to leave a little of this tissue in the socket. The theory goes that the lesions are non-inflammatory and the tissue is healing the defect. My worry is that the lesion has been chronically exposed to oral bacteria by the time the lesion is detected and so I expect that bacterially induced inflammation must extend at least part way down the "root". Therefore, my approach is still to remove all identifiable dental tissue and then suture the wound closed.

Even those who advocate the more conservative approach of "intentional root retention" agree that removing just the crown is not enough. In the radiograph above, we can see that there is still some coronal enamel at the most distal aspect of the tooth and there are also portions of the root projecting above the alveolar crest. Much of the root tissue has been replaced by bone-cementum tissue and so the roots appear as ghosts. The gingiva overlying this tooth typically would have a fistula and so there is ongoing bacterial invasion. Left on its own, the rest of this tooth will likely resorb, but in the meantime, there is an open and contaminated wound with inflammation and pain. At the risk of being repetitive, my approach would be to reflect gingival flaps, remove all visible or radiographically detectable dental tissues, smooth the bone and suture the wound with 5-0 monofilament absorbable.

In the radiograph below, the left lower 3rd premolar seems to be almost completely resorbed and replace by new hard tissue.

In the clinical photo of the area, the gingiva is fistulated and inflamed over the remains of the 3rd premolar. So I reflected a flap and removed all that remained of the 3rd premolar as shown in the post-op radiograph.

I do not consider this intentional root retention as there was no root left - it had been completely resorped and replaced. This is in contrast to the right side. Here are the images of the area.



In that pre-operative radiograph, I felt the tissue where the root should be also looked like new hard tissue and so I removed the crown and part way down into the socket, but I did not remove the new hard tissue. Again, I do not consider this to be so-called crown amputation or intentional root retention as I removed everything that bore any resemblance (visually or radiographically) to dental tissue and what I left behind was the new hard tissue that had replaced the resorbed root.

Here is a more recent paper on the issue that seems to lend further support to the practice of intentional root remnant retention:

**Radiographic changes associated with tooth resorption type 2 in cats.**

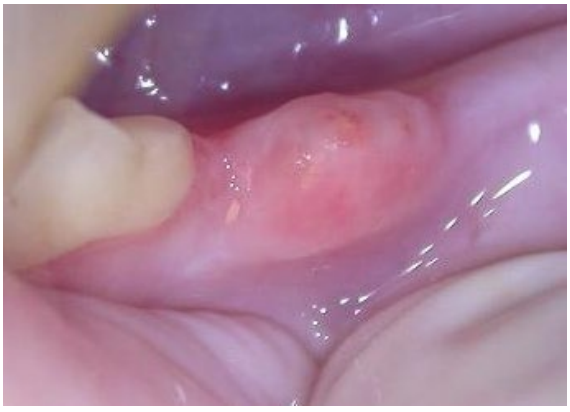
Mihaljevic SY, Kernmaier A, Mertens-Jentsch S.

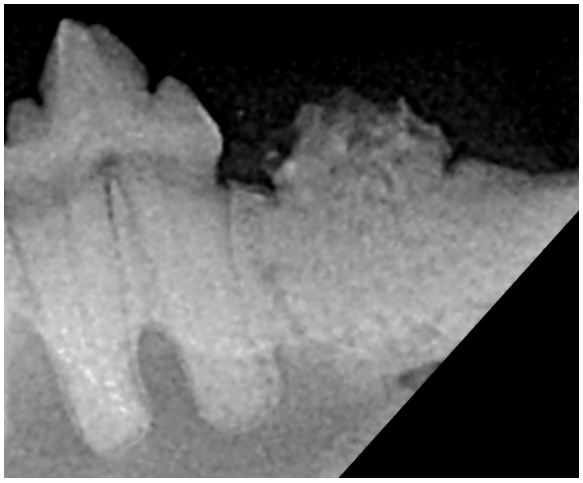
*Summary: The aim of this retrospective study was to follow the progression of radiographic changes in intentionally retained roots of teeth affected with tooth resorption type 2 in cats. Emphasis was placed on assessment of degree of resorption as well as the occurrence of inflammatory changes in tooth roots. The results confirm that crown amputation is an adequate treatment in cat for teeth affected by type 2 resorption. J Vet Dent 29 (1); 20-26, 2012*

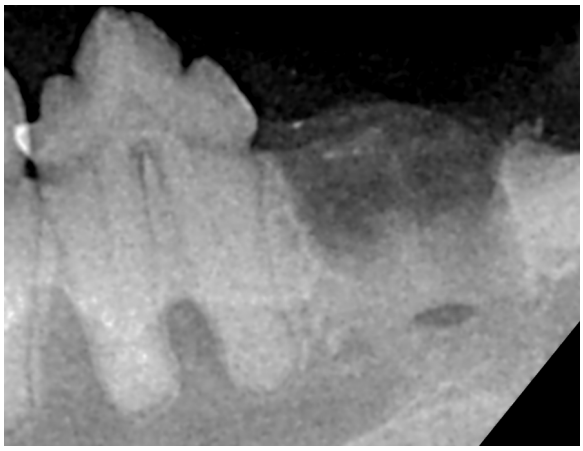
Now, this paper purports to validate the practice of intentional root retention, but I found the logic used to reach that conclusion unconvincing. The paper refers to lack of radiographic signs of inflammation, but inflammation does not show up on radiograph and neither does pain. I have seen plenty of cats with persistent inflammation around retained root remnants and so my approach is, if I am removing any of the root, I will remove ALL of the root. Since I can remove all of the root, why would I leave any behind to potentially cause persistent pain? It might save a bit of time to leave some roots behind, but saving time is not the priority. Doing the job properly is the goal and in my view, that still means removing all that remains of the tooth.

Here is a case where the lower 3rd premolars were in advanced stages of tooth resorption but I could still tell the difference between tooth and bone and so I completely removed these teeth.

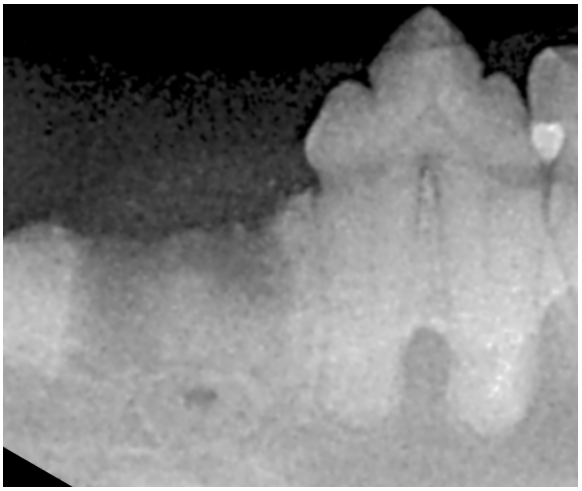
First the photo, pre-op and post-op radiographs of the right lower 3rd premolar (note the inflammation of the soft tissue over the remains of the tooth).







And next the same images of the left 3rd premolar.

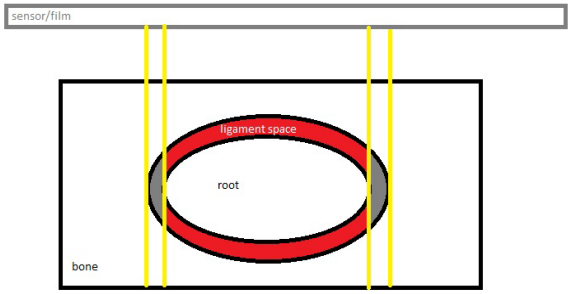


## More on Radiographic interpretation

Now, one of the criteria you will see for intentional root retention is that if you cannot see the periodontal ligament space on the radiograph, then you can leave the roots in place. I could not disagree with this terrible over simplification more.

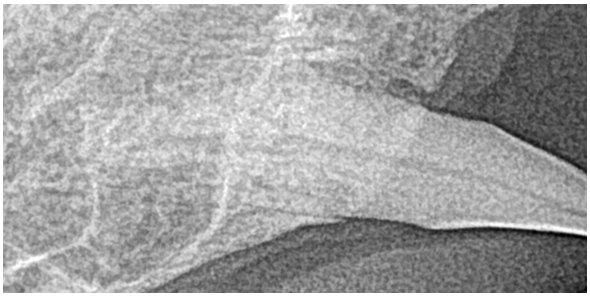
A radiograph is a two-dimensional representation of a three dimensional group of structures. On even the best radiograph, you can only ever see a tiny percentage of the periodontal ligament space. In the highly simplified representation of the cross-section of an oval root in an oval socket with a periodontal ligament space in between them, there is a radiograph film/sensor to the top of the image to capture the radiation passed through the tissues. The yellow lines represent some of the x-ray beams. The radiographic shadow cast by this section of jaw with the root in place will only

show the periodontal ligament space in the area between each pair of yellow lines (shaded grey). None of the red periodontal ligament space is going to be seen on the image because it is hidden within the superimposed hard tissues of the root and the bone. There might be some ankylosis within the visible grey areas but if the rest of the (red) periodontal ligament space is normal, then the tooth should come out in one piece without trouble. On the other hand, the visible (grey) area might look fine on the radiograph but the tooth might be a monster to extract due to ankylosis within the invisible (red) areas. So, while radiographs are completely essential, they are only part of the overall picture.

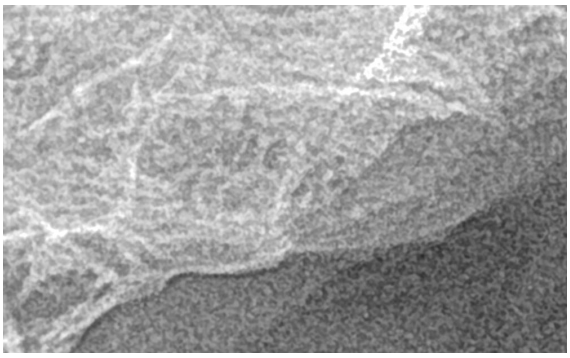



I commonly find teeth that look on radiograph as if they are ankylosed suggesting that there is no chance I will be able to remove them intact, yet I am still able to get them out entirely without breaking any of the root(s).

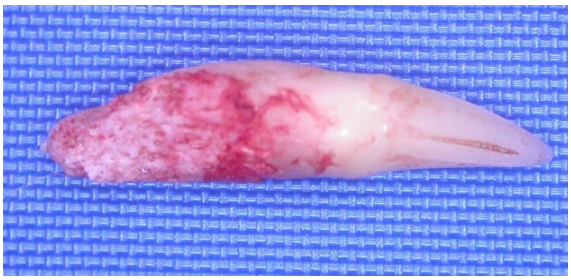
Here is the pre-operative radiograph of a resorbing right upper canine tooth in a cat. The periodontal ligament appears absent.



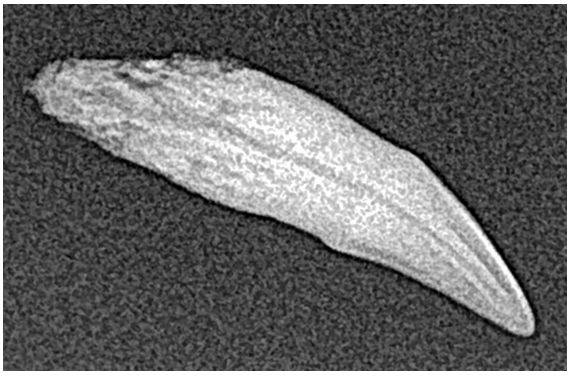
Top of the next page is the post-operative radiograph showing that the entire canine tooth was removed and the bone at the top of the socket has been reduced in preparation for wound closure.



Here is the extracted tooth, all in one piece.



And a radiograph of that extracted tooth.



It is also common to have teeth that look, on radiograph, as if they should co-operate and come out intact, yet they crumble to bits.

## Conclusion

How do I want you to manage TRs?

In my fantasy world, you would just refer them all to me.

If you are going to treat cats with TRs here is what you have to do:

Radiograph every tooth in the head (even those that appear to be missing) and examine each tooth subgingivally with a dental explorer. If you are not going to radiograph, then do not try to treat these cats, just refer them to someone who will radiograph them.

For type 1 lesions, extract the entire tooth and root(s), smooth off the alveolar bone and suture the wound closed with a fine, absorbable monofilament (I like 5-0 Monocryl™).

For type 2 lesions, extract as much of the tooth as you can without causing excessive trauma (that is a judgment call), being sure to at least get everything above the alveolar crest and 1 – 2 millimeters into the socket before smoothing the bone and suturing as above. Personally, I will continue with my habit of removing all that remains of any tooth I am removing.

Plan to re-examine and re-radiograph annually as cats that have had one lesion will almost certainly get others sooner or later.

Send the animals home with analgesics (I like transdermal codeine for cats) for at least four days and put them on softened food for 14 days.

Have the owners keep the pet quiet for a few days and tell them to not touch the mouth for 2 weeks. Consider sending home an E-collar to prevent pawing/rubbing at the face.

Antibiotics are for the treatment of infection, not for the prevention of infection. When I do oral surgery, I remove the infected tissue and so only rarely (almost never) do I feel the need to send home antibiotics.

There will continue to be confusion and frustration around tooth resorption until we know what causes it and can offer some solid recommendations for prevention. There will also continue to be controversy regarding the advisability of intentional root retention. Hopefully we will have some solid answers down the road, but in August of 2012, this is it.