Veterinary Dental Specialties & Oral Surgery

San Diego Veterinary Dental Training Center

Get ready for Dental Health Month CE

Brook A. Niemiec, DVM

Diplomate, American Veterinary Dental College
Diplomate, European Veterinary Dental College
Fellow, Academy of Veterinary Dentistry

Southern California Veterinary Dental Specialties www.dogbeachdentistry.com
San Diego Vet Dental Training Center www.vetdentaltraining.com
Veterinary Dental Telemedicine www.vetdentalrad.com

BASIC PERIODONTAL THERAPY
The basis of periodontal therapy today is plaque control. This is accomplished via two to four components depending on the stage of the disease. These include a thorough dental prophylaxis, periodontal surgery, homecare, and extraction. There are numerous variations and treatment options for therapy. This lecture will cover the basics and touch on the available options.

The cornerstone of periodontal therapy is a thorough dental prophylaxis. This MUST be performed under general anaesthesia including a properly inflated endotracheal tube. The prophylaxis should include the following steps.

**Step 1:** Pre surgical exam and consultation
This is often a much neglected step of a professional dental prophylaxis. The veterinarian should perform as complete as possible physical and oral exam. The physical exam (along with pre-operative testing) will help ensure anesthetic safety. The oral examination will identify obvious pathology (fractured, intrinsically stained, or mobile teeth; oral masses; and resorptive lesions) as well as allow for a preliminary assessment of periodontal status. The veterinarian can then discuss the various disease processes found and the various available treatment options. Based on the physical findings, the practitioner can create a more accurate estimate (both financial and time). Both of which will decrease problems with over scheduling and client finances during the anesthetic event. This small time investment will improve the experience of everyone involved (veterinarian, technician, receptionist, client, and patient).

**Step 2:** Chlorhexadine lavage
The oral cavity is a contaminated area and a dental cleaning is a mildly invasive procedure. In this way, it often results in a transient bacteremia. For this reason it is recommended to rinse the mouth with a 0.12% solution of chlorhexadine gluconate prior to commencing the prophylaxis to decrease the bacterial load.

**Step 3:** Supragingival cleaning
This can be performed via mechanical or hand scaling. The mechanical scalars decrease anaesthetic time and include both sonic and ultrasonic types. The most common type of mechanical scaler in veterinary dentistry today is the ultrasonic scaler. There are two main types magnetostrictive and piezoelectric. Both of these scalers vibrate at approximately 45,000 Hertz. They are very efficient and have an additional benefit of creating an antibacterial effect in the coolant spray (cavitation). They are however can be more damaging to the tooth, and may leave some calculus behind. Thus, it has been recommended that hand scaling be performed after ultrasonic scaling to ensure the complete removal of calculus. Sonic scalers run on compressed air and vibrate at 8-18,000 hertz. They are safer, but slower than sonic scalers and do not offer cavitation. The area of maximum vibration is 1-3 mm from the tip. Do not use the tip or back of the instrument as these are not effective for calculus removal and can potentially damage the tooth. The instrument is placed on the tooth and LEFT on the tooth for up to 15 seconds. Once the instrument looses contact with the tooth, the scaler can no longer be effective. Run the instrument SLOWLY over the tooth surface in wide sweeping motions to cover every mm² of every tooth surface. Hand scaling is performed with a scaler. This is a triangular instrument with e sharp cutting edges. In addition, the tip is very sharp. Scalers are designed for SUPRA-gingival use only. The scalers (as well as curettes below) are held with a modified pencil grip. The instrument is gently held at the gnarled or rubberized end with the thumb and index finger TIPS. The middle finger is placed near the terminal end of the shaft and is used to feel for vibrations which signal residual calculus or diseased/rough tooth/root surface. Finally, the ring and pinkie fingers are rested on a stable surface.

Hand instruments are used with a gentle touch and are run over the tooth numerous times in overlapping strokes until the tooth feels smooth. This step may be performed with a curette and combined with subgingival scaling (see below).

**Step 4:** Subgingival plaque and calculus scaling
This step is best performed by hand with a curette. A curette has 2 cutting edges and a blunted toe and bottom. In this way, it will not cut through the delicate periodontal attachment as long as excess force is not applied. The proper curette is selected based on its angulation. The lower the number (i.e. 1-2) the less the angle and the further rostral in the mouth the instrument is used. The face of the instrument is placed flat against the surface of the tooth and inserted gently to the base of the sulcus or pocket. Once there, the instrument is rotated so that the shaft is parallel to the long axis of the tooth. This will engage the calculus as well as place the instrument in the proper position for root surface and subgingival debridement. This is repeated with numerous overlapping strokes until the root feels smooth. Cleanliness can be further evaluated by gently directing compressed air into the sulcus. Any remaining calculus will appear chalky. This is a very technically demanding procedure and the practitioner is directed to continuing education programs to hone their skills.

Traditional ultrasonic scalers should not be used subgingivally due to thermal damage to the gingiva and pulp. This occurs because the water coolant cannot reach the tip of the instrument. However sonic and ultrasonic scalers with specialized periodontal tips have been developed for subgingival use. These are much easier to use and therefore will likely result in superior cleaning in the hands of novices. Like supragingival scaling, it is recommended to perform mechanical scaling first to remove the majority of the plaque and calculus first, and then follow up with hand scaling.

**Step 5:** Polishing
Scaling (especially mechanical) leaves the tooth surface (and especially the root) rough, which increases plaque attachment. Polishing will smooth the surface of the teeth which will retard plaque attachment. Polishing is typically performed with a prophy cup on a slow-speed hand-piece with a 90 degree angle. The hand-piece should be run at a slow rate and no greater than 3,000 RPM. Ensure that adequate polish is used at all times. Running the prophy cup dry is not only inefficient, it may also overheat the tooth. Just like with scaling, every mm² of tooth surface should be polished. In addition, slight pressure should be placed down onto the tooth to flare the edges of the prophy cup so as to polish the subgingival areas. One tooth may be polished for a maximum of five seconds at a time to avoid overheating. The tooth can be further polished after a short break (while other teeth are polished).

**Step 6: Sulcal lavage**

The cleaning and polishing steps will result in debris such as calculus and prophy paste (some of which is bacteria laden) to accumulate in the gingival sulcus. In some cases there are visible deposits, but in all cases there is microscopic debris. These substances will allow for continued infection and inflammation. Therefore a gentle lavage of the sulcus is strongly recommended. The lavage is performed with a blunt ended cannula which is placed gently into the sulcus and the solution is injected while slowly moving along the arcades. The typical lavage solution is sterile saline, although some authors favor a 0.12% Chlorhexadine solution.

**Step 6 (a): Fluoride therapy (optional)**

This is a controversial step with some dentists recommending that it be performed in all cases and some that it never be done. The positive aspects of fluoride include ant plaque and antibacterial activities, hardening tooth structure, and decreases tooth sensitivity. The latter activity is most important in patients with gingival recession and secondary root exposure. When root planing is performed, cementum is removed which may expose underlying dentin. In this case, sensitivity may result from the hydrodynamic theory of tooth sensitivity. Application of fluoride should help decrease this sensitivity.

**Step 7: Periodontal probing, oral evaluation, and dental charting**

This is a critical, however often poorly performed and underappreciated step. The entire oral cavity must be systematically evaluated using both visual and tactile senses. Careful visual examination should be performed during the periodontal evaluation. The periodontal probe should be inserted at six spots around EVERY tooth to identify periodontal pockets. This is performed by gently inserting the probe into the pocket until it stops and then “walking” the instrument around the tooth. The normal sulcal depth in a dog is 0-3 mm, and a cat is 0-0.5 mm. All abnormal findings must be recorded on the dental chart. Dental charting should be performed 4-handed. This means that one person evaluates the mouth and calls out pathology to the assistant who records it on the chart. Using the modified triadan system will greatly increase efficiency of this step. Dental charts must be of sufficient size to allow for accurate placement of pathology. The minimum size for an acceptable dental chart is 1/3 of a page, however veterinary dentists use full page charts. Samples of these may be downloaded at [www.vetdentalrad.com/educationaldownloads](http://www.vetdentalrad.com/educationaldownloads).

**Step 8: Dental radiographs:**

Dental radiographs should be performed of ANY pathology noted on dental exam. This includes any periodontal pocket which is larger than normal, fractured or chipped teeth, masses, swellings, or missing teeth. Dental radiographs are a critical aid in the evaluation of dental pathology. Help is available for any questionable cases at [www.vetdentalrad.com](http://www.vetdentalrad.com).

**Step 9: Treatment planning**

The practitioner, utilizing all available information (visual, tactile, and radiographic) then decides on appropriate therapy. Additionally, the prudent veterinarian will keep in mind the patient as a whole, the owner’s wishes and willingness to perform homecare, and necessary follow-up. Following the creation of a dental plan for the patient, an estimate is created and the client contacted for consent.

**Step 9 (a): Additional therapies**

Based on the oral examination and client wishes, any additional therapy is performed. If this is extensive and would result in a long anesthesia or the practitioner to be unduly rushed, rescheduling the remainder of the work is an acceptable alternative. There are numerous possibilities for this (including referral), and the reader is directed not only to the extractions and composite bonding articles in this issue as well as to texts or hands-on labs for more information on these procedures. In this issue we will only cover periodontal therapy (see below).

**Step 9 (b): Barrier Sealant**

A barrier sealant has recently been introduced as a means to decrease plaque and calculus accumulation. This is a waxy sealant that has been proven clinically to decrease plaque and calculus. While it has not been proven to decrease gingivitis and therefore periodontal disease, due to its placement at and below the gingival margin, it should theoretically work. Following a prophylaxis, the teeth are dried and then the product is applied. Following this, the client applies the home version on a weekly basis.

**Step 10: Client education**

The post-surgical release is an important step in periodontal therapy. Use this opportunity to go over radiographs (and pictures if available) with the client. This will not only re-enforce your findings and treatment, it will also allow you to discuss periodontal disease. This discussion should not only include immediate post-operative instructions; but also cover periodontal disease and long term periodontal care.

**Home care:**

[continued]
Dental Radiology

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Periodontal Therapy

Periodontal therapy is aimed at removing the infection from the root surface (plaque, calculus, and granulation tissue) as well as smoothing the diseased root surface. This will allow for reattachment and decrease in pocket depth.

Any pockets greater than normal for the species are pathologic and in need of therapy. It is important to note that this is a separate procedure from the prophylaxis and the practitioner should be charging for this. Periodontal therapy is aimed at removing the infection from the root surface (plaque, calculus, and granulation tissue) as well as smoothing the diseased root surface. This will allow for reattachment and decrease in pocket depth.

In the canine patient, pockets between 3 and 5 mm which do not have mobility or other issues are best treated with closed root planing and subgingival curettage. This step is performed in a similar manner to subgingival scaling above, with a combination of mechanical and hand scaling. This should be meticulously performed in order to achieve as clean a tooth as possible to promote healing.

An additional way to promote reattachment is the instillation of a sustained release doxycycline product. This has been shown to temporarily locally control the microorganisms as well as decrease inflammation. It is performed by mixing the product according to package directions and then inserting the product into the pocket until it is just over flowing. The product is then wetted, which will harden it, and tapped gently into the sulcus. If some of the product extrudes from the pocket, it should be rewetted and then placed. This should continue until the pocket is full.

Pockets greater than 5-mm require direct visualization of the root surface for effective cleaning. If the tooth is not effectively cleaned, the infectious agents remain along with the plaque and calculus. Visualization is best accomplished via periodontal flap procedures. These procedures are very effective in animal patients. If the clients are interested in salvaging the teeth, periodontal surgery can be performed. These are advanced procedure, but can be learned by general practitioners. However, the reader is encouraged to attend a hands on wet-lab prior to undertaking these surgeries.

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Periodontal Surgery

Periodontal surgery is the other option for minimizing periodontal disease. Since this requires no work by the owner, compliance is more likely. This is especially important since long term consistency is the most important factor in the effectiveness of dental care. There are currently several diets that decrease tartar and plaque build-up. In addition, tartar control chews and treats have been developed.

All of these products have been shown to decrease plaque and calculus, however, they are most effective on plaque and tartar on the cusp tips not at gingival margin. Supragingival plaque and calculus is in general non-pathogenic. Of the available products, only two have been clinically proven to decrease gingivitis.

The downfall of all passive homecare products is that the patient is not likely to chew with the entire mouth; therefore areas will be missed. Passive homecare is most effective on the carnassial and surrounding teeth, where chewing is concentrated. Active homecare, in contrast, is most effective in controlling plaque and calculus on the incisor and canine teeth, likely due to the ease in accessing these teeth. Therefore, a combination of active and passive homecare is likely ideal.

Active homecare consists primarily of tooth brushing. There are various veterinary brushes; however a soft child’s toothbrush is also effective. There are numerous veterinary toothpastes available. These increase the palatability of the toothbrush, and many add a cleaning aid. Human tooth pastes are generally not recommended. There are also antimicrobial preparations that can be used in certain cases. Technique: Use a circular motion with the brush at a 45-degree angle to the gingival margin.

Frequency: once a day would be ideal, as this is required to stay ahead of plaque formation, but for most owners this is unrealistic. Three days a week is considered the minimum frequency for patients in good oral health. If the patient has periodontal disease, daily brushing is necessary. One other option for active homecare is to rinse with a chlorhexadine solution. This has been shown to decrease gingivitis if done consistently over time. Even though brushing and rinsing greatly improves periodontal health, it does not completely eliminate the need for professional cleanings.

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This is a very important part of periodontal therapy. A recent study has shown that periodontal pockets are reinfected within 2 weeks of a prophylaxis if homecare is not performed. Therefore, homecare must be discussed with each client following a prophylaxis.

There are two divisions of homecare active and passive. They both can be effective if performed correctly, however active homecare is still the gold standard in homecare.

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The final modality for the therapy of periodontal disease is extraction. While extreme, it is the only true cure. Without a commitment to homecare or routine professional cleanings, advanced periodontal surgery should likely not be attempted. Depending on the stage of periodontal disease, the involved teeth should be extracted.
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distortion.
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Place the film in the mouth so that the entire tooth (crown and entire root surface) is covered by the radiograph.

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Step 3: Positioning the beam head

There are two major techniques for positioning the beam head in veterinary patients. Both of these techniques are used daily in veterinary practice.

Dental Radiographic Film:

Dental film is non-screen film. This means that it is directly exposed by the x-ray and does not require an intensifying screen. This gives much more detail than standard radiographic film, but requires a higher amount of exposure. It is packaged in its own paper or plastic sleeve, to protect it from light and the oral environment.

There are two types of dental film commonly used in dental radiology. These are Ultra-speed “D” and Ektaspeed “E” film. Recently “F” speed film has become popular. The difference is in the size of the silver halide crystals and secondary to this the amount of exposure required to expose the dental film. “E” speed film requires approximately ½ the amount of radiation for exposure than “D” speed film, and “F” speed even less. This decreases exposure to the patient and staff as well as decreases the wear and tear on the x-ray unit. There is a slight decrease in resolution with faster films due to the larger crystal size, but according to most experts, the difference is negligible. Therefore, it is recommended in human dentistry to use “E or F” speed to decrease exposure time. They are more technique sensitive, however, in both the exposure and development of the image. This may be frustrating for the novice, therefore it is generally recommended that practitioners start with “D” speed and advance to “E or F” speed when they are more comfortable with the settings and positioning.

There are several different sizes of dental film available (4, 3, 2, 1, and 0). The most common sizes used in veterinary medicine are 4, 2, and 1. Size 3 are bite wings and are generally not used in veterinary medicine. Size 4 (occlusal) film is the largest available, it is used mostly in large breed dogs or when taking whole mouth radiographs. For small dogs and cats and most any single tooth radiograph, size 2 (standard) is commonly used. For the mandibular first and second premolars, and very small cats and puppies size 1 (or 0) (periapical) are used. Another consideration in selecting film size is cost. Size 4 film is about 3 times the cost of size 2. Therefore, if you can use a size 2, it is recommended. However, it is much easier to position size 4 films, allowing for much more latitude in positioning. This will result in less retakes. Therefore, the less experienced may consider practicing with size 4 film and graduating to size 2 when a level of skill is obtained.

Digital Dental Radiology:

There are numerous human veterinary digital systems. These are excellent means of obtaining dental radiographs. The only major problem currently is the lack of a number 4 sensor. The major advantages to these systems are the decrease in radiation exposure, rapidity of the development, and that you can reposition the sensor if the view is not correct the first time. There is one company, however which makes a size 4 phosphor plate (CR).

Taking a dental radiograph:

Step 1: Patient positioning

Position the patient so that the area of interest is convenient to the radiographic beam. In general this is where the object is “up”. For maxillary teeth, the patient should be in ventral recumbency. For mandibular canines and incisors the pet should be in dorsal recumbency. Finally, for maxillary cheek teeth, the patient should be in lateral recumbency with the affected side up. This being said, in our practice virtually all radiographs are exposed in lateral recumbancy with the affected side up. This being said, in our practice virtually all radiographs are exposed in lateral recumbancy. This takes some getting used to, but decreases the number of times a patient must be rolled when doing surgical or endodontic procedures.

Step 2: Film Placement within the patient’s mouth

There is an embossed dot on the film. The convex side of this should be placed towards the x-ray beam. In most films, this side is pure white. The opposite or “back” side of the film will usually be colored (purple or green). Place the film in the mouth so that the entire tooth (crown and entire root surface) is covered by the radiograph. Remember, the roots of all teeth are very long. This is especially true of canine teeth, which are longer than you think. Always err on the side of having the film too far in the mouth to ensure you do not cut off the root apexes. The film should be placed as near as possible to the object (generally touching the tooth and gingiva) to minimize distortion.

Step 3: Positioning the beam head

There are two major techniques for positioning the beam head in veterinary patients. Both of these techniques are used daily in veterinary practice.
Parallel technique: This is where the film is placed parallel to the object being radiographed and perpendicular to the beam. This is how standard (large) films are taken. This gives the most accurate image. Unfortunately, this is only useful in the lower cheek teeth in the dog and cat. This is due to the fact that these patients don’t have an arched palate. The film cannot be placed parallel to the tooth roots because of the palate’s interference. Therefore, this technique is not always possible.

Bisecting Angle Technique: This is the most common type of dental radiograph taken in veterinary patients. This uses the theory of equilateral triangles to create an image that accurately represents the tooth in question. To utilize this technique, the film is placed as parallel as possible to the tooth root. Then the angle between the tooth root and film is measured. This angle is cut in half (bisected) and the beam placed perpendicular to this angle. This gives the most accurate representation of the root.

If this angle is incorrect, the radiographic image will be distorted. This is because the x-ray beam will create an image that is longer or shorter than the object imaged. The best way to visualize this is to think of a building and the sun. The building will create a 90 degree (right) angle to the ground. The bisecting angle in this case is 45 degrees to the ground.

Early and late in the day, the sun is at an acute angle to the building and casts a long shadow. In radiology, this occurs when the angle of the beam to the object is too small and is known as elongation. At some point in the late morning and early afternoon, the sun is at a 45 degree angle to the building, which is the bisecting angle. This gives an accurate representation of the building height. As the sun continues up in the sky, the shadow shortens. This occurs in veterinary radiology when the angle is too great and is known as foreshortening. Finally, at noon, the sun is straight up from the building, which gives no shadow.

The “Simplified Technique” as developed by Dr. Tony Woodward does not utilize direct measurement of any angle, instead relying on approximate angles to create diagnostic images. There are only 3 angles used for all radiographs in this system: 20, 45, and 90.

Mandibular premolars and molars are exposed at a 90 degree angle, maxillary premolars and molars at a 45-degree angle, and incisors and canines at a 20 degree angle.

To initiate any radiograph, place the film in the mouth and set the positioning indication device (PID) perpendicular to the film. For mandibular cheek teeth, this is the correct placement. For the maxillary premolars and molars, rotate the beam to a 45 degree angle. For the incisors and mandibular canines rotate 20 degrees. For the maxillary canines an additional rotation 20 degrees lateral is necessary to avoid superimposition of the first and second premolars.

**Step 4: Setting the exposure**

If you are using a machine where you set the exposure manually, you will need to set up a technique chart similar to one for a standard (large) unit. The good news is that there is only one variable that needs to be adjusted. If you are utilizing the computer controlled system, set the buttons for the species, size of the patient, and tooth to be imaged. If you have correctly set the machine and the image is incorrectly exposed, the easiest way to adjust is to change the f-number. By pressing this button, you will see the numbers go up on both sides. The one on the left is the f-number and the one on the right is the exposure time. If you continue to press the button it will continue to increase the exposure until you reach 9 when it will markedly lower and the f-number will go back to 1. If the radiograph is overexposed (too dark) lower the f-number by 1. If it is underexposed (too light) increase the number by 1. Continue this process until you have the film that you want. Generally, the f-number will be the same for all radiographs once you have discovered the correct setting for your machine start at that number in future sessions.

**Step 5: Exposing the radiograph**

Dental radiograph machines have a hand held switch to expose the radiograph. If it is possible, leave the room prior to exposing the radiograph. If it is not, stand at least 6 feet away at a 90 to 130 degree angle to the primary beam (meaning to the side or back of the tube head, not in front or behind). Once everything is set, press the button. It is important to remember, that these switches are “dead man’s”. This means if you let up during the exposure, it will stop the production of x-ray beams. On a standard unit, this will make a light radiograph, on a computer controlled one it will give an error message and you will need to start over. Make sure you hold the button down until the machine stops beeping.

**Step 6: Developing the radiograph**

The most economical way to develop the radiograph is coffee cups filled with dental developing solutions in your darkroom. (Using chemicals other than products for dental radiology will result in inferior film quality) Although developing films in a darkroom can produce quality films, the use of a chair side developer has several distinct advantages.
The chair side developer also allows you to easily judge when development time is correct, and be able to evaluate your films in only 1-2 minutes. The technician does not leave the room and can still monitor the patient. The units take up very little space, minimize chemistry use, clean up easily and store quickly.

To develop films, begin by peeling back the covering layers from the film, taking care to handle the film only by the edges. Use a film clip to grasp the corner of the film and place it in the developer. When developing a size 4 film, make sure to immerse the entire film in the liquid to ensure that the whole film gets developed. Develop the film until an image is just visible (sight developing). Then rinse the film briefly in a water bath, and place the film in the fixer for one minute until partially fixed. The film may be evaluated at this time, but should be placed back in the fixer for an additional 10 minutes to ensure complete fixation (archival quality). When completely fixed, the film becomes clear and will lose all traces of a greenish color. The film should then be thoroughly rinsed in running water or placed in a clean water bath for 10-15 minutes. This is followed by a final rinse to remove all traces of fixer. Be sure to remove the clip and rinse all film surfaces thoroughly. Traces of fixer remaining on a dental film give it a characteristic “slick” feel, therefore rinse the film under running water while gently rubbing the film between your fingers, for a few seconds, until the film does not feel slick. The film is then placed in drying clips overnight to dry. Make sure to dry the film completely to ensure that they do not stick together. Be sure to change the solutions whenever the developing and fixation times seem to be slowing down. This will occur after you have developed and fixed around 20 smaller (#0 or #2) films, or 10-15 larger (#4) films. Use of exhausted chemistry results in poor image quality and hazy images.

DENTAL RADIOGRAPH INTERPRETATION

Interpreting dental radiographs can be daunting, but it is very similar to interpreting a standard boney radiograph. The major difference is that dental radiographic changes are often more subtle. In addition, there are pathologic states that are unique to the oral cavity. Finally, there are several normal anatomic structures that may mimic pathologic changes.

This lecture concentrates on the most common pathologies, which are illustrated by classic examples. Note that in practice, these lesions are often less obvious. The reader is directed to additional continuing education meetings to further their expertise. In addition, vetdentalrad.com is an excellent resource for questionable cases.

Determining which teeth were imaged:
The first step in radiographic interpretation is determining which teeth have been imaged. This requires not a firm knowledge of oral anatomy as well as the architecture of dental films. Digital systems with veterinary templates do not require this step as long as the images are properly placed (DO NOT ASSUME THIS WAS DONE CORRECTLY). If your system does not support a veterinary template, there is a mark on the image which is in a consistent location. Review the owner’s manual for instructions on its use.

The key to properly identifying the imaged teeth is the embossed dot, which is on one corner of the film. When exposing a radiograph, if the film is properly positioned, the convex surface will point towards the radiographic tube head. There is no way to expose a diagnostic radiograph with the film in backwards, due to the lead sheet on the back side of the film. Therefore, when interpreting the film, the embossed dot is facing out of the mouth. First, place the dot towards you (this is done for you on most digital systems). This means you are looking at the teeth as if you are the beam.

Next, rotate the film so that the roots are in their natural position (up on maxillary and down on mandibular).

Canines and incisors: This orients the film so the right side of the mouth is on the left, and right side is on the left. This is like a VD abdomen radiograph.

Molars and Premolars: Ascertain mesial from distal. If the mesial side is on the left side of the film, it is a radiograph of the left side of the patient and vice versa for the right.

Normal radiographic anatomy:
There are numerous structures within the oral cavity that mimic pathologic states depending on the projection. Knowledge of normal radiographic anatomy will help avoid over interpretation. Normal alveolar bone will appear gray and relatively uniform throughout the arcade. It is slightly more radiopaque “darker” than tooth roots. In addition, it appears slightly but regularly mottled. Alveolar bone should completely fill the area between the roots (furcation) and end at the cementoenamel junction (CEJ). The root canals should all be the same width; allowing for differences in the diameters of the root. There should be no radiolucent areas in teeth or bone. A regular thin dark line (periodontal ligament) should be visualized around the roots.

There are several normal anatomic findings that are commonly misinterpreted in dental images as pathologic. On radiographs of the mandibular cheek teeth, a thick, horizontal radiolucent line courses parallel to and just coronal to the ventral cortex of the mandible. This is the mandibular canal. In addition, there are three circular radiolucent areas seen in the area of the apices of the first three premolars, which are the mental foramina (rostral, middle, and caudal). On rostral mandibular views, a radiolucent line will be present between the central incisors. This is the fibrocartelagenous mandibular symphysis. In the rostral maxillary area: there are paired radiolucent areas distal to the intermediate incisors, which are the palatine fissures. Finally, a significant widening of the periodontal ligament at the apex of the cuspid teeth is normal. This may appear to be a periapical lesion, but is differentiated from pathology because it is very regular and v-shaped, as opposed to irregular and round.

Any questionable areas should be evaluated by exposing a comparative view. A suspicious periapical lucency (especially in the area of the mandibular premolars) should be evaluated with an additional film exposed at a slightly different angle (in the horizontal or vertical plane). If the lucency is still centered on the apex, it is likely real. If the lesion moves off the apex or disappears, it is an artifact. Suspect changes in the diameter of the root canal of a tooth should be compared against surrounding as well as contralateral teeth. Surrounding
teeth can be seen on the same film with the “lesion”. The contralateral view should be taken at the same angle as the original. It is important to note that root canals are not exact cylinders (especially cuspids). A lateral view may have a much different canal width than a V/D view.

**Periodontal disease:**
Periodontal bone loss results from the combination of bacterial induced inflammation and host response creating osteoclastic resorption of bone. This resorption will result in crestal bone loss to a level below the cementoenamel junction. This decrease in bone height may also create furcational exposure. Horizontal bone loss is the most common pattern in veterinary patients is horizontal. This appears as generalized bone loss of a similar level across all or part of an arcade. The other pattern is angular (vertical) bone loss. The radiographic appearance of angular bone loss is one area of recession below the surrounding bone. The surrounding bone may be normal or be undergoing horizontal bone loss. Therefore it is common to have a combination of the two types in the same arcade. Bone loss does not become radiographically evident until 30-50% of the mineralization is lost. Therefore, radiographic findings will always underestimate bone loss. In addition, bone loss on only on surface (i.e. lingual, palatal, or facial) may be hidden by superimposition of bone or tooth. This may resulting in a non-diagnosed bony pocket. Always interpret radiographs in light of the complete oral examination findings.

**Endodontic disease:**
Endodontic disease may be demonstrated radiographically in several ways. An individual tooth may have one, some, or all of the different changes listed below. However, only one need be present to establish a presumptive diagnosis of endodontic disease. Radiographic changes can be broken into two major classifications: 1) changes in the surrounding bone, or 2) changes within the tooth itself.

**Bony changes:** The classic and most obvious finding is periradicular rarefaction. This appears as a radiolucent area surrounding the apex of a root. On rare occasions, this may also be seen mid-root, but these will virtually always be associated with periapical disease. Other, more subtle changes include a widened periodontal ligament, a thickened or discontinuous lamina dura, or even periradicular opacities. It is important to be aware of superimposed lucencies which are artifactual. These structures (i.e. mental foramina) can be imaged over an apex and falsely appear as osseous rarefaction. There are several clues that superimposed lucencies are artifactual. First, superimposed artifacts are typically seen on only one root, whereas it is very rare to find a true periapical lesion on only one root of a multi-rooted tooth. In addition, artifacts tend to be regular in appearance, whereas true periapical lesions are ragged. If any area is in question, it is best to expose an additional film with a slightly different angle. If a periradicular lucency is still centered over the apex, it is likely real and not an artifact.

**Tooth changes:** The most common change in endodontic disease within the tooth itself is a root canal with a different diameter. As a tooth matures, secondary dentin production will cause a decrease in canal width. When a tooth becomes non-vital, this development stops secondary to the death of the odontoblasts. Consequently, non-vital teeth have wider root canals than the surrounding vital teeth. Conversely, on rare occasions, pulpitis may result in increased dentin production, and create an endodontically diseased tooth with a smaller root canal. This is especially common in teeth that are also periodontally diseased. This could potentially lead to a misdiagnosis of the endodontically diseased tooth as healthy and vice
versa with the contralateral tooth. Hence it is important to evaluate the adjacent teeth as well as the contralateral.

Width discrepancy can be compared to any tooth (taking the size of tooth into consideration) but it is most accurate is to compare to the contralateral tooth.

Endodontic disease may also be manifested radiographically as internal resorption. This results from osteoclastic activity within the root canal system due to pulpitis. These changes create an irregular, enlarged region within an area of the root canal system. Finally, external root resorption can be seen with endodontic disease. It will appear as a defect of the external surface of the root, generally accompanied by a loss of bone in the area. External resorption most commonly occurs at the apex in companion animals and is quite common in cats with chronic endodontic disease.

**Feline Tooth Resorption (TR’s)**

TRs are the result of odontoclastic destruction of feline teeth, and are classified as either type 1 or type 2. In type 1 there is no replacement by bone, whereas in type 2 there is replacement of the lost root structure by bone.

TRs are very common in our feline patients. Studies have reported up to a 70% incidence in felines over 6 years of age! The etiology at this point is unknown. They are not bacterial in nature, although in some cases the inflammation which activated the odontoclasts may have been bacterial in nature. There are numerous theories; however none have been proven at this time. Osteoclastic resorption will generally begin at the cervical line of the tooth and progress at varying rates until in some cases no identifiable tooth remains.

Type 1 TRs are typically associated with inflammation such as gingivostomatitis or periodontal disease. Thus, they are commonly associated with periodontal bone loss on dental radiographs. In these cases, it is believed that the soft tissue inflammation activated the osteoclasts. The teeth will have normal root density in some areas and a well defined periodontal space. In addition, there is often a definable root canal in the intact part of the tooth. This type will have significant resorption of the teeth and tooth roots that is not replaced by bone.

Type 2 TRs are usually associated with only localized gingivitis on oral exam, in contrast to the more severe inflammation due to periodontal disease or gingivostomatitis seen with type 1. In these cases, the gingival inflammation is secondary to the TR. The radiographic appearance is that of teeth which have a different radiographic density as compared to normal teeth, as they have undergone significant replacement resorption. Findings will include areas with no discernable periodontal ligament space (dentoalveolar ankylosis) or root canal. In the late stages, there will be little to no discernable root structure (ghost roots). In these cases, the lost root structure will be replaced by bone.

The importance of dental radiography in TR cases cannot be overstated. Type 1 lesions typically retain a viable root canal system, and will result in pain and endodontic infection if the roots are not completely extracted. However, the concurrent presence of a normal periodontal ligament makes these extractions routine. With type 2 lesions, there are areas lacking a normal periodontal ligament (ankylosis) which also demonstrate varying degrees of root resorption, which makes extraction by conventional elevation difficult to impossible. The continued resorption in type 2 teeth is the basis for crown amputation therapy. It is this author’s opinion that teeth with an identifiable root canal on dental radiographs MUST be extracted completely, while teeth with no discernable root canal may be treated with crown amputation. If there is any question, always err on the side of complete extraction.
Neoplasia:
Neoplasia is defined as the abnormal growth of cells that is not responsive to normal growth control. Neoplasms can be further classified by their biologic behavior as benign or malignant.

Benign masses: Most benign neoplastic growths will have no boney involvement on dental radiographs. If bone involvement does occur with a benign growth it will be expansive, resulting in the bone “pulling away” from the advancing tumor leaving a decalcified soft tissue filled space in the tumor site. Bony margins are usually distinct. Finally, this expansive growth will typically result in tooth movement.

Cysts: Cystic structures will appear as a radiolucent area with smooth bony edges. Similar to other benign growths, they grow by expansion and thus displace the other structures (eg teeth). Dentigerous cysts are typically seen as a radiolucent structure centered on the crown of an unerupted tooth.

Malignant neoplasia: Malignant oral neoplasms typically invade bone early in the course of disease, resulting in irregular, ragged bone destruction. Initially, the bone will have a mottled “moth eaten” appearance, but radiographs late in the disease course will reveal a complete loss of bone (the teeth will appear to float in space). If the cortex is involved, an irregular periosteal reaction will be seen.

Histopathologic testing is always necessary for accurate diagnosis of oral masses since a variety of benign or malignant tumors appear radiographically similar. In addition, osteomyelitis can create the same radiographic findings as malignant tumors. Finally, aggressive tumors will show no bone involvement early in the course of disease. The prudent practitioner will note the type and extent of bony involvement (if any) on the histopathology request form (and may include copies of the radiographs and pictures) to aid the pathologist. It is key to interpret the histopathology result in light of the radiographic findings. A diagnosis of a malignancy without bony involvement should be questioned prior to initiating definitive therapy such as aggressive surgery, radiation therapy, or chemotherapy. Conversely, a benign tumor diagnosis with significant bony reaction should be further investigated prior to assuming that the patient is safe.

Additional diagnostic tests in questionable cases include complete blood panel, urinalysis, bacterial and/or fungal culture, as well as fungal serology.

Retained tooth roots:
Persistent tooth roots following extraction attempts are a common occurrence in veterinary medicine. In the vast majority of cases, there are no outward clinical signs, however the patient suffers regardless. In rare cases, the retained root may abscess, resulting in significant morbidity to the patient and possible legal action from the client.

Dental radiographs must be exposed following all extractions. Regardless of the appearance of complete extraction, there is still a possibility of retained roots or other pathology. Therefore, post-operative radiographs are critical in all cases. In addition, they will serve as a legal document in cases of complications.

Regional Anesthesia for Oral Surgery
An additional, critical method of pain management is regional anesthesia (also known as local nerve blocks). When correctly administered, regional nerve blocks provide not only elimination of pain perception in the innervated tissue but also positive systemic effects. Proper blockade of oral tissues prior to surgical manipulation eliminates central perception allowing anesthetic planes similar to that for non-painful procedures. This reduction in the percentage of inhalant anesthetic will have positive effects on intraoperative physiology. This includes minimizing negative effects.

Intravascular administration must be avoided. Aspirating prior to injection will ensure that the agent was given outside the vasculature. Excessive systemic uptake or intravascular administration could cause CNS or cardiovascular complications.

There are two agents which are commonly employed for regional anesthesia: lidocaine and marcaine. Lidocaine has the distinct advantage of fast onset (1-2 minutes) but only lasts 30-60 minutes. Therefore, it does not provide adequate analgesic duration in lengthy procedures. In addition, it offers only minimal if any pain relief in the postoperative period. Conversely, bupivacaine’s analgesic effect is significantly longer in duration (6-8 hours). The concern with its use has been that it was thought to have a longer onset of action, however, recent studies reveal efficacy in as little as 4 ½ minutes. The desire of short onset with longer duration made combining the products a popular option. However, recent research has shown that the combination may result in decreased efficacy.

All local anesthetic agents are vasodilative, and therefore create faster removal from the area and thus a shorter duration of action. Adding epinephrine to local agents has been shown to increase the active time by up to 50%. Adding an opioid such as buprenorphine or morphine to a bupivacaine block may result in a doubling the time of effect of bupivacaine alone. This author utilizes plain marcaine exclusively as 6-8 hours is sufficient time for effect for patient comfort without lasting too long into the post-operative effect that eating may be compromised.

While there is some concern with marcaine use and cardiotoxicity in cats, if intravenous injection and overdoseage is avoided, this complication should not occur. For this reason, it is critical to aspirate prior to each injection of local anesthetic. If blood is encountered, the needle should be redirected (and reaspirated) to insure that intravenous (or intra-arterial) injection is not inadvertently performed.

Recommended infusion volumes vary from 0.1ml – 1.6 ml from small to large patients. As far as dosage of local anesthetics is concerned, the published recommended maximum total dose of local anesthetics is 2 mg/kg (single agent or combination). This level is easy to reach in small patients when utilizing 2% lidocaine in feline and small and toy breed dogs. For example, a 5 kg patient should receive a maximum dose of 0.5 cc of 2% lidocaine. For this reason, it is advised to dilute this product to decrease the possibility of overdoseage. This author has never experienced complications at these dosages. Clinically, prehension and mastication does not appear to be compromised postoperatively in dogs and cats receiving dental blocks even if all four quadrants have been blocked. These guidelines are being reviewed, as the published maximum dose is based on intravenous injection and some anesthesiologists are utilizing much higher dosage for local injection.

The three major blocks are the infraorbital, mental, and mandibular. Some dentists/anesthesiologists utilize the caudal maxillary block, but this author does not recommend it due to the increased possibility of orbital penetration. If properly performed, the infraorbital block can effectively anesthetize the entire ipsilateral maxillary quadrant.
The depth to which the needle is placed within the foramen is one of significant debate. Some dentists recommend that the foramen be barely or not entered, while others will place the needle very deep within the infraorbital canal to block the molar teeth. I tend to be somewhere in between (see individual blocks below).

*Infraorbital block*

The infraorbital block is highly effective for the ipsilateral maxilla and teeth as well as the associated soft tissues. The infraorbital canal runs rostrally just above the apices of the maxillary fourth premolar and exits the maxilla over the distal root of the third premolar. To approximate the dorso-ventral location it is helpful to imagine the fourth premolar as being approximately the same size mesio-distal as corono-apical. Therefore, measure the width of the tooth and then measure that distance dorsally from the cusp tip. The infraorbital canal is just apical to this point. The foramen is easily palpated, especially in cats and large breed canines.

Manually retract the lip and the infraorbital neurovascular bundle dorsally. Advance the needle in a caudal direction close to the maxillary bone and just ventral to the retracted bundle to a point just inside the canal (and up to the medial canthus of the eye). The needle should pass into the canal without engaging bone.

In feline patients, the infraorbital canal is VERY short, which allows for orbital penetration. For this reason, we recommend that the foramen be barely entered and the needle directed ventrally. In dogs, do not advance past the medial canthus of the eye. The block will diffuse distally to the molars if a finger is placed over the foramen for 30-60 seconds after injection.

*Mental Block:*

The middle mental foramen is located apical to the mesial root of the second premolar in the dog, and in the halfway in the diastema between the canine and third premolar in the cat. It is approximately 2/3 of the way down from the dorsal border of the mandible. This will anesthetize from the ipsilateral mandibular third premolar to the central incisor and the surrounding bone and associated soft tissue.

The mandibular labial frenulum is retracted ventrally and the needle is inserted at the rostral aspect of the frenulum and advanced at an approximate 45 degree angle along the mandibular bone to just enter the canal.

*Mandibular Block*

The inferior alveolar nerve enters the mandibular foramen on the lingual aspect of the caudal mandible. The caudal mandibular block is performed by infiltrating the nerve at this level prior to its entry into the canal. This author tends to perform this block intraorally. The patient is placed in dorsal recumbancy and the mouth opened. With the index finger of the non-dominant hand, feel the notch on the ventral aspect of the caudal mandible. Then slide the finger a bit dorsally on the lingual aspect. Measure the width of the third molar and inter the mucosa right on the lingual aspect of the mandible at a point that far back from M3. Insert on a 45 degree angle advancing along the bone until the needle is felt moving through the tissues and inject at this point. If correctly performed, all mandibular teeth, bone, and soft tissue on the treated side are affected by this block.

Exceedingly rarely, patients who are not monitored postoperatively can cause severe trauma to the tongue during the recovery period. Whether this is specifically associated with regional anesthesia or recovery from any procedure is not reflected in the literature. To wit, this author has seen it twice in 15 years, both were boxers, and one did not even have blocks performed. In any case, proper patient monitoring during recovery should preclude this problem.
Conclusions
The vast majority of veterinary dental patients have some to significant oral pain which is acutely worsened with therapy (especially extractions). Proper pain management will decrease MAC and the secondary negative effects of increased inhalational anesthetics as well as smooth recovery. A multimodal approach, including regional anesthesia, is ideal. Finally, preemptive analgesia is superior to attempting to manage pain which has already been perceived.

Marketing Veterinary Dentistry

Why is marketing the dental department important?
1. Oral disease is by far the most common problem in veterinary medicine and there are generally only subtle to no clinical signs. However, patients afflicted with dental disease are quite often painful despite the lack of clinical signs. In addition, these disease processes cause significant localized and systemic medical problems. Ignorance abounds regarding dentistry both in the general public as well as in the veterinary field. This results in most patients being under treated. Therefore proper dental therapy is financially rewarding and good medicine.
2. Over the last decade or so, there has occurred a significant loss of traditional revenue streams due to many factors. Vaccine revenue has been markedly reduced by new studies. In addition, flea and heartworm prevention as well as other prescription revenue has been lost due to online prescriptions. Finally, increased reliance on the internet or other information decreases the client trips to the clinic

How to Increase Dental Revenue
Dental revenue can be improved in four distinct ways. However, they do not stand alone; all of them should be included in the marketing plan. In fact they are synergistic, by increasing more than one, they positively affect each other, further improving gains.

1. The first and most cost effective way to attain this goal is to increase the number of dental prophylaxis procedures performed.
   a. Client education: This is best performed by enlightening the population about dental disease. This should come not only from the veterinarian, but the entire staff. This includes technicians and possibly most importantly, receptionists. By educating the veterinary staff, you educate the clients and provide more dentistry. This ideally is in person, but if time is an issue, handouts or qualified websites can be effective as well. There are can be in person, or via handouts and/or websites. Client educational videos are available at [www.dogbeachdentistry.com](http://www.dogbeachdentistry.com)
   b. Superior, new equipment: Once the marketing plan is underway and the days are full, superior equipment will speed procedures. A new drill, ultrasonic scaler, elevator, or curette can markedly cut down on surgical time and increase the number of procedures performed a day. If a practice can do one more procedure a day 5 days a week at an average of say $400 it will pay off $4,000 worth of equipment in a month. Moreover, this will result in shorted anesthetics, which is better for the patient.
   c. Continuing education/training: By learning better techniques veterinarians and technicians can speed the dental procedures benefiting the practice and the staff. The staff can be more efficient, which will also allow for the possibility of additional procedures. Furthermore, this efficiency will decrease operator stain and stress. Finally, proper performance of dental procedures should result in
less surgical trauma and superior patient care. Ask your AHI rep if a lab is scheduled in your area, or visit www.vetdentaltraining for a San Diego class schedule.

2. The next way to increase income is by **increasing the per dental procedure charge**. Increase the number of treatment options for the clients. This does not mean doing things like root canals, jaw fracture repair and major oral surgery since what most DVM’s charge for these it is not efficient time usage. By spending that time doing office calls the practitioner will increase income with less stress. A more efficient way to do this is by offering superior “basic” care. This should include: dental radiology, root planing/doxirobe/clindoral, oravet, nerve blocks, proper pain management, bonded sealants, and fluoride therapy. All of these will greatly increase income without a significant investment of time or money. Practitioners, who have mastered the basics, can consider proceeding to composite restorations and periodontal flap surgeries, which are taught at the level 2 course in San Diego (See above).

3. Clinics can markedly improve their dental and income by **improving their pre-operative testing protocol**. Furthermore, perform the pre-operative testing the day the cleaning is recommended, this will help lock clients into the procedure.

   A. Complete blood panel (renal, hepatic, CBC, T4)
   B. Urinalysis
   C. Chest radiographs
      - HCM is often not ausculted
      - Over 50% of patients over 6 have significant findings on chest films

4. Provide superior (and necessary!) **post-operative treatment**
   a. Pain management: Opiates, NSAIDS, Local Anesthetics (nerve blocks)
   b. Maxiguard, Oravet, homecare kits
   c. Rechecks

5. **Specific cases where income can be increased**
   A. **Persistent deciduous teeth** are a very common problem in small animal patients, especially toy breeds. Most clinics will do this and charge for it, but in general they will way under charge and under treat. These are large teeth that are time consuming extractions. By keeping the teeth, the clients can understand why the extraction is expensive. In addition, proper pain medication and radiology will increase the fee to a reasonable level.
   
   B. **Fractured teeth with pulp exposure** are a very common occurrence in veterinary medicine (approximately 10% of dogs have a broken tooth with pulp exposure). All teeth that are fractured with pulp exposure are either painful, infected, or both. Therefore, all teeth need to be treated via root canal therapy or extraction. This does “bother the dog” and therapy is critical. If a minor tooth, extraction is a viable option. If it is a major tooth and the client is to be referred for root canal therapy, the patient should be placed on pain medications and/or antibiotics and a minimum database performed.

   C. **Worn teeth** with root canal exposure need to be treated with root canal therapy or extraction. Teeth without root canal involvement should be radiographed to ensure lack of endodontic infection and then treated with composite bonding if indicated.

   D. **Discolored (intrinsically stained) teeth**. A study by Hale in 2001 reported that only 40% of discolored teeth have radiographic signs of endodontic disease. However, when physically examined, it was discovered that 93% of the teeth were in fact non-vital. Therefore all discolored teeth should be treated as dead and infected (root canal therapy or extraction).
E. **Feline tooth resorptive lesions** are reported to be present in up to 60% of all cats greater than 6 years of age. These are VERY painful lesions and require therapy. These are diagnosed with an explorer along the gingival margin. Full mouth dental radiographs are indicated when lesions are found as they will generally have additional lesions. These teeth need to be extracted.

F. **Periapical Abscess** can be treated by root canal therapy or extraction. If electing to perform an extraction, remember that they are surgical procedures and should be charged as such. By calling it oral surgery it changes client perception of the procedure. Dental Radiographs and pain management including local anesthetics should be administered.

G: **Oral masses** are incredibly common in small animal dentistry (especially dogs). All growths no matter how small and normal appearing should be sampled and submitted to the lab for histopathologic analysis. In my experience about 1% of these biopsies will turn out to be malignant and need additional therapy. In addition they should all be radiographed to evaluate for bony involvement. This will help the pathologist to determine level of aggressiveness.

H. **Uncomplicated Crown Fractures** are a very common finding in large breed dogs (at least 50%). This occurs when a piece of the crown is broken, which exposed the dentin, but not the root canal. Occasionally, these teeth can become infected through the dentinal tubules which will go undiagnosed without dental radiology. However, teeth with no to small pulpal exposures tend to be the ones with clinical abscession. Even if these are not infected, they are at least transiently sensitive and require restoration.

- **Treatment**
  - Dental radiographs are WNL
  - Bonded sealant
  - Recheck radiographs in 9-12 months
  - Radiographic evidence of endodontic disease
  - Root canal therapy
  - Extraction

I: **Periodontal disease** is the number one diagnosed problem in small animal patients today. By the age of 2: 70% of cats and 80% of dogs have some degree of periodontal disease. This incidence increases with age. This has both local and systemic problems associated with it. By stressing these issues, the practitioner will greatly increase compliance with recommendations. Severe local effects include: oronasal fistula, class II perio-endo abscess, pathologic fracture, osteomyelitis, and ocular problems. Severe systemic effects include: renal, hepatic and cardiovascular disease; chronic obstructive pulmonary disease, diabetes mellitus, adverse pregnancy effects, osteoporosis. It is a state of chronic disease which the patient needs to deal with on a daily basis. This leads to early mortality.

The majority of dental patients will have periodontal pockets greater than 3-mm. These pockets are pathogenic and need to be treated to control periodontal disease. This will not only increase the oral health of the patient, but also the overall health and practice income. These teeth should all be radiographed to rule out endodontic involvement and under diagnosed periodontal loss. If more than one or two teeth are involved, full mouth dental radiographs should be considered. Following this, all pockets between 3 and 6 mm are best treated with root planing and instillation of a sustained release doxycycline product. Pockets greater than 6 mm or teeth with furcation level 2 or 3 exposure require periodontal flap surgery or extraction to remove the infection.
CONCLUSIONS

Dogs
- 80% have periodontal disease
- 10% have fractured teeth with pulp exposure
- 25% (conservative) have uncomplicated crown fracture
- 5% have other dental problems (neoplasia, orthodontic problems, cares, etc)

Cats
- 70% have periodontal disease
- 40% have TRs
- 10% have other problems (including fractures)

120% of veterinary patients have some type of dental disease!
There is no other area of veterinary medicine that has the potential that veterinary dentistry does. Just by doing proper and thorough dental work (do the basics well) practitioners can greatly increase dental income.