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small animal & exotic animal dentistry
How to use the WSAVA dental guidelines to improve your practice

Brook A. Niemiec

Southern California Veterinary Dental Specialties & Oral Surgery, San Diego, CA, USA

Many veterinarians have not heard of the World Small Animal Veterinary Association; much less know they are members. However, the vast majority of veterinarians worldwide are members. The WSAVA is an association of associations, counting over 200,000 members and 100 associations. Therefore, you likely are a member of this excellent group and have access to all of the educational and promotional material on the website and any CE provided.

The WSAVA will launch global dental guidelines next month. This work is a culmination of 2 years of writing and research. The committee includes not only Diplomates of the American and/or European Veterinary Dental Colleges from 5 continents but also specialists in anesthesia and analgesia as well as nutrition. Finally, there are two animal welfare advocates providing input.

This document is tiered by the socioeconomic position of various countries, to improve the minimum standards of care in a realistic fashion while still promoting best practice. The authors have strived to create a document that is not only available world-wide for free, but also written in a very accessible way.

The guideless document contains sections on oral pathology, anesthesia and pain management, and the universities role in improving oral and dental education. Further is a section on the importance of and how to perform a complete oral exam, which includes instructions on the use of a free on line charting system. Step by step instructions with full color images detail the basics of dental prophylaxis, dental radiology and extraction. Minimal equipment recommendations are made for the various areas as well as a thorough review on dental homecare. While non-anesthesia dentistry is discouraged throughout the text, it’s inappropriateness is the subject of its own section. Finally, the animal welfare impact of untreated dental disease is introduced.

This lecture will cover the many uses for this document in general practice, and how practitioners can make the best use of them. It is important to note that this document recommends “best practice” in the various areas and therefore is of most value to clinics who strive to provide the ideal care. By quoting the recommendations, these clinics can separate them from clinics who perform lower quality care.

The sections on oral pathology provide current diagnostic and treatment recommendations for common oral pathology. The text is supported by numerous full color pictures as well as dental radiographs. Since this is available on line for free, it can facilitate client communication. This will improve dental compliance, thus improving patient care and practice income.

The oral exam section provides instructions for a thorough oral exam while arming practitioners with a free basic on line charting system. This system also allows print outs which further improve client communication.

The techniques sections equate to “mini-textbooks” which due to their online availability, are always at hand for review. While current literature is available in tier 3 countries, for tier 1 and 2 they provide a critical resource.

The anesthesia & analgesia section contains instructions and recommendations for pre-anesthesia testing, drugs, and monitoring. This is the latest information and is a valuable resource for the practitioner. Further, this section details the most current level of safety, which should further increase compliance.

The numerous mentions of the inappropriateness of NAD will greatly aid practices in decreasing this wholly ineffective practice. The arguments against this procedure are presented in not only the dental prophylaxis section, but also in the anesthesia and welfare areas. This combination, together with a listing of all the professional associations who oppose it will aid in client discussions.

Finally, but perhaps most importantly, is the section on the welfare aspect of untreated dental disease in small animal medicine. This well referenced section, penned by non-dentists, highlights the plight that our pets face on a daily basis when dealing with untreated dental conditions. By using the term “animal welfare concern” we can improve the acceptance of recommendations on a personal as well as association level. Together we can strive to improve oral care for pets worldwide.
Introduction to feline dentistry and oral pathology

Judy Force
Dentistry for Animals (private practice veterinary dental specialty practice)

**Rule #1**: Cats are NOT small dogs. They have unique problems such as chronic feline gingiva stomatitis, tooth resorption (formerly known as: Feline oral resorptive lesions, FORL's, neck lesions, etc.) and root resorption, lip trauma following maxillary canine extraction and eosinophilic granuloma complex. They are less affected by the common dog problems such as fractured teeth (endodontic disease) and periodontal disease.

**Rule #2**: Cats DO NOT read textbooks. They do not follow the nice rules set out in textbooks for their treatment. Treatments and procedures that work for one cat may not work for another. Cats often have unusual presentations for their oral problems. Be prepared for your initial assessment to be proved wrong.

**Rule #3**: Cats will almost never stop eating because their mouth hurts. Often the most horrific mouths are seen in cats that are eating and grooming normally. When they stop eating it is usually due to some systemic disease process such as renal insufficiency or failure, neoplasia or infectious disease. Chronic feline gingivostomatitis and severe oral trauma are the exceptions to this rule.

**Feline dental formulas**

- Adult I3/3, C1/1, PM3/2, M1/1  30 teeth
- Kitten I3/3, C1/1, PM3/2  26 teeth

Maxillary 4th premolar has 3 roots (supposedly maxillary 1st molar also has 3 roots, but this tiny tooth varies a lot). Incisors, canines and max 2nd PM have 1 root. All the rest have 2 roots. However variations occur regularly.

**Preoperative testing**

This is critical in all patients, but is especially important in cats as they hide things very well. They can be very ill and their owners may not have noticed anything wrong.

- Complete blood panel (renal, hepatic, CBC, T4, U/A).
- Chest radiographs +/- cardiac ultrasound.
- Cardiomyopathy does not always present with a murmur or arrhythmia.

**Anesthetic safety**

- IV catheter & fluids are a must. Thermal support beneath and around patient (circulating water blanket, convection heat, towels and blankets) is also critical. Monitors to check blood pressure, heart & respiratory rate, temperature, ECG, ETCO2 and pulse oxygenation are also extremely important. Dedicate a technician to monitor the patient & all the equipment during anesthesia. Know your anesthetic drugs.

The importance of dental radiography can not be stressed enough. This is especially true in feline practice. Dental radiology is essential to diagnose and treat dental disease in cats. You will find 30-40% more significant pathology with dental radiographs. This includes tooth resorption, root resorption, oral tumors, retained root tips, osteomyelitis, fungal disease, fractures and many other dental diseases and oral pathologies.
Dental radiography – positioning and screening

Bob Partridge

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Obtaining useful dental x-rays is always a challenge, especially when you are first starting. Having a system that allows you to quickly and efficiently obtain quality views is the holy grail. Having a system that can be easily taught to your support staff, allowing them to obtain the radiographs for you, is even better!

Whilst, by its nature, a screen will never be perfect, it does form a useful starting point for the dental clinician. Studies have clearly identified the need for dental radiography to obtain accurate diagnosis of significant pathology.

Client acceptance of the additional costs has always been cited as a barrier. The author has formulated a step-by-step plan which engages clients and allows veterinary dentists to do the job the way it should be done. These are tools that all of your team need to be using – so that the message of “best possible care” is uniformly delivered to your clients. Whilst being a referral specialist, the author is firmly grounded in first opinion work and knows first-hand the problems involved in persuading ordinary clients to pay for procedures. The author will describe the major indications for dental radiography in a way that your team can use to encourage client uptake.

An understanding of the “bisecting angle technique” is always necessary to fully develop good dental radiographic technique. The author presents an easy to understand way to come to grips with this challenge.

Finally, what you do with the radiographs after the procedure can have a major impact on client satisfaction. This in turn will influence other clients, either making acceptance of your recommendations easier or harder. In addition the feedback to your team will either encourage or demotivate them from offering dental radiography. The author will again offer hints and tips from real world experience.

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SURPRISE
Feline dental radiology techniques and basic interpretation

Brook A. Niemiec

Southern California Veterinary Dental Specialties & Oral Surgery, San Diego, CA, USA

Dental radiology techniques – 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. 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.

The extraoral technique for the maxillary P4s of feline patients requires placing the film/sensor on the table and the cat on the sensor with the arcade to be imaged down. The beam is angled through the mouth to create a bisecting angle which is about 30 degrees. Remember that this film will be opposite the arcade determined by the techniques used below for determining what side was imaged.

**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 setting. 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.

**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...
Puppies need dental care too!

Kris Bannon

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Most people tend to think of dental disease as a problem only in old animals with periodontal disease. However, many puppies and kittens can have painful oral health issues that need treatment. Just because they are eating and playing does not mean they do not have pain. This is a very common misconception!

Pain can be especially hidden in young animals. Because they often have not known life without dental pain, they just assume that pain is part of life and go on about their day being a puppy. Think about the people you know with chronic knee pain, or maybe back pain. Most people with chronic pain don’t act much different than the rest of us. They still go to work, and go to the grocery store. But that doesn’t mean that they don’t wish for a day when they feel better and their pain is treated and goes away!

In order to understand when things have gone wrong and might be causing pain (and thus need our help!), first we have to understand normal. Puppy teeth start to develop inside the jaw bone. The first set of teeth erupt starting about 3-6 weeks old in most animals. By 8 weeks old, most puppies and kittens have all of their baby teeth in place (deciduous teeth, or “milk teeth”). Puppies have 28 teeth, and kittens have 26.

The roots of the deciduous teeth begin to break down and resorb around 4 months of age, and when the root is completely gone, the baby tooth falls out. Usually the puppy or kitten swallows it while they are eating, although occasionally some owners find baby teeth around the house. By 6 months of age, all of the permanent (adult) teeth should be erupting or almost completely in place. Normal dogs will have 42 permanent teeth, and cats have 30.

As young animals come into the veterinary hospital for their well puppy and kitten visits each month, make a habit of examining the oral cavity each time. This offers several advantages:
1. The animal gets in the habit of allowing an oral exam
2. The owner understands the importance of regular oral exams
3. Discussion about tooth brushing, proper oral hygiene, and lifelong oral health can be started
4. Evaluation for and identification of problems can occur early

What types of problems are we watching puppies and kittens for?

1. **Malocclusions** – this is any type of abnormal tooth-on-tooth or tooth-on-soft tissue contact. This can occur with puppy teeth, and it can occur with adult teeth. Some cases don’t require intervention, but unfortunately, most do. This can be anything from extraction of the misplaced puppy teeth, to puppy braces. Yep, braces for dogs!

2. **Fractured teeth** – puppy and kitten teeth are very small, thin and fragile. And they can be hard on their young teeth. If a baby tooth fractures, it will allow infection down into the area where the adult tooth is developing and cause permanent damage to the adult tooth. As soon as a broken baby tooth is identified, removal is recommended, even if it is expected to fall out very soon!

3. **Missing teeth** – As the permanent teeth erupt, counting them for the presence of all teeth is very important. If they are missing teeth by the age of 6 months, dental radiographs of the area should be obtained. If the teeth are truly missing, that is not a major problem unless the animal is expected to be used for show or breeding. But if they are impacted under the gumline or inside the bone, this can cause major problems. These impacted teeth should be identified and treated.
   a. **Delayed eruption** – This is when a tooth is trying to erupt, but gets stuck underneath a very thick layer of fibrous gum tissue. If identified in time, the gum tissue can be trimmed over the tooth and the tooth can be allowed to erupt normally. This is called an operculectomy. If the tooth is not angled correctly for eruption, or was not identified until the root closed and is no longer erupting, then removal of the tooth is necessary.
   b. **Dentigerous cyst** – This is caused by an impacted tooth that remains inside the bone. Fluid can accumulate around an impacted tooth, causing a very large and destructive cyst to form within the bone. This can damage the surrounding teeth, and left untreated, can even fracture the jaw. It will take a significant amount of bone damage to be able to visibly see the problem in the awake patient. Therefore, it is very important that any missing teeth are radiographed early to avoid this major problem.

4. **Retained deciduous teeth** – Another problem in slightly young animals is when the adult teeth come in, but the baby teeth did not fall out. A good rule is that no two teeth of the same type should be in the same mouth at the same time. If so, the baby tooth should be removed as soon as this problem is noted. If not, problems can occur from the crowding of these teeth, including malocclusions, periodontal disease, and pain!

5. **Enamel hypocalcification** – Weeks to months after the adult teeth erupt, the enamel can start to flake off and the teeth appear to be rough and irregular. This is called enamel hypocalcification. This is caused by injury to the tooth as it was developing inside the jaw bone, typically from a fever or from a traumatic injury to the jaw. As the enamel flakes away, this exposes the sensitive dentin, and can allow bacteria inside the tooth. Treatment involves radiographs to make sure that the teeth are still healthy and developed normally, then removing the unhealthy enamel and fillings (restorations) to prevent or treat sensitivity, pain, and infection. Extraction is sometimes necessary.

6. **Tumors** – yes, sadly, puppies can get tumors too. Typically these are rapidly growing, and can occur as young as 8-12 weeks. The most common tumors in young animals are papillary squamous cell carcinomas and odontomas. Most of the time, if caught early, these tumors can be completely removed and the dog can live a normal life. However, they grow very rapidly and can expand beyond the point of being able to surgically remove them very quickly. Early identification as a tumor rather than a facial swelling from an infection or other cause is extremely important for long term success.

Most puppies and kittens go about their childhood with very normal, healthy mouths, develop all of their teeth correctly, and do not have dental or oral health problems until they get older. However, when they do have problems, early detection and treatment can prevent pain and trauma, and can even save an animal’s life. Knowing what normal looks like helps identify abnormal, and immediate intervention is always best.
Senior dental care – Special considerations for an important population

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Introduction

It has been shown that periodontal disease increases in prevalence as age increases, and as body weight decreases (small dogs vs large dogs). With any chronic process, particularly one with loss of tissues (gingival and bone), the disease is likely to get worse without intervention until the final phase of periodontal disease, which is actually tooth loss. The co-influence relationship of dental disease with diabetes and even renal disease underscores the importance of addressing issues in senior pets before they cause more problems.

Senior dental issues

Periodontal disease has increased incidence in older pets, as does any of the conditions that can increase over time, such as tooth resorption or stomatitis in cats. Extensive periodontal disease that has destroyed mandibular bone at the level of the first molar can lead to pathological fractures, sometimes bilaterally, that have insufficient osseous structure for stabilization. Older cats may exhibit a thickening of the alveolar bone surrounding the canine teeth, especially the maxillary ones, with a concurrent super-eruption of the teeth, making them look longer than normal. This chronic osteitis/alveolitis may be minor, with periodontal management sufficient for treatment. If the tooth is mobile or the surrounding tissues inflamed, extraction may be the best route.

Oral tumors are also seen more frequently in mature/older patients, and early detection and identification of any mass can provide the only possibility for adequate management. In dogs, melanocytic tumors, fibrosarcoma and squamous cell carcinomas (SCC) are some of the most frequent types found, while the three forms of SCC (gingival, lingual, tonsillar) are the most common types found in cats.

Treatment concerns

Yet, as the increase in periodontal disease would warrant professional care, it is the presence of the co-morbidities that can make the necessary anesthetic procedure potentially riskier. In very few instances is the level of disease so severe, or unresponsive to management, that the dental care should be avoided completely. Most cases can be evaluated pre-operatively to identify underlying issues, and those identified disease processes can be treated to return the patient to a more stable level, to decrease the risk an anesthetic procedure would entail. In each patient, the risk of retaining the dental disease its potential effects on the rest of the body typically is outweighed by the benefits of treatment.

Individualized treatment plans are essential for senior and geriatric patients: from the pre-operative evaluation and stabilization therapy (if needed) to the immediately pre-operative period and peri-operative time frames. Many comparisons can be made to guidelines for human patients for dental procedures, including the benefit of pre-operative laboratory screening, but we have to realize that our patients can give us details on how they are feeling. In fact, dentistry and blood work can help support each other’s efforts: if a recent senior screening has been done, that might be a good time to get dental work accomplished, and if dental care is needed, it is a good time to update that patient’s lab work profile (especially if it has been declined in the past). While not always common, it is possible to pick up on underlying, inapparent disease of a patient when doing the pre-op screening.

For those patients in the mature-senior-geriatric categories, utilizing the patient anesthetic risk classification is a good starting point for evaluation and for determination of what level of assessment should be done. ASA levels of I and II might require basic blood work, UA and ECG, while adding additional chemistries to the levels III-V. Monitoring urine output (1-2 mg/kg/hr) is seldom done, but can provide beneficial information.
Pre-operative medications often play a role in these patients, including evaluating what medications could have an impact on anesthetic and analgesic drugs utilized. Decisions may have to made about what medications need to be given on the day of the procedure, and how fasting may influence diabetic patients. For most patients, while food should be taken up the evening before, small amounts of water can be given until they are admitted to the hospital.

Antibiotic use and selection will always generate plenty of discussion, and again, while human dental recommendations are to be considered, adding in the complications of anesthesia, with possible hypovolemia, hypotension and hypothermia, should be considered in each patient. If it is determined that the individual has some systemic risk (cardiac disease, borderline renal disease, etc), it may be appropriate to use a broad spectrum antibiotic (such as amoxicillin-clavulanic acid) just prior to the procedure, or to consider interoperative administration of an IV ampicillin/amoxicillin. In some patients with extreme dental infection, prior use of an antibiotic such as clindamycin has greatly improved the health of the dental tissues, and also the patient, in this author’s opinion.

Pain management

Another very important aspect of dental care is pain management. By customizing the analgesia and anesthesia protocols for each patient, appropriate use of pre-operative agents can reduce the anxiety and stress on the patient in the pre-operative stage, which could have a positive effect on stress-induced immunosuppression. With good pre-operative, multi-modal analgesia, combined with local and regional blocks, the level of general anesthetic needed for the patient can be reduced significantly. If NSAIDs are chosen (renal-healthy), perfusion with fluids is important.

For local and regional blocks, the total dose should be calculated, particularly in small dogs and cats. Bupivacaine (0.5%) premixed with epinephrine (1:200,000) provides a longer time for analgesia, with some hemorrhage control, but should not be used in cases with contraindications (cardiac arrhythmias, hyperthyroidism). It also needs to be placed 10-20 minutes before the extraction or periodontal procedure for maximum effectiveness. Lidocaine doesn’t last as long, but does provide quicker analgesic effects.
Patient care

Perfusion before and throughout the procedure is critical in dental anesthetic cases, to maintain adequate blood volume, particularly for renal function. An initial bolus (5-10mg/kg) may be provided preoperatively, with 5-10mg/kg/hr for a maintenance dose. Cardiac patients might have a decreased fluid capacity, so monitor patients closely for any signs of overhydration, including increased pulmonary sounds or even monitoring HCT. This interoperative replacement of fluids will offset loss of water by evaporation, third space losses into traumatized tissues, and even volume replacement for hemorrhage loss in some cases.

Maintain body temperature in dental cases can be quite challenging at times: most are older, smaller, and the oral cavity is constantly wet, or being rinsed. Geriatric patients in particular can have exaggerated hypothermia with a decreased basic metabolism rate. Body temperatures less than 98 degrees can alter mentation, the immune competency of the patient, and can affect wound healing. Decreased body temperature can also impact recovery time. Keep the patient as dry as possible and provide patient warming devices where appropriate. Passive and active surface rewarming with warm water blankets, air warming devices or conductive fabric blankets can be helpful, as can active core rewarming with warmed isotonic fluids.

Patient monitoring

The reason we have more confidence in safer anesthesia events is the combination of individualized analgesia/anesthesia protocols and the level of patient monitoring that can be provided. General anesthesia depresses many systems of the patient that may already be compromised: respiratory, cardiovascular, CNS, thermoregulatory, hepatic and renal, to name a few. Monitoring should be constant throughout the procedure, and into the post-operative period as well, where most unexpected deaths occur.

With all the advances in monitoring equipment available, the best monitor is still a good technician. Observation of general parameters, in addition to readings from monitoring equipment can provide the best assessment of the depth of anesthesia, or when changes indicate a need for intervention. Heart rate and respiration recorded every 5 minutes can be combined with pulse oximetry, blood pressure, CO2 levels, body temperature and continuous ECG readout. CNS evaluation of the muscle tone of the jaw and eye position/palpebral reflex are more subtle indicators of anesthetic depth.

A dental procedure can sometimes be lengthy, and in particular with older patients, this can lead to concerns about decreasing body functions as the time goes on. Maintaining perfusion and blood pressure with fluids can decrease body temperature, as can moisture associated with the procedure. Anesthetic levels should be kept to as low of a level as possible to help maintain blood pressure, without waking the patient. There are situations, either due to the patient’s body systems, the length of time needed, or the extent of treatment needed that could necessitate ‘staging’ the procedure and completing a portion of the surgery at a later date.

Emergency situations should be anticipated ahead of time with printed protocols for the common drugs that may be needed in such events. Regular monitoring should consider any trends in parameter changes that could precede an emergent event, and if patient response is inadequate, immediate recovery should be instigated.

Recovery

Patient management and monitoring should not end when the anesthesia is turned off, or when the endotracheal tube is removed. In fact, since the patient is not observed as closely as during the peri-operative period, the recovery time is when many adverse events happen, sometimes leading to patient death. Brachycephalic patients in particular should be closely monitored, as the challenges to their air passages return once the tube is removed, so the tube should remain in place for as long as possible. Any swelling, hemorrhage or pain flare-up can add to the morbidity of the case. In patients with emergent delirium, a very low dose of dexmedetomidine may be administered (if not contraindicated) to help relieve the anxiety, stress and pain for a smoother, slower recovery. If a patient show significant pain beyond that, additional opioids may be required.

If a patient had issues with hypotension, fluid administration and even inotropes may be considered in the post-operative period, with close monitoring. Bradycardia may be present due to the effects of anesthesia, as well as any prolongation of hypothermia. If any medication (alpha 2) was used, a reversal agent would be recommended, and an anticholinergic may be used, with caution. Providing a safe means of keeping the patient warm – and dry – is also recommended.
Monitoring urine output, either a specific measurement, or encouraging conscious voiding, can assess if additional fluids are needed. With smaller patients, and certainly those with diabetes mellitus, monitoring blood glucose during and after anesthesia can point out those that might need supplementation.

**Post-operative**

Returning the patient to normal function as quickly as possible helps in the recovery process. Post-operative medications from analgesics to antibiotics should be discussed with the owner for proper administration. Eating and drinking small amounts should be encouraged that evening, though the food may need to be softened for a period of time after the procedure. Supplemental feeding may be necessary, to include anything from syringe feeding to a peg tube, depending on the case. Phone recheck the next day and a physical exam in two weeks allows for continued monitoring of the patient with plans for ongoing management.

**Summary**

While senior pets may present with particular circumstances that make anesthesia planning more complicated, in most instances appropriate patient evaluation and care will provide the opportunity for good dental care. If dental health can be

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**Bad bites – How can we correct them?**

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**Introduction**

Orthodontics is probably the least employed of the veterinary dental disciplines, probably because people associate orthodontics only with dental appliances. The discipline is in fact divided into three classes: 1) Preventive orthodontics consists of counseling the owner to help him provide the right exercises and chew toys in order to avoid developing a malocclusion. Genetic counseling helps eliminate poor subjects from the breeding pool. 2) Interceptive orthodontics consists of preventing the formation of malocclusion. This is usually accomplished by extracting teeth in the deciduous or mixed dentition stage. Interceptive orthodontics can correct both skeletal and dental problems. 3) Corrective orthodontics is the treatment of a malocclusion in the permanent dentition. This is where dental appliances are used to move teeth. Most of the problems dealt with in this category should be dental in nature. It is not recommended to use orthodontics to mask skeletal abnormalities.

**Normal occlusion**

There exist three types of canine skulls:

1. **Mesaticephalic** – mid size skull with a snout not too long and not too large. This type is seen in the Beagle, Labrador Retriever, German Shepherd, etc.
2. **Brachycephalic** – Short jaws and short wide skull as seen in the English Bulldog, Shih Tzu, Pekinese, etc.
3. **Dolichocephalic** – Long and narrow skull and jaws as seen in the Collie, Doberman, Borzoi, etc.

The normal occlusion, based on the mesaticephalic skull, is as follows: The lower incisors rest on the cingulum of the upper incisors. The lower canines fit, without touching, between the upper lateral incisors and the upper canines. Maxillary and mandibular premolars interdigitate. The tip of the central cusp of the mandibular fourth premolar points to the gingiva between the maxillary third and the fourth premolar. The tips of the crowns of the maxillary and mandibular second premolars are at the same level. Finally, the angle
of the mandible lies directly below the posterior border of the coronoid process of within 3 mm of that point. Any deviation from the above is an abnormality.

**Class I malocclusion (Neutroclusion)**

It is characterized by dental irregularities, but with a normal rostrocaudal (mesiodistal) relationship of the mandible and the maxilla.

Individual teeth malpositions – Examine to find out whether or not the malposition results in trauma. If yes, treatment has to be instituted. If not, just enter the malposition in the dental records.

Rotations – The most common rotation involves the maxillary third premolar, in brachycephalic patients. The affected tooth ends up crowded between second and fourth premolar. The crowding exacerbates periodontal disease and often leads to early tooth loss. Moreover, in some cases the distal root of the third premolar is displaced buccally and is actually found outside the maxilla. In other words, the bone support is missing which, by definition is a form of periodontal disease. Treatment consists in extracting the rotated tooth to make space for second and fourth premolars and to minimize the periodontitis.

![Diagram of a normal or class 0 occlusion](image)

Variations in tooth sizes – Fairly rare. Here too one wants to ascertain that the condition does not result in dental trauma, in which case treatment is indicated.

Missing teeth – An abnormality that rarely requires any correction. It suffices to note it in the file.

Supernumerary teeth – These on the other hand, cause trauma secondary to crowding. In the majority of cases, the affected tooth needs to be removed to make space for the other.

Gemini teeth – One adult bud tries to divide to create two teeth. The division is partial and as a rule, one ends up with two crowns fused and one root system. One needs to verify that the crowns are completely covered with enamel, that there is space for the extra crown, and that the endodontic system is normal (need x-ray). If the answer is yes to all three, no further treatment is required. If not, restoration, endodontic treatment, or extraction is necessary.

Fused teeth – Two adult buds fuse and create a doubled crown tooth but with two radicular systems. Examination and treatment are similar to those done on Gemini teeth.

Rostral open bite (maxillary-mandibular asymmetry in a dorso-ventral direction) – This condition is often the result of bone deformation. The incisors do not overlap when the mouth is closed.

Caudal open bite – There is space between the premolars when the mouth is closed.

Rostral cross bite – Upon closure of the mouth, the mandibular incisors land labial to their maxillary counterparts. If no other abnormality exists, this condition can be corrected using orthodontic appliances.
Caudal cross bite – Upon closure of the mouth, the mandibular premolars end up buccal to their maxillary counterparts. In case of traumatic occlusion, extraction of one tooth is necessary for correction of the problem.

Linguoversed mandibular canine teeth – Common orthodontic condition in dogs. The mandibular canine teeth are too close to each other or are not tipped buccally sufficiently and end up contacting the palate upon closure of the mouth. Two treatments exist; 1) crown amputation of the canine teeth and direct pulp capping (vital pulpotomy) to eliminate the trauma to the palate. 2) orthodontic movement of the canine teeth to their intended position. Either treatment is adequate; the choice will depend on the exact presentation and on the desiderata of the owners.

Mesially displaced maxillary canine tooth – The adult canine is tipped mesially into the space where the mandibular canine normally occludes. Correction takes the form of extraction, crown amputation and direct pulp capping, or orthodontic movement.

Lance canine – An extreme form of mesially displaced maxillary canine tooth: the canine points straight rostrally out of the maxilla. Its tip is usually dorsal to the neck of the lateral incisor. Correction consists of extraction (careful, this is a nasal surgery) or orthodontic movement. The orthodontic treatment is by the best for the patient.

Class II malocclusion (Mandibular distocclusion – mandibular brachygnathism – overshot)

The mandible is too short relative to the maxilla; therefore, the mandibular incisors do not touch the cingulum of the maxillary incisors. The amount of space between the maxillary and the mandibular incisors varies with the severity of the condition. The position of the mandibular cuspids varies from being rostral to but touching the maxillary cuspids to being caudal to the maxillary cuspids. Finally, the mandibular premolars are shifted caudal in relation to the maxillary premolars, to varying degrees, disrupting the “pinking shear” effect normally seen. The central cusp of the lower fourth premolar is now touching or hidden behind the upper carnassial.

Class III malocclusion (Mandibular mesiocclusion – prognathism – undershot)

It is the opposite condition to class II malocclusion. The mandible is too long in relation to the maxilla. In fact, most of the time, it is the maxilla that is too short. The mandibular incisors contact the incisal edge of the maxillary incisors or even are rostral to them. The position of the mandibular cuspids varies from being caudal to the lateral maxillary incisors but touching them, to being rostral to the lateral incisors. The mandibular premolars are shifted rostrally, to varying degrees, in relation to the maxillary premolars.

Always make sure that you look at all the teeth when doing a bite evaluation, not just at the incisors and the cuspids.

Fig.2 – Diagram of a class II malocclusion.
Preventive orthodontics

Genetic counseling is simple but often unsuccessful. It is mostly used with breeders whose prime objective is to produce puppies. The last thing they want to hear is that their “champion” needs to be removed from the gene pool. Compliance, on the part of the owner, is often poor.

Interceptive orthodontics

It is by far the largest part of veterinary orthodontics. Patients brought in for their first vaccinations often have retained teeth. It is easy to explain to the owner that for the succedaneous teeth to erupt in the proper position, the “baby” teeth have to be removed (there should never be 2 teeth of the same type, at the same place, at the same time). Treatment of adverse dental interlocks also falls into the same category. The mandible and maxilla do not grow continuously or simultaneously. Thus a tooth or teeth can interfere with a growth spurt from either jaw. Correction consists of extracting the tooth or teeth causing the lock. Removing the dental interlock allows the mandible of the maxilla to grow to its genetically predetermined length. A patient genetically prognathic or brachygnathic will remain that way. If, on the other hand, it is genetically normal, removing the lock will prevent the formation of a malocclusion. The best results are obtained when dealing with 8 to 12 weeks old patients. Even then, the success rate is between 25 to 50%.

To avoid complications, you should 1) Start by taking an intraoral radiograph to visualize the position of the root of the tooth to be extracted. Thus doing, you also verify that the permanent tooth bud is present (guess who is going to be at fault if no permanent tooth erupts after you extracted the deciduous counterpart). 2) Be as gentle and atraumatic as possible. Begin with a circumferential intrasulcular cut. Use small, sharp elevators suited to the tooth being worked on (go buy more luxators). 3) Once the extraction complete, do not suture the coronal defect in the gingiva as this could cause formation of scar tissue, which would interfere with the normal eruption pathway. If a flap is necessary during the extraction, suture the buccal incision only. 4) Take a post-operative radiograph to ascertain that the whole root was removed and that the adult bud is intact. 5) The sooner the retained tooth is removed, the better the chance of correcting the occlusion (do not wait till the patient comes back for neutering to act, by then it is too late).

Corrective orthodontics

It is the controlled movement of the tooth and its attachment apparatus through bone. Actually, it is the periodontal ligament that moves through bone. The best way to accomplish effective dental movement is to use light (15-150 gm) continuous forces. The length of time the forces are applied to the tooth, daily, is more
important than the amount of force applied. The minimum is 6 hours per day.

The three most common conditions amenable to correction are: linguoversed mandibular canine teeth, mesioversed maxillary canine teeth, and rostral cross bite. All three were once believed to be the result of retained deciduous teeth. With more research being done, familial relationships are emerging and in some cases, these abnormalities are now thought to be genetic.

**Specific orthodontic conditions**

**Persistent deciduous canine tooth.** The permanent maxillary canine erupts rostrally (mesially) to its deciduous counterpart. In case of retention, the permanent comes to occlude against or on top of the mandibular canine, preventing it from tipping labially. The permanent mandibular canine erupts caudomedially (distolingually) to the deciduous. In case of retention of the deciduous, the permanent canine ends up as base narrow (linguoversed) canine, which causes soft tissue trauma to the palate. The retained deciduous teeth need to be removed as soon as possible (as in yesterday).

**Linguoversed mandibular canine teeth.** Often seen in conjunction with class II malocclusion. Untreated, this painful condition can cause palatal damage, oronasal fistula, partial eruption or root shortening due to external resorption. Performing crown amputation, and direct pulp capping (vital pulpotomy) can improve this condition. To correct it, the mandibular canine teeth need to be moved to their normal position. Several appliances are available to accomplish this task (incline plane, telescopic incline plane, W wire, expansion screw etc.).

W wires and expansion screws are bonded to the mandibular canine teeth. They push one canine against the other, and therefore are used only when both canine teeth are similarly displaced. The incline plane, on the other hand, can move each tooth independently; it also has the advantage of being able to move the teeth in 2 different directions. The telescopic incline plane is best used in young patients because it does not restrict the growth of the palate. Its disadvantage is that it usually needs to be fabricated by a dental laboratory, necessitating an extra anesthesia, impressions, stone models, and thus extra costs. A simple round telescoping bar connects the inclines making it easier to clean thus reducing the chance of a serious infection developing. The regular incline plane is made of acrylic and can be fabricated directly in the mouth. Several teeth serve as anchors resulting in a large part of the palate being covered by the appliance. This makes it harder to clean and a severe inflammation of the palate often develops. This inflammation disappears as soon as the incline is removed.

The process of building an incline plane is fairly simple: The margins of the appliance are delineated with sticky wax. The teeth to be incorporated into the appliance are cleaned with flour pumice and etched with phosphoric acid. A self-mixed, chemically cured, composite resin is used to build the inclines. It is often necessary to extubate the patient to see exactly where the mandibular canine teeth contact the appliance. Once the resin has set, it can easily be shaped using a “goldie” bur mounted on a slow handpiece. With a little bit of practice, one can also make a telescopic incline: a band of wax is placed in the center to separate the two halves of the appliance. The rod and tube are made of a 22 gauge 1 to 1.5 inch hypodermic needle slid into a 19 gauge 1 to 1.5 inch hypodermic needle. They are cut for measure, bent and embedded in the wax and in the acrylic on either side. Once the appliance is set the wax is removed and the telescope is functional.

Follow up visits should be set at weekly intervals until the teeth have reached their goal. Once the desired position has been reached, a retainer is not needed, as the palate stops the teeth from relapsing to their original position.

**Mesioversed maxillary canine.** An extreme form of this abnormality, commonly referred to as a “lance” tooth, is often found in Shelties, where the canine erupts horizontally just distal to the lateral incisor. To reposition this tooth, simply place brackets or lingual buttons on the upper fourth premolar and the first molar, to serve as anchor. Then place a wire with a hook around the crown of the canine. Wire and brackets are bonded into place and an elastic chain is run from the canine to the anchor teeth. One can reinforce the anchor by wiring the fourth premolar to the molar. At first the elastic chain is stretched to 80% of its resting length. Fourteen days later and every two weeks thereafter, it is replaced and stretched to 75% of its resting length. An average of eight weeks is necessary to reposition the tooth. During its move the canine slides on the lingual side of the mandibular canine. In some cases, the mandibular canine is displaced buccally. It normally returns to its original position under the pressure of the lips. In rare occasions, this is not enough and another brace must be designed to tip the mandibular canine back lingually. This increases the total time of...
the orthodontic move to 14 to 18 weeks. A retainer is not needed because the mandibular canine stops the maxillary canine from returning to its former position.

**Rostral cross bite.** Believed to be the result of retained deciduous incisors, this malocclusion presents the most variations. Any number of incisors can be involved, resulting in numerous presentations. The basic principle remains the same; a bite plane must keep the mouth partly open to allow the maxillary incisors to slide rostrally and the mandibular incisors to slide caudally/lingually. A labial bow or a modified Maryland bridge is used to move the upper incisors rostrally (labially). Using study models, an appliance is prepared at the laboratory. It can also be built directly into the oral cavity. In the maxillary appliance, a bite shelf is incorporated to prevent the incisors from overlapping during closure. The mandibular incisors are tipped caudal (lingually) with the help of a lingual bar or with various combinations of brackets, wires and elastics. The teeth move into position in 6 to 10 weeks. As soon as they are in scissors bite, the appliances are removed. A retainer is not needed as the incisors overlap, preventing each other from relapsing into cross bite.

**Level bite.** Maxillary and mandibular incisors meet on their incisal edges. The extreme forces can result in broken crowns or the early loss of incisors. This condition can be associated with a class III malocclusion. To correct it, one needs to move the upper incisors rostrally and/or to move the lower incisors caudal, as in a case of anterior cross bite.

**Maxillary-mandibular asymmetry in a side to side direction.** It is the uneven growth of one side of the maxilla or the mandible. In its mild form, one sees a one-sided brachygnathism or prognathism. In a more severe form, one can see a crooked head, deviated midline, and open bite. Orthodontic improvement may result in a functional occlusion but still far from perfect. Some veterinary dentists do not recommend doing any orthodontic work with these cases.

**Rotated upper third premolar.** Seen in brachycephalic breeds, where there is no sufficient space for all the teeth. The third premolar can be tightly impacted; its caudal (distal) root often sticks out laterally under the gingiva with very little or no bone support. Untreated, the situation develops rapidly to a case of periodontal disease with gingival inflammation, periodontal pockets, and bone loss. Early extraction prevents the formation of periodontitis by reestablishing a more normal anatomy.

A few final comments: orthodontics is not for everybody, choose your patients and clients carefully. Patients should be amenable to mouth manipulations, and clients should be ready to supervise their pets at home (i.e.: no chewing of toys or hard objects) and to clean their mouth daily (not once in a while). They should also be able to visit regularly; if they live too far, problems with missed follow up appointments can and will arise.

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**Antimicrobial usage in veterinary dentistry: Why or why not?**

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**Introduction**

Antimicrobial usage in the field of veterinary dentistry has been a contentious issue within the veterinary dental fraternity for a long time, as is the usage of antibiotics in general.

In the 1990s, it was recommended that a certain antibiotic be given to veterinary patients for a number of days prior to performing any periodontal procedure\(^1\).

The overuse of antibiotics in human and veterinary healthcare is becoming a major concern throughout the world. Overuse or incorrect use can lead to bacterial resistance. This can result in some cases to death, as well as drug interactions/hypersensitivity and disturbances to the normal and beneficial gut flora.
Antimicrobials (ABs) are defined as those agents that arrest the growth of bacteria. They can include antibiotics and antiseptics, both of which are used commonly in the management of periodontal disease (PD) in veterinary patients.

AB usage has often been based on the assumption that PD is only a bacterial infection, and therefore antibiotics should be used to treat this infection.

Often, the choice of AB is decided upon on empirical grounds, and no culture and susceptibility testing is carried out (often due to the cost and difficulty of testing). However, the management of PD is quite different to the treatment of most bacterial infections. PD is a chronic slowly progressive disease, rather than having an acute onset.

The bacterial flora present is always heterogenous and relatively complex and often varies from animal to animal. Rarely can the presence or absence of a single bacterial species be directly correlated with disease presence. In addition the presence of the disease itself is often hidden. There are differences between the bacterial flora that cause periodontal disease in man compared to those found in dogs and cats. Certain bacteria such as gram negative aerobes (Moraxella spp., Capnocytophaga spp.) are associated with periodontal health at least in dogs.

There are over 500 different species of oral bacteria and a number of these species are very difficult to culture. Furthermore, there may well be other species of bacteria that have not been identified yet. Culturing of periodontal pockets is technique sensitive and prone to error. Because of these factors antimicrobial susceptibility testing for oral infections is not performed often and usually antibiotics are selected on an empirical basis. Accurate records of treatment and outcome should be maintained to evaluate therapeutic antibiotic usage.

Before prescribing ABs, the veterinarian must consider such issues as choice of antibiotic, dosing regimen, length of treatment, evaluation of treatment outcome and short and long term benefits from ideally what should be adjunctive antibiotic therapy rather than a monotherapy.

Veterinarians now need to take stewardship over their use of antimicrobials whether it is in the treatment of oral disease or any other organ or systemic disease. Sometimes, the veterinarian must resist pressure from pet owners to prescribe ABs as a monotherapy without any other periodontal management.

Rational prescribing of antibiotics would include the selection of the AB with the narrowest spectrum of activity against known periodontal pathogens, the least side effects and the use of so called 'first line ABs', saving other agents for when resistance is encountered.

However, the scarcity of information on AB usage in the veterinary dental literature makes it difficult to draw conclusions re the prescribing of ABs.

The risks may not be apparent and bacterial resistance to antibiotics is often difficult to determine. The two most common antibiotics prescribed by human dentists around the world are amoxicillin (penicillin β lactam) and clindamycin hydrochloride (lincosamide). In veterinary dentistry, a survey showed that the two most common antibiotics prescribed for periodontal disease are amoxicillin combined with clavulanate (penicillin β lactam and a β lactamase inhibitor) and clindamycin hydrochloride (lincosamide).

Overprescribing of antibiotics by human dentists was found in a British study. This study found factors affecting prescribing antibiotics included writing prescriptions in the absence of infection where failure of previous operative treatment had occurred, shortage of clinical time to undertake treatment, patients who were unable or unwilling to accept operative treatment, patient requests for antibiotics and in the treatment of acute periodontal conditions.

This lecture will discuss the benefits/risks of AB usage for oral disease, but will also look at the grey areas involving their use in both the human and veterinary dental fields.

It should be said from the outset that antibiotics should not normally be used as a monotherapy or as a substitute for more suitable treatment of oral diseases.

Why use antimicrobials?

Antimicrobials can be used as a part of the management of:

- Severe chronic periodontal disease, acute periodontal abscess and recurrent PD.
- Oral surgery cases: surgical extractions, surgical periodontal therapy, guided tissue regeneration (GTR).
- Oral trauma including compound jaw fractures
• Endodontic disease/abscess with acute swelling/cellulitis
• Immuno-compromised patients or patients with cardiovascular disease and valve dysfunction - although recently, at least for man, the guidelines have changed and AB prophylactic cover is no longer required for most patients with valvular disease
• Patients with underlying systemic disease - depressed immune system and the theoretical possibility of organ seeding?
• Other oral pathology where tissue necrosis occurs (such as oral tumours) and there is concurrent systemic illness

In a 2007 article, Harvey concluded that “adjunctive antimicrobial usage would be warranted for a number of oral conditions or systemic diseases including treatment of severe periodontitis which involved “infected bone” with or without tooth extractions”. He stated that “the local tissues would withstand the effects of surgery better and healing would be more rapid if local periodontal infection was controlled at the time of the dental procedure. In that circumstance, antimicrobial treatment was commenced several days prior to surgery and was continued for several days following surgery”. Also antibiotics needed to be used “when the periodontal infection had progressed to wide-spread osteomyelitis (i.e. affecting the trabecular bone and outer cortical bone of the involved jaw) and infected bone would be left in place following extraction or deep scaling. Antimicrobial treatment was best started several days prior to the procedure, and continued for several weeks following the dental procedure”.

He went on to say that “In cases of local oral immunopathy, where ulceration occurs in the presence of minimal plaque (chronic ulcerative paradental stomatitis in dogs and chronic gingivostomatitis in cats), adjunctive antibiotic use would also be warranted and in those patients that are having a clean surgical procedure at the same time as a dental procedure including dental scaling, then a perioperative dose of a bactericidal antibiotic was warranted. In some but not all cases, continuation of the antibiotic treatment for 3-5 days post-operatively was recommended. Harvey stated the reason for this was “to ensure that any bacteria trapped in blood clots are exposed to an effective concentration of the antimicrobial drug”.

Harvey stated that “antibiotic usage should be considered in cancer patients undergoing chemotherapy, or patients with severe skin disease and other severe reactive or auto-immune disorders. In uncontrolled or poorly controlled diabetic patients, the use of adjunctive antibiotics when combined with periodontal treatment was warranted.”

Today, there are patient, operator and surgery factors that need to be considered prior to prescribing antibiotics. Some of those factors include the age and wellness of the patient, the severity of the oral disease and the skill of the surgeon in minimising tissue trauma. Factors such as the cell turnover in the oral cavity, the local immune system and the tremendous blood supply to the oral structures usually assist in the rapid healing that is often seen in the oral cavity post-surgery.

**Periodontal disease**

The use of antibiotics in PD is the subject of much debate amongst health professionals.

A closer look at the aetiology and progression of periodontal diseases is required, so as to make a more informed decision re the prescribing of ABs.

Periodontal disease:

• Is due to infections of the periodontium
• Is bacterial in origin. Usually due to a complex bacterial infection
• Bacteria elicit a subsequent immune response by the host and the host inflammatory response can be more damaging to the periodontium than the bacteria themselves
• There are several putative periodontal pathogens involved in the disease process (human studies). Some periodontal pathogens have the ability to evade the host immune system by invading host cells
• Elimination of all bacteria from the periodontal pocket is not possible
• Bacterial reservoirs on the tongue, tonsils, and oral mucosa may recolonise treated areas (human studies)
• Elimination of inflammation is the critical objective of periodontal treatment

In a number of human studies, the effectiveness of various subgingival debridement procedures showed
that 50-80% of treated roots harbour residual plaque or calculus, and the deeper the pockets and furcation involvements, the more deposits are left behind. Despite this, generally subgingival mechanical debridement not only results in the eradication or suppression of putative organisms, but also induces higher titres of protective antibodies to mop up any remaining bacteria. In human studies, with poor oral hygiene, subgingival recolonisation may re-establish within 42-60 days after a single periodontal treatment (this finding has serious implications for PD treatment in our pets).

There are however differences between the bacteria that reside in the oral cavities of man and animals both in health and disease.

Several bacteria have strong associations with periodontal disease (man) and these include:

- **Porphyromonas gingivalis** (P.g)
- **Bacteroides forsythus** (new name: *Tannerella forsythia*)
- **Actinobacillus actinomycetemcomitans** (new name: *Aggregatibacter actinomycetemcomitans*, abbreviated A.a) – is found in the canine oral cavity in low numbers – unknown whether pathogenic in animals
- **Prevotella intermedia** and **Treponema spp**.

Bacteria are necessary for disease, but their presence alone is not sufficient to predict disease initiation or progression. There are other factors involved in disease, some of which are still unknown. The role of the host in the progression of disease is well documented.

For disease to occur and progress, certain criteria are required:

- Susceptible host
- Pathogens present
- Virulent pathogens exceed a tolerable threshold for the host
- Absence of beneficial species
- Conducive environment

**Bacterial biofilms**

Bacterial biofilms occur both supra and subgingivally. They are ecologic communities of bacteria which provide:

- Microenvironments (different pH, O₂ levels)
- Metabolic co-operation – exchange of metabolites for the growth of the community
- Anti-drug factors i.e. beta-lactamases (especially after recent penicillin exposure)
- An exopolysaccharide matrix for mutual protection from host defences and anti-microbial attack

Some microbes (P.g, *Spirochaetes*, and A.a) can invade periodontal tissues. However, the relationship between invading tissues and disease progression is not known.

If pathogens can invade epithelial cells, then antibiotics (i.e. tetracyclines, erythromycin) that can penetrate into cells may be of benefit, compared to antibiotics that act in the extracellular environment (i.e. penicillins).

Concentrations of ABs may have to be up to 500 times higher, than can normally be achieved by systemic delivery, to be effective against biofilms. Even with locally delivered ABs, these concentrations may not be achieved. Some organisms in the biofilm may protect other key organisms from antimicrobial attack (i.e. *Enterococcus faecalis* protects *Bacteroides fragilis* from metronidazole).

A recent review article showed the benefits of combining two antibiotics in improving outcomes for refractory periodontal patients. The combination of metronidazole and amoxicillin for 14 days leads to greater clinical and microbiological improvements than when given together for 7 days, with similar safety and tolerability.

However, as previously stated, mechanical disruption of plaque at the time of local or systemic antimicrobial drug delivery is needed to facilitate optimal results.

**Periodontal disease has been implicated as a risk factor in systemic illnesses**

DeBowes discussed an association between periodontal disease and diseases of the kidney, myocardium, and liver.
Further research needs to be done before a definite link can be made between certain systemic diseases and periodontal disease.

Bacteraemia following periodontal debridement poses a potential risk to those animals with cardiac valvular disease, as well as animals that are immuno-compromised.

Prophylactic antibiotics commonly used to combat this bacteraemia include Amoxicillin/Clavulanate, Clindamycin hydrochloride and Penicillin.

**Systemic antibiotics**

- Enter periodontal pockets and furcation sites via saliva and crevicular fluid.
- Provide ready exposure of the agent to all periodontal sites, but also pose a risk of adverse reactions to non-oral sites such as the gut.
- In human periodontal pockets, crevicular fluid is exchanged about 40 X/hr., which limits the contact time of ABs either given systemically or placed into the pocket.
- May reduce the need for surgical debridement.
- There is the risk of causing bacterial resistance or super infections when using systemic antibiotics.

**Antibiotic usage for endodontic disease**

Endodontic disease usually involves bacterial ingress into the root canal system of the tooth often through a complicated tooth fracture. Because the bacteria are trapped within the root canal system of the tooth leading to pulp necrosis, systemic antimicrobials cannot get to the source of infection within the tooth due to a lack of blood supply within the root canal system. Apical inflammation and abscess usually occur due to leakage of bacterial toxins through the apex of the tooth and not normally due to bacteria that invade the periapical tissues. The best way to treat pulp necrosis due to bacterial ingress is to either extract the tooth (thus removing the source of bacteria) or to perform root canal therapy which also disinfects the root canal system (therefore removing the bacteria).

A recent Cochrane review in man of antibiotic usage for apical periodontitis (periapical inflammation) or apical abscess stated that clinical guidelines recommend that the first-line treatment for teeth with symptomatic apical periodontitis or an acute apical abscess should be removal of the source of inflammation or infection by local, operative measures, and that systemic antibiotics are currently only recommended for situations where there is evidence of spreading infection (cellulitis, lymph node involvement, diffuse swelling) or systemic involvement (fever, malaise). Despite this, there is evidence that dentists continue to prescribe antibiotics for these conditions. There is concern that this could contribute to the development of antibiotic-resistant bacterial colonies both within the individual and within the community as a whole.

**Use of prophylactic antibiotics to prevent infective endocarditis or infection of orthopaedic prostheses**

Today, the use of prophylactic antibiotics prior to dental procedures for those patients with valvular disease or cardiac stents is usually not recommended. The recommendations for antibiotic prophylaxis were changed several years ago, based on a number of factors relating to risk/benefit analyses.

- Allergic reactions to antibiotics (especially the penicillins)
- Alterations in gut flora leading to gastrointestinal upsets
- Spontaneous bacteraemia arising from every day oral functions and habits can be similar in magnitude to dental procedures
- There is no evidence to support the efficacy of any agent in the prevention of infective endocarditis arising from dental treatment
- The precise methods whereby antibiotics (especially the penicillins) prevent infective endocarditis are unknown

**The same recommendation should apply in veterinary medicine**

The American Dental Association and the American Academy of Orthopaedic Surgeons guidelines are similar in as much as they also conclude that antibiotic prophylaxis is not indicated for dental patients with
pins, plates, or screws, nor is it routinely indicated for most dental patients with total joint replacements. However, it is advisable to consider premedication in a small number of patients who may be at potential increased risk if experiencing haematogenous joint infection.

**Reports on antimicrobial use in the veterinary dental literature**

- Antimicrobial therapy can provide additional improvement in severe or refractory cases of periodontitis when combined with dental prophylaxis if ongoing plaque control is not provided.\(^{15}\)
- Amoxicillin-clavulanate, Clindamycin, and metronidazole seem to be particularly effective against periopathogens, based on pharmacokinetic and clinical studies.\(^{8}\)
- The pre-operative use of clindamycin\(^e\) showed a significant reduction in plaque and aerosolised bacteria during ultrasonic scaling. This author also advised the use of pre-operative antibiotics to benefit medically compromised animals as well as reducing the risk to operative staff of inhaling plaque bacteria.
- Stomadhex bio-adhesive tablets (chlorhexidine diacetate) placed on the labial mucosa showed reductions in subgingival anaerobes and spirochaetes for at least 14 days.\(^{17}\)
- Selected antibiotic treatment (clindamycin, doxycycline and spiramycin /metronidazole) of cats with PD showed a marked reduction in the number of *Porphyromonas* spp. in the gingival pocket.\(^{16}\) However, amoxicillin/clavulanic acid did not reduce *Porphyromonas* spp (Pc and Ps) numbers significantly and there was a discrepancy between the in vitro and in vivo response. The failure of amoxicillin/clavulanic acid in vivo was put down to the inoculum and biofilm effects.\(^{18}\) * No dental prophylaxis performed.
- Periodontal pocket treatment in beagle dogs using subgingival Doxycycline.\(^{19}\) Eight beagle dogs with naturally occurring PD (mean pocket depth 6mm), four treated with subgingivally delivered 10% doxycycline\(^e\) (experimental group), four given subgingival delivery polymer without active drug (control group). Results showed that after four months, the doxycycline treated group showed 2.1 mm average periodontal attachment gain, and control group showed no improvement. Conclusion: treated group showed substantial improvement in periodontal health, although it was noted in the discussion that “reports have indicated that the results after treating periodontal pockets with local delivery methods may be more transient than those from conventional mechanical methods”. Note: that no mechanical debridement was performed on either group of dogs and that treated sites received thrice weekly brushing. A relatively new antibiotic on the veterinary scene is cefovecin sodium (Convenia®), a third generation broad spectrum cephalosporin.\(^{20}\) One study showed the benefits of this antibiotic in the treatment of periodontal disease (however there was no control group that did not receive any antibiotic and it was a short term study of 42 days). Its’ main benefits over antibiotics given per os seemed to be due to there being no need for owner compliance and therapeutic AB blood levels were present for up to 14 days. Three potential issues with the long acting nature of this drug is, firstly, that most bacterial infections do not require a 14 day course of antimicrobial to resolve the infection and, secondly, the subtherapeutic levels of antibiotic remains for weeks after the initial injection. This could possibly lead to bacterial resistance. Thirdly, any adverse side effects to the drug may not be alleviated by withdrawing the antibiotic (prolonged systemic drug clearance of up to 65 days)
- Another study\(^{21}\) showed that *Porphyromonas gulae* and *P. crevisioricanis* were the dominant anaerobic organisms isolated from periodontal pockets of dogs and cats with at least grade 2 periodontal disease in Australia. Although all the bacterial isolates were susceptible to cefovecin and Penicillin G, a subgroup of 15 isolates showed resistance to one or more additional antimicrobials, including, ampicillin, amoxicillin and erythromycin
- A study\(^{22}\) looked at sub-antimicrobial dosage of Doxycycline for the management of PD. The authors concluded that “A doxycycline dosage of 2 mg/kg daily appeared to be an appropriate sub-antimicrobial regimen for dogs with periodontitis. Furthermore, this dosage may be suitable for long-term treatment of gelatinolytic inflammatory diseases such as periodontitis in this species”.

**Position statement by American Veterinary Dental College (AVDC) on use of antimicrobials in veterinary dentistry April 2005**

The AVDC endorses the use of systemic antibiotics in veterinary dentistry for treatment of some infec-
tious conditions of the oral cavity. Although culture and susceptibility testing is rarely performed on individual patients that have an infection extending from/to the oral cavity, the selection of an appropriate antibiotic should be based on published data regarding susceptibility testing of the spectra of known oral pathogens.

Patients that are scheduled for an oral procedure may benefit from pre-treatment with an appropriate antibiotic to improve the health of infected oral tissues. Bacteraemia is a recognized sequela to dental scaling and other oral procedures. Healthy animals are able to overcome this bacteraemia without the use of systemic antibiotics. However, use of a systemically administered antibiotic is recommended to reduce bacteraemia for animals that are immune compromised, have underlying systemic disease (such as clinically-evident cardiac, hepatic, and renal diseases) and/or when severe oral infection is present.

Antibiotics should never be considered a monotherapy for treatment of oral infections, and should not be used for the preventive management of oral conditions.

**Summary re the use of systemic antimicrobials**

Traditionally, in the treatment of PD in humans, ABs have been used in the management of aggressive periodontitis (juvenile PD, HIV PD, others) or chronic refractory (recurrent) PD (mainly due to the concurrent risk factor of cigarette smoking).

Antimicrobials such as Clindamycin, Amoxicillin/Clavulanic acid, Chlorhexidine gluconate and metronidazole have been used in the management of PD in dogs.

Veterinary dental studies show only short term benefits re AB usage. There are few long term studies showing the benefits of AB usage in the management of PD.

AB choice has usually been made on an empirical basis. Culture and susceptibility should be considered in refractory cases of PD.

There is a new trend in human periodontal therapy that when ABs are used, they are used in combination especially the combining of amoxicillin with metronidazole, amoxicillin and clavulanic acid. However, avoid combining a bacteriostatic antibiotic such as clindamycin hydrochloride which inhibits growth of bacteria, with bactericidal antibiotics such as penicillin which relies on rapid growth of bacteria to destroy the bacterial cell wall.

**Locally delivered antimicrobials**

Locally delivered antimicrobials can be divided into:

- Non sustained (nonbinding) or
- Sustained/controlled release

Non sustained release includes professional pocket irrigation with anti-microbial agents such as povidine iodine and chlorhexidine gluconate (includes ultrasonic delivery).

The rapid clearance of nonbinding agents may limit their usefulness in periodontal treatment.

Sustained release products have been incorporated into gels, pastes, films, strips, polymers and fibres i.e. tetracycline fibres, gels.

Efficacy of locally delivered anti-microbial agents depends on:

- Obtaining adequate subgingival delivery
- Attaining sufficient contact time between the antimicrobial agent and microbes (crevicular fluid volume in a periodontal pocket changes up to 40 times per hour*, thus limiting the contact time i.e. Chlorhexidine irrigation)* Human studies.
- Achieving adequate levels of the agent
- Some agents bind to serum proteins (higher levels in periodontal pocket) and are flushed out, reducing their efficacy i.e. Chlorhexidine

**Preperi operative irrigation**

One study looked at the use of chlorhexidine gluconate in controlling gingivitis/periodontitis by inhib-
biting the growth of plaque. The product was used in homecare or prior to/during professional cleaning.

Another study noted that dental staff had 3 times the level of respiratory disease when compared to the normal population\textsuperscript{25}. The risk of aerosols to dental staff could be minimised by the use of patient pre-operative bactericidal mouth rinses\textsuperscript{26-27}.

It is strongly recommended to use 0.12\% chlorhexidine gluconate as a preoperative rinse before periodontal therapy is commenced. This will help reduce bacterial aerosols which may pose a risk to dental staff as well as reducing the number of bacteria entering the animal’s circulation.

The use of a 10\% solution of povidone-iodine for subgingival irrigation of deep pockets (>6mm) has shown small to moderate improvement in pocket depths in a number of human studies\textsuperscript{28}.

Hoang in his study concluded that “the addition of subgingival PVP-iodine irrigation to conventional mechanical therapy may be a cost-effective means of reducing total counts of periodontal pathogens and helping control periodontal disease”.

This author has used 10\% povidone-iodine irrigation of pockets for a number of years. However, due to the difficulty of owner return for re-assessment, it is impossible to say whether there is any clinical reduction in pocket depths with povidone-iodine irrigation compared to scaling and root planing on its own. Certainly there is no harm in irrigating post cleaning but at least one minute contact time in the pocket is required for any benefit. There is no known bacterial resistance to povidone iodine and no reported side effects with its use in human studies.

**Advantages of locally delivered antibiotics include**

- Local delivery can obtain up to 100 fold higher concentration of an agent in subgingival sites compared to a systemic drug\textsuperscript{29}.
- Can use agents not suitable for systemic use, such as various broad spectrum antiseptics.
- Reduces the burden of owner compliance in administering tablets etc.
- Decreases the chance of non-oral side effects, as well as reducing the risk of developing drug resistance.

**Disadvantages of locally delivered antibiotics include**

- Difficulty in placing therapeutic concentrations of antimicrobial agent into deeper parts of periodontal pockets and furcation lesions.
- Failure to eradicate two common periopathogens: P.g or A.a from deep pockets\textsuperscript{30}.
- Deep pockets requires placement of agent in multiple sites and is time consuming.
- Some agents eg pastes may mechanically interfere with the healing of the gingival tissues, when placed immediately after root debridement.
- The theoretical risk of overgrowth of opportunistic organisms such as yeasts, pseudomonads.
- Bacterial drug resistance can still develop in the pocket.
- Expense.

Zetner’s study\textsuperscript{31} showed improvements in probing depths by 39\% in a split mouth study in beagle dogs. On one side of the mouth teeth 204, 208, 304, and 309 received a doxycycline polymer into the periodontal pocket whereas teeth 104, 108, 404, and 409 did not receive antibiotic therapy. The authors concluded that local application of doxycycline complements traditional subgingival curettage therapy in a reasonable and effective way and can significantly improve treatment success, especially with regard to pocket depth reduction and attachment gain.

**Antibiotic resistance**

The use of antimicrobials for growth promotion is common in intensive agricultural farming; the residue of antimicrobials in animal products consumed by humans may contribute to overall antibiotic resistance in man. Surveys looking at the prescribing practices of companion animal veterinarians have been published. They have found misconceptions and a lack of knowledge when prescribing antibiotics for companion animals. They also found antibiotic under dosing to be an issue as well.

As a result, efforts to encourage the judicious and correct use of antimicrobials need to involve veterinarians both at an undergraduate and a practice level, as well as human healthcare providers.
In a Washington State survey conducted in 2013, antibiotic prescribing was found to be concentrated on a number of broad spectrum antibiotics. Culture and susceptibility testing (C/S) was not performed often, although it was recognised by the veterinarians that it was best practice (due to the number of species of oral bacteria, C/S may not be useful). The majority of veterinarians surveyed chose a particular antibiotic on an empirical basis, considering a number of factors including best practice, previous experience, cost of treatment, and ease of administration by the owner. For each system affected and/or disease syndrome, there was at least one drug class that was significantly more frequently preferred to other drug classes. β-lactams and fluoroquinolones were the most commonly identified drug classes across all systems and syndromes; β-lactams were the most commonly prescribed drug class overall. The most commonly mentioned individual drugs included enrofloxacin, cephalaxin, amoxicillin trihydrate/clavulanate potassium and metronidazole. These drugs were often listed individually or in combination with other drug classes. Broad-spectrum, clinically important antimicrobials like ciprofloxacin, enrofloxacin and third-generation cephalosporins including cefovecin, cefpodoxime and ceffotaur were also reported in this survey. In man, the most common antibiotic prescribed for oral conditions is the mid spectrum β-lactams; amoxicillin trihydrate with or without clavulanate potassium. They were usually prescribed for 3-5 days. Ideally, the narrower spectrum antibiotic penicillin V should be prescribed instead, at least in man. As a general rule, the broader the spectrum, the greater the risk of resistance to that antibiotic. Poor patient compliance can also lead to resistance where an antibiotic is taken less often than recommended (under dosing). Coercion by patients can also be a problem in human medical and dental practice. Antibiotic prescribing to delay surgical treatment, or as a stop gap measure until a specialist can be seen, is also commonly done by practitioners.

In addition to the low prevalence of C/S use indicating that empirical therapy is most common, respondents reported frequent use of critically important broad spectrum antibiotics such as fluoroquinolones and third-generation cephalosporins; a practice that could contribute further to antimicrobial resistance based on WHO data.

In summary

The veterinarian is often placed under pressure from owners to prescribe antibiotics for the management of oral diseases in companion animal practice. The use of ABs without periodontal debridement is not acceptable practice. However, exceptions to this rule may include the elderly animal with severe periodontitis which may be a poor anaesthetic risk.

The benefits of AB adjunctive therapy include the reduced need for surgical or open periodontal debridement, penetration into periodontal tissues to eliminate bacteria such as P.g (systemic Abs only), reduction in periopathogens including bacterial reservoirs (systemic Abs only) and moderate improvement in periodontal probing depths when compared to root debridement alone. Adjunctive therapy may also lengthen the time between professional scaling which may be important in veterinary dentistry minimising the number of procedures under general anaesthesia.

The disadvantages of ABs include cost (especially local delivered ABs), possible bacterial drug resistance (short or long term), gastrointestinal irritation (systemic ABs), superinfections, and unknown long term benefits. Also, owner compliance can be a deterrent to AB prescribing (systemic ABs only).

In conclusion, treatment of most oral diseases usually involves a surgical or endodontic intervention with or without AB usage. Periodontal treatment aims at restoring a microbiota compatible with periodontal health.

Both systemically and locally delivered antibiotics (when combined with mechanical periodontal therapy or endodontic or surgical intervention) should be reserved for

- Severe periodontitis
- Acute periodontal or endodontic disease with swelling or bone involvement
- Systemically unwell (fever)
- Oral trauma involving tissue destruction
- Have impaired host defences or who are immuno-compromised
- Surgical extractions and bone removal

References: Available by emailing author: toothdoctor@optusnet.com.au

Glossary of terms (adapted from American Veterinary Medicine Association guidelines of judicious the-
**Local and regional anesthesia for oral procedures**

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Local anesthesia is defined as the desensitization of a localized area of the body by blocking the generation and propagation of electrical impulses in nerves. The use of local and regional analgesia can decrease the amount of systemic drugs needed for general anesthesia and thus may reduce a patient's risk of showing adverse effects towards inhalants and injectable anesthetics. It also provides a significantly better control of intraoperative and postoperative pain. Nerve blocks should be used routinely when doing dental and oral surgical procedures. The most commonly used local anesthetics in dogs and cats are lidocaine, bupivacaine, mepivacaine - alone or in combination with injectable analgesics or vasoconstrictors. The total number of nerve blocks, species (cat or dog), weight of the patients, local anatomy, presence of infection or inflammation in the area of injection, area of blockage, and pharmacology of the drug should be considered to get the best result and avoid complications.

The most common nerve blocks used in dentistry and oral surgery are the inferior alveolar, middle mental, maxillary, infraorbital, and major palatine nerve block.

The maxillary nerve block desensitizes the full quadrant. If the anesthetic also blocks the major palatine nerve, regional anesthesia of the hard palate may be achieved. The local anesthetic is deposited in the pterygopalatine fossa, and the point of injection in the mucosa is distal to the last maxillary molar tooth (Fig. 1).

The block of the inferior alveolar nerve desensitizes the body of the mandible. The anesthetic drug is deposited around the mandibular foramen in the medial aspect of the mandible in the transition between body and ramus of the mandible. The landmarks to consider are the angular process of the mandible and

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dog Onset: 5-10 min</th>
<th>Dog Duration: 1-3 hours</th>
<th>Dog Maximum dose: 5-10 mg/kg</th>
<th>Cat Onset: 5-10 min</th>
<th>Cat Duration: 1-3 hours</th>
<th>Cat Maximum dose: 1-5 mg/kg</th>
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<tbody>
<tr>
<td>Lidocaine</td>
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<tr>
<td>Bupivacaine</td>
<td>Onset: 20-30 min</td>
<td>Duration: 3-10 hours, commonly 6 hours</td>
<td>Maximum dose: 2 mg/kg</td>
<td>Onset: 20-30 min</td>
<td>Duration: 3-10 hours, commonly 6 hours</td>
<td>Maximum dose: 1-1.5 mg/kg</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>Onset: 5-10 min</td>
<td>Duration: 1-3 hours</td>
<td>Maximum dose: 5-6 mg/kg</td>
<td>Onset: 5-10 min</td>
<td>Duration: 1-3 hours</td>
<td>Maximum dose: 2-3 mg/kg</td>
</tr>
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the last molar tooth. If the foramen is not palpable, a line can be imagined between the two landmarks. The foramen is located halfway between the angular process and the last molar tooth. The point of injection in the oral mucosa is distal and lingual to the last molar tooth (Fig. 2).

The infraorbital nerve block desensitizes incisive area and the area of the canine tooth. It can be used to desensitize the premolar area and to reach the pterygopalatine fossa if the needle is advanced enough caudally. The infraorbital foramen can be palpated dorsal to the distal root of the maxillary third premolar tooth. The point of injection in the oral mucosa is a few mm rostral to the infraorbital foramen. The needle should be advanced parallel to the hard palate (Fig. 3).

The middle mental nerve block desensitizes the rostral mucosa of the lower jaw and decreases the sensation of the incisors, canine and maybe also the first and second premolars; however, the effect is not so predictable. The inferior alveolar nerve block is preferred for dental extractions or other involved procedures in the rostral mandible.

Another technique to be used is infiltration directly around the area to be blocked (e.g., injection along planned incisions).

A splash block is an application of a local anesthetic onto a surface such as after maxillectomy prior to wound closure. A common combination used by the authors is 0.25 mL phenylephrine 1% and 50 mL lidocaine 2%. The maximum dose is 0.05 to 0.1 mL/kg in cats and 0.1-0.2 mL/kg in dogs.

Complications such as nerve damage, uveitis and ocular trauma, hematoma, and toxicity can occur, but in most situations they can be avoided with a correct knowledge of the drug, patient and technique. Inadvertent injection of local anesthetic close to the lingual nerve could result in loss of sensibility and self-mutilation of the tongue.

References are available upon request (anacaste@vet.upenn.edu).
Flaps and failures: What is the best flap for your extraction?

Barden Greenfield

Your Pet Dentist of Memphis and Little Rock @ Memphis Veterinary Specialists and Arkansas Veterinary Specialists

Before a practitioner attempts a surgical extraction, an understanding of flap technique and principles must be known. This lecture will review flap designs, indications for each flap, proper periosteal release and closure. Choices of suture material will be discussed as well as tips to prevent surgical dehiscence.

Dental extractions

Bob Partridge

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Dental extractions can be challenging and the consequences of getting things wrong can be devastating—both for the patient, the client and the practitioner. The aim of this presentation is to provide a logical approach to extractions, based on anatomic, physical and mechanical characteristics. The choice of instruments and their correct application will be discussed. A systematic approach is presented, with specific guidance for the more “challenging” teeth. However, the system can be adapted for use on other teeth, or where anatomic variations occur. The benefits of closing extraction defects will be discussed in ways that allow communication to owners. Flap theory will be outlined so that practitioners can safely close defects, without the need to revisit them. Post-operative care will be discussed.

In the author’s referral practice it is not uncommon for patients to be presented after failed dental extraction attempts. The aim of this presentation is to try and give guidance, based on logical assessment of the anatomy of the patient, together with sound bio-mechanics to try and avoid these problems.

A systematic approach is outlined, detailing the necessary steps for a successful extraction. This approach is then demonstrated in various “challenging” teeth. Diagrams, clinical photographs and video footage will all be used to follow through various extractions.

Closing extraction sites is frequently not performed in general practices. The author will outline the reasons for the additional time and expense this involves, in ways that can be easily used to communicate the benefits to owners who may have been “shopping around” for a cheap option.

Flap design principles and practical applications will be discussed and illustrated.

The author will concentrate on his preferred techniques, some of the advantages and disadvantages of other techniques will be commented upon.

Patience and good surgical extraction technique will reduce the frequency of complications, it would be naïve to think that problems will not occur at some time. The secret is to have prepared contingency plans already in place.

Whilst extremely rare in experienced hands, colleagues may encounter brain and ocular penetrations in referred cases. The [limited] treatment options will be discussed. Haemorrhage control measures will be outlined and the problems encountered with large scale sub-lingual oedema sometimes seen in cats will be tackled. Tube feeding options will be briefly outlined.

It is widely accepted that the first attempt to repair an oro-nasal fistula will usually have the best chance of success. The author will present the factors that can help you achieve a good result at first presentation. Iatrogenic mandibular fractures and separations do occur – avoidance is always the best policy (as discussed in the partner lecture) – however once present what treatment options are the most appropriate?

Fractured root tips will occur, even in the most skilled of hands. The decision to retrieve, or to leave, will
Oral cavity examination in rabbits

Vladimir Jekl and Karel Hauptman

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Summary

Rabbits are very commonly kept pet animals in the Europe, USA and also in other regions of the Globe. With increasing popularity, the complexity of diagnostic and surgical procedures performed in rabbits is increasing. Oral cavity diseases are the most frequently reported diseases in exotic companion mammals. In rabbits, a wide range of local and systemic conditions which affect the mouth and oral cavity have been described: hereditary, infectious, metabolic, lack of chewing, lack of diet abrasive properties, traumatic (foreign bodies included), and neoplasm. Different forms of dental disease are clinically manifested by hypersalivation, anorexia, chewing disturbances, change of feed component preferences and poor body condition. Dental disease can be also accompanied by the development of facial abscesses, moist dermatitis, epiphora, exophthalmia and damage of the temporomandibular joint. Factors that affect tooth positioning, such as abnormalities of jaw width, length and height may also result in malocclusion, as may variations in tooth arrangement along the jaw, the degree of eruption, tooth rotation and tipping. As the complexity of various pathology of dental disease and associate clinical signs a term “syndrome of dental disease” is used, when describing acquired dental disease in rabbits. This article describes anatomy and step-by-step basic to advance oral cavity examination, as one of the most important part of the diagnostic process of the dental disease.

Anatomy

Rabbits have completely elodont dentition (continuously erupting, aradicular). The permanent rabbit dental formula is I (2/1), C (0/0), P (3/2) and M (3/3). Their incisors, premolars and molars are continuously erupting through the life at the rate of 0.2-0.3 cm per week for incisors and 0.3-0.4 cm per months for cheek teeth. Dentition is diphyodont (deciduous and permanent teeth) and heterodont. Rabbits also belong to Duplicidentata due to the presence of double set of maxillary incisors (incisors and peg teeth). Premolars and molars have similar structure and form in each quadrant of the oral cavity a uniform functional grinding unit. Enamel width is more prominent at the labial part of the cheek teeth and buccal part of the maxillary cheek teeth; it is why the larger enamel ridges are present at these locations, which could imitate spikes. The mandibular arcade is narrower than the maxillary arcade.

Oral cavity examination

- Evaluation of facial symmetry and palpation of the jaws. Signs of heat, discharge, crepitus and presence of lumps and bumps should be noted.
- Lateral and horizontal lower jaw excursion should be evaluated. Pain on manipulation of the jaws may be due to a jaw fracture, disease of the temporomandibular joint or because of retrobulbar pathology.
- Palpation of ventromedial border of the mandible and zygomatic area could reveal bony swellings associated with apical teeth elongation or periapical pathology.
- Palpation of the cheeks is not recommended before oral cavity inspection due to possible coronal cheek teeth elongation with spike formation which could induce unnecessary discomfort and pain.
- Submandibular lymph node and mental scent glands palpation could reveal inflammatory or neo-
plastic changes.

**• External soft tissue and incisor examination**
- Lips are lifted with the thumb and forefinger and nasal philtrum is examined for any inflammatory lesions, foreign bodies or traumatic injury
- Mucosal surface, gingiva and gingival sulcus surroundings the incisors are evaluated for colour, presence of exudate, foreign bodies or any other lesions.
- The lower incisors occlude normally behind the primary maxillary incisors and a pair of secondary small incisors. A sharp chisel like cutting edge is present at labial surface of maxillary and mandibular incisors. The labial surface of the incisors is easily inspected and palpated. Physiological labial surface is white in colour and smooth on palpation, so any horizontal ridges and roughness is pathological.

**• Conscious oral cavity examination**
- The oral cavity of rabbits is long and narrow, making its careful clinical examination technically more difficult than in carnivores and insectivores. The premolars and molars form the uniform functional grinding unit with a relatively horizontal occlusal surface with transverse enamel folds. The enamel folds correspond to deep invagination of the enamel on the palatal side of the maxillary cheek teeth and the buccal side of the mandibular cheek teeth. Enamel folds are filled with cementum-like material and are visible on the outside as developmental grooves. The enamel is thickest on the lingual surfaces of the maxillary cheek teeth and the buccal surfaces of the mandibular cheek teeth.
- The use of an otoscope is often proposed as a tool for conscious oral examination. Even though the otoscopic image of the examined area is zoomed out, some of the lesions can remain undetected due to limited visual field.
- A bivalve nasal speculum allows a broad angle imaging and, therefore, higher possibility for detection of pathologic lesions.
- Based on author experiences, the paediatric laryngoscope enabled clear imaging of the buccal, occlusal and lingual surfaces of premolars and molars. Indeed it provided the depression of the tongue and separation of the cheeks from the teeth which created more space for visualization and detection of potential changes/pathology.
- For the conscious examination is a rabbit restrained manually. An assistant holding the animal’s thorax, thoracic limbs included, and supported its back while the examiner holding the animal’s head and retracted its upper lips with one hand while examining the oral cavity with the laryngoscope in the other hand. An alternative is to wrap a rabbit into a towel and held firmly and carefully against the body of the nurse. If any significant pathological change is identified in the oral cavity, the examination should be immediately terminated to avoid the risk of injury due to any unexpected movement during the conscious examination.

**Oral cavity examination under general anaesthesia**
- An assistant is holding the anaesthetic supply and the horizontal mouth gag. Author recommend to use these instruments for the oral cavity examination under general anaesthesia: Mouth gag, check teeth dilator, paediatric laryngoscope, dental spatula, source of light and endoscopic equipment.
- Lips, oral cavity commissures and surrounding mucosal surface and skin are inspected again and more thoroughly.
- Mandible, maxilla and all other superficial skull bones are palpated again for the presence of any irregularity or presence of apical tooth elongation.
- To perform the oral examination well and safely, it is necessary to open the oral cavity in both horizontal and vertical directions.
- The special rabbit or rodent mouth gags are inserted between maxillary and mandibular incisors and mouth is opened in a vertical direction.
- Check dilators are used to open mouth cavity in a horizontal direction.
- An alternative for mouth gags is special table top dental equipment for rabbits.
- Intraoral inspection
Thorough oral cavity examination comprises a combination of evaluation of teeth, periodontium, soft tissues, tongue and data recording. Each tooth should be examined individually along with its supportive struc-
It is possible to examine mouth cavity by practitioner’s naked eye or with the use of rigid endoscopy. Author recommends using always the same approach as missing any pathology is then minimized. Complete intraoral inspection consists of:

- Evaluation of all surfaces of all maxillary and mandibular incisors are examined, peg teeth included.
- Dorsal part of the oral cavity is evaluated and incisival papilla, palatal rugae, soft palate and gingiva are inspected
- Number of teeth is recorded
- Clinical crowns of all teeth are evaluated for
  - Colour

Brown pigmentation of the occlusal surfaces is normal and is caused by the presence of natural pigment in herbivorous diet.

- Tooth shape
- Tooth position
- Tooth structure
- Fractures, resorptive lesions
  - Clinical crown size
  - Tooth surface
  - Tooth mobility
  - Gingival sulcus probing

The gingival sulcus is a space between the gingival margin and the tooth and can be up to 0-1 mm in depth for the premolars and molars in the normal rabbit. The periodontal probe is gently and without force inserted into the gingival sulcus to the depth of the epithelial attachment. Any unnecessary force could cause damage of the epithelial attachment and pain. Based on clinician preferences teeth are palpated and gingival sulci probed during the examination or at the end of the procedure.

- Evaluation of the interdental spaces (distance between two adjacent teeth)
- Dental spatula or paediatric laryngoscope is used to push aside buccal gingiva from buccal teeth surfaces, which allows its proper examination.
  - Right buccal vestibule is inspected
  - Evaluation of all the visible surfaces of right mandibular cheek teeth.
  - All the procedures are repeated on the left side of the oral cavity.
  - Then a tongue is push down to see if there is a presence of sharp spikes on the labial parts of both mandibular arcades. If this pathology is present the affected side is evaluated and the other side is inspected after crown size and occlusal adjustment. If no obvious pathology is present a tongue is pushed aside with dental spatula to allow proper visualization of buccal gingival sulcus and gingiva.
  - Then, a right lateral and right sublingual surface is examined when holding tongue gently with anatomical forceps.
  - Soft tissues are evaluated for
    - Colour
    - Swelling
    - Hyperplasia
    - Erosive and ulcerative lesions
    - Gingivitis and stomatitis
    - Food impaction
    - Foreign bodies
    - Purulent discharge

**Oral and dental records**

It is optimal to keep accurate records of dental pathology and its treatments. There are numerous ways of recording such data, with the simplest being based on diagrams. Useful features of dental protocol include name and details of an owner, animal’s sex, weight and age, date of oral cavity examination, illustrative images of dentition, tooth identification and coding systems. Dental charts also consist of pathological findings and performed procedures.

Under current accepted scientific anatomic nomenclature there are no molars in deciduous teeth, and it is always the most rostral premolars that are missing in rabbit dental formulas. A proper tooth identification
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sequence is helpful when discussing case or writing case report and is as follows: Dentition (deciduous or permanent), arch (maxillary or mandibular), quadrant (left or right) and tooth (incisor, cheek tooth).

An oral finding recording charts, endoscopic records and X-Ray/CT images serves as an essential clinical record for further therapy and treatment.

Table 1 – Permanent rabbit teeth identification with the use of simplified cheek teeth numbering system and with modified Triadan tooth numbering system in brackets.

<table>
<thead>
<tr>
<th>Dental arcade/Tooth</th>
<th>I1</th>
<th>I2</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplified numbering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxillary right</td>
<td>101</td>
<td>102</td>
<td>106</td>
<td>107</td>
<td>108</td>
<td>109</td>
<td>110</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>(I1)</td>
<td>(I2)</td>
<td>(CT1)</td>
<td>(CT2)</td>
<td>(CT3)</td>
<td>(CT4)</td>
<td>(CT5)</td>
<td>(CT6)</td>
</tr>
<tr>
<td>Maxillary left</td>
<td>201</td>
<td>202</td>
<td>206</td>
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<td>209</td>
<td>210</td>
<td>211</td>
</tr>
<tr>
<td></td>
<td>(I1)</td>
<td>(I2)</td>
<td>(CT1)</td>
<td>(CT2)</td>
<td>(CT3)</td>
<td>(CT4)</td>
<td>(CT5)</td>
<td>(CT6)</td>
</tr>
<tr>
<td>Mandibular left</td>
<td>301</td>
<td>307</td>
<td>308</td>
<td>309</td>
<td>310</td>
<td>311</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(I1)</td>
<td>(CT1)</td>
<td>(CT2)</td>
<td>(CT3)</td>
<td>(CT4)</td>
<td>(CT5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular right</td>
<td>401</td>
<td>407</td>
<td>408</td>
<td>409</td>
<td>410</td>
<td>411</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(I1)</td>
<td>(CT1)</td>
<td>(CT2)</td>
<td>(CT3)</td>
<td>(CT4)</td>
<td>(CT5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments to anaesthesia

A balanced approach to anaesthesia is indicated when conducting oral examinations and administering dental treatments in rabbits. Intravenous cannula placement and endotracheal intubation are optimal choices, especially in animals with impaired general health status. The patient is placed on the heating pad and is monitored thorough the procedure. Oxygen should be delivered via tracheal tube or nasal/facial mask during all procedures and also during recovery. Anaesthetic gas delivery could be maintained by endotracheal tube or by nasal mask.

- An endotracheal tube or laryngeal mask (i.e. V-gel) could restrict access to the oral cavity in small rabbits and the use of a nasal mask is preferred in some cases. The advantage of endotracheal intubation is precise delivery of the anaesthetic gas to the patient and prevention of gas leakage. As an alternative, it is possible to use commercially available small facemasks designed for rodents which are applied over the rabbit nostrils or home-made face masks.
- Before inhalation isoflurane anaesthesia a premedication and induction with buprenorphin (0.03 mg/kg IM), midazolam (0.2-0.3 mg/kg IM), medetomidin (0.01-0.02 mg/kg IM) and ketamine (3-5 mg/kg IM) can be used.

Recommended reading

**Oral cavity examination in rabbits**

Vladimir Jekl and Karel Hauptman

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**Introduction**

Oral tumors compromise 5.3% of all neoplasia in the dogs and 6.7% in cats. Therefore, it is necessary for the clinician to be diligent in oral examinations and diagnostics. This lecture will review the most common oral tumors in dogs and cats, and treatment plans for each.

The most common oral malignancies in dogs in order of occurrence: Malignant melanoma, squamous cell carcinoma, fibrosarcoma. In the cat, squamous cell carcinoma.

**Malignant versus benign tumors**

Malignant tumors tend to destroy bone and soft tissue, while leaving teeth in their normal arcade positions. This gives the impression of teeth being suspended in soft tissue with marginal bone. Benign tumors can move teeth due to the soft tissue expansion, thereby redirecting teeth.

**Malignant melanoma (MM)**

This is the most common oral tumor in the dog. Sex predilection: Males with a male-to-female ration of 1.4-6.0:1. Typically occurs in older dogs (mean 11 years). Cocker spaniels, Labrador retrievers, Golden retrievers and German Shepherds and dogs with heavily pigmented oral mucosa may be predisposed. Non-pigmented (amelanotic) tumors do occur as well (33%). Melanomas are rare in cats. Otherwise, dark pigmented raised masses are noted.

These tumors have focal infiltration, with early metastasis to regional lymph nodes. Metastasis to the lungs and liver are less frequent. Bone destruction is common.

**Location** – Any part of the oral cavity including the dorsal tongue surface and lips. Encompassing mandibular and maxillary together, 32% were located rostrally and 20% were located caudally.

**Diagnostic tests** – Intraoral radiographs are needed to assess bone involvement (57%). FNA of mandibular lymph node, incisional biopsy. Once MM has been diagnosed, conventional oncology workup is recommended (CT, CBC, Serum chemistries, UA, 3 view thoracic radiographs and abdominal US).

**Treatment options** – Curative intent surgery with wide margins (1-2 cm margins), even as a sole treatment often extends PFI (Progression free interval) and ST (Survival times). Metastasis at time of diagnosis carries a poor prognosis and a lower ST. Rostral mandibular and maxillary masses provide the surgeon a more favorable clean tumor-free margin. Also, tumor size directly affects the ability for a surgeon to achieve clean surgical margins. Other therapy: Maximum tolerable dosage (MTD) chemotherapy (Carboplatin), xenogenic canine melanoma vaccine, radiation therapy, metronomic chemotherapy (combination of doxycycline, NSAID, cyclophosphamide), and interferon.

**Survival times** – The survival time is short, ranging from <4 months to 5.8 months and 8 months in other studies. However, a longer survival time was noted with dogs with histologically welldifferentiated melanocytic neoplasms (Mean survival time of 23 months and median survival time of 34 months after surgery).

**Squamous cell carcinoma (SCC) – Non-papillary / Non-tonsillar**

This is the most common oral malignancy in the cat and 2nd most common one in the dog (17-25%). This occurs in older dogs (mean 8-10 yrs) with larger dogs overrepresented. The gingiva is the most common site for this neoplasia. The gingiva usually appears ulcerated with secondary bone involvement (77%). Metastasis to regional lymph nodes is rare (<10%) and low to moderate metastasis to the lungs in dogs is noted (3-36%). Some facial changes (exophthalmos) can be noted. These masses are slow growing, locally destructive mostly
on the buccal mucosa. (See comparison of this mass with papillary SCC)

**Location** – In the dog, the gingival mucosa is the most common site. In the cat, premolar / molar area of maxilla, premolar region of the mandible, and sublingual lesion. Metastasis is late to regional lymph nodes and distant organs. SCC is locally aggressive with bone involvement. Tonsillar and lingual SCC are less common but have a higher and earlier metastatic rate.

**Diagnostic tests** – Incisional biopsy and regional lymph node aspirates are recommended. Once the non-papillary SCC has been diagnosed, conventional oncology workup is recommended.

**Treatment options** – Wide surgical excision (1-2 cm margins). Rostral mandibular SCC is more favorable with cats but case selection prior to aggressive excisional surgery must be considered. Rostral mandibular provide a more favorable long-term prognosis. SCC is responsive to radiation therapy with a medium survival time (MST) of 16 months. Radiation is radiosensitive but not radiocurative. Cisplatin and piroxicam have been reported to be effective.

### Papillary SCC (PSCC)

Previously thought to only occur with young dogs, this form of SCC can occur with middle to older aged dogs as well. The mean age is ~4 years (0.5-9.0 years) in a 9 dog study. CT of these lesions showed bone lysis with our without osteoproliferation. These masses are more infiltrated, rapid growth, and atypical cellularity. PSS do not metastasize.

**Location** – Most were large breed dogs and the most common location was the rostral maxilla (7/9), however, tumors were noted in the rostral mandible and mid/caudal maxilla.

**Diagnostic tests** – Same as SCC.

**Treatment options** – Surgical wide margins (1 cm) provide excellent clinical results.

### Fibrosarcoma (FSA)

This neoplasia is the 3rd most common neoplasia in dogs (7.5-25%) and 2nd most common malignancy in cats (13%). The median age of 7.3-8.6 years in dogs, and <25% of dogs are <5 years of age. In cats, the average age is 10.3 years. There is a sex predilection of male to female of 1.4-2.8:1. Larger breed animals >50# (Golden Retrievers) have a higher predisposition for FSA. Metastatic potential is low and can occur late in the disease process with lymph nodes (19-22%) and lungs (6-27%) in dogs. The low metastatic potential is the same in cats.

Clinical appearance show a firm, flat, multilobulated and deeply attached to the underlying tissue with rare ulceration noted. Bone lysis occurs in 72% of canine cases.

These tumors are histologically low-grade and biologically high-grade which potentially provides confusion to the DVM when interpreting an aggressive oral tumor. These tumors may be misdiagnosed as benign fibromas or low-grade sarcomas. High grade anaplastic oral FSAs have a more metastatic potential than do low-grade tumors.

**Location** – The site predilection in dog is maxillary arcade between the canines and carnassial teeth (56-87%), hard palate (7-17%) and buccal or labial mucosa (4-22%). There is no site predilection in the cat.

**Diagnostic tests** – After initial incisional biopsy, routine staging with FNA of mandibular lymph nodes, 3 view orthogonal thoracic images, serum chemistries/CBC/UA and CT.

**Treatment options** – Wide surgical excision (2 cm) is warranted. Local recurrence occurs more frequently than metastasis. Radiation therapy post wide excisional surgery, radiation therapy alone, and radiation therapy with local hyperthermia can prolong the survival times.

**Survival times** – Median survival time (MST) is approximately 11-12 months for both mandibular and maxillary FSA resection with local recurrence rate of 46%. Radiation therapy MST is 6-26 months.

### Osteosarcoma (OSA)

Oral osteosarcomas are the 4th most common oral tumor in dogs (6-18%). Feline oral OSAs are much less frequent (2.4%). Medium to large breed dogs that are middle aged to older are mostly represented. Females appear to be more represented.

**Location** – Most OSAs occur in the maxilla (43%) followed by mandibular (32%) and the calvarium (23%).

**Diagnostic tests** – After incisional biopsy, regional lymph node aspirates, along with conventional oncological workup.
The metastatic rate of oral OSA is lower than the appendicular counterpart. Occurrence in the mandible and maxilla are noted, with a more unfavorable outcome with OSA in the TM joint and caudal maxilla / mandible.

Treatment options – Wide radical excision (1-2 cm) of the tumor should be performed if possible. Dogs treated with surgical excision had a Median Survival Time (MST) of 329 days. Surgery resulting in complete excision improved prognosis, whereas calvarial tumor location and increased monocyte count were associated with a poorer prognosis. Radiation therapy and chemotherapy have not shown a decrease in hazard of death progression.3,6

**Odontogenic tumors**

These tumors are derived from ectodermal, ectomesenchymal, or mesenchymal components of the tooth forming apparatus. These include Canine acanthomatous ameloblastoma (CAA), peripheral odontogenic fibroma (POF), and focal fibrous hyperplasia (FFH). Of the three, POF and FFH are relegated to the gingiva only.3

Canine acanthomatous ameloblastoma (CAA) – In a recent study of odontogenic tumors, CAA occurred 45% (68/152). This is an aggressive benign odontogenic tumor that is non-inductive in nature; therefore, the cells of ameloblastic origin do not induce the surrounding mesenchmal cells. Therefore, no dental hard tissues formed and is a soft tissue neoplasia. These raised, lobulated masses also cause local bone infiltration and tooth displacement. Metastasis to regional lymph nodes or distant organs has not been reported. CT is recommended prior to oral surgery to establish bone involvement. 1-2 cm margins are recommended. Intrallesional bleomycin has been documented to resolve this oral mass with no recurrence. Local side effects to bleomycin injections have been documented. Predilection to the rostral mandible is common.7,8,9

Peripheral odontogenic fibroma (POF) – These are slow growing masses. These benign masses are not locally invasive, and occur in 31% of odontogenic tumors. Clinically, they appear as rough-surfaced masses on the gingiva. Radiographically and histologically, there may be dystrophic calcification within the mass, but no alveolar bone involvement. As with other odontogenic tumors, tooth movement due to expansion of the mass is possible. Regional distribution is mostly the rostral maxilla (47%) and caudal mandible (21%), but these masses may occur anywhere along the gingival margin. There is controversy whether these tumors are actually remnants of the periodontal ligament, and whether removal of the tooth and adjacent periodontal ligament is warranted. Some recommend removal in the reactive zone and the surrounding pseudocapsule. Others recommend a more aggressive approach to remove the tooth and the PDL, which means removal of alveolar bone that supports the tooth, to achieve complete removal.3,7

Focal Fibrous Hyperplasia (FFH) – This encompasses 16% of odontogenic tumors in the dog. Clinically, these appear raised, smooth and sometimes very firm. Regional distribution of these masses are mostly relegated to the rostral maxilla (57%) as well as rostral (22%) and distal (17%) mandible. Surgical removal is similar with POF.3,7

**References**

Complicated oral surgery

Peter Emily

Peter Emily International Veterinary Dental Foundation

Objectives

Attendees will learn the concepts and techniques for successful Oronasal fistulae closure, as well as suggested treatment for mandibular odontoma and anterior mandibulectomy with examples from case studies.

Presentation description

This presentation will show special considerations for complicated Oronasal fistula closures, mandibular odontoma and anterior mandibulectomy. The presentation will feature case reports, including diagnosis and treatment, as well as surgical outcome.

Etiology is commonly associated with severe periodontal disease and failure of primary flap closure after exodontia. Other etiologies include neoplasia, avulsion and maxillary fracture, however ONF secondary to extraction is by far the most common etiology.

Mechanical turbinate exposure is commonly encountered during exodontia. Flap closure after tooth removal must adhere to two essential principals of oral flap management. First, the flap must be tension-free, and secondly, the suture line must not be placed over the surgical defect. Any violation of these principals will result in flap failure.

Existing fistula present with a pressure that varies between the nose and the mouth that perpetuates the patent fistula. Closure is effectively accomplished by a double-sliding flap, utilizing the palatal gingiva and the alveolar mucosa adjacent to the defect.

ONF can also be closed with the use of nasal septal buttons. The case will dictate whether or not suturing to soft or hard tissue will lead to successful ONF closure with a tension-free flap.

This lecture will also discuss a complicated anterior mandibular fracture on an African lion. A partial mandibulectomy was performed with root canal therapy on the retained root segment.

Finally, a young dog presented with a very large odontoma that encompassed almost half of the mandible. The surgical treatment will be discussed, which included removing the cystic membrane and the application of bone augmentation material.

The evolution of endodontic obturation – Where it was, where it is, and where it will be

Peter Emily

Peter Emily International Veterinary Dental Foundation

The history of endodontic therapy is vague. Many theories of the origins of endodontic therapy are mixed regarding what happened, why, and how.

Most theories suggest that dentists and/or barbers in the 19th century drove wooden sticks up the incisor
Small animal & exotic animal dentistry

canal, to drive out the demons that were in place, purportedly the source of a patient’s pain. Despite being incredibly painful, the wooden stick must inadvertently sealed the apex, as in some cases it worked as a form of treatment. Likely due to unsatisfactory treatment success rates, other methods were tried, such as obturation of the canal with pieces of copper wire, rag filaments, and cotton, to name a few. Success rates were likely as bad.

Root canal therapy floundered in the ensuing decades. Obturation attempted with a variety of different materials without consideration for treatment of the canal prior to obturation continued to result in failure.

In the later 19th century, canal preparation prior to obturation was performed rather poorly, with some increased success attributed to better obturation materials, such as the use of gutta percha and silver points. Mixed results were experienced. Some accidental apical seals started to produce better results.

The 20th century started to see root canal therapy develop into a much-needed dental discipline. New obturation materials and improved techniques advanced root canal success. The use of gutta percha and zinc oxide powder mixed with eugenol started to produce more reliable results. However, much more research and development was needed. For instance, why did small diameter silver points work, while larger diameter failed? Why use silver points at all?

New techniques such as the new discipline of surgical endodontics presented exaggerated techniques with some favorable results. Other techniques were attempted and soon be discarded. The present endodontic obturation materials and techniques, particularly the newer obturation cements such as those containing MTA, help to make properly performed root canal therapy successful.

Pathophysiology and local, regional and systemic effects of periodontal disease

Barden Greenfield

Your Pet Dentist of Memphis and Little Rock at Memphis Veterinary Specialists and Arkansas Veterinary Specialists

We’ve heard it time and time again that 80% of dogs and cats over the age of 3 have some form of periodontal disease, however, have you considered the consequences of this disease? Local, regional and systemic consequences can be extremely deleterious to the canine patient, even contributing the mortality. Know why it is important to prevent periodontal disease, and why it is important to be proactive vs reactive with this disease.

Inability or unwillingness to open the mouth in dogs and cats

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The TMJ is composed of the condylar process of the mandible, the mandibular fossa and retroarticular process of the temporal bone, the intraarticular disc, and the capsule. The contraction of the masseter, (medial and lateral) pterygoid and temporal muscles closes the mouth, whereas the contraction of the digastricus muscles opens the mouth. When the mouth opens the coronoid process of the mandible displaces rostrally. Swellings located rostrally to the coronoid process of the mandible will be compressed during the normal movement of the TMJ, thus causing pain and unwillingness to open the mouth. Retropulsion of the eyes may be decreased in some cases. The oral examination may not show any abnormality, but palpation of the
caudal aspect of the oral cavity including the pharyngeal walls may help locate the lesion.

**Oral tumors** – The most common oral tumors are oral malignant melanoma, squamous cell carcinoma and fibrosarcoma, but other tumors may also occur (acanthomatous ameloblastoma, osteosarcoma, etc). These tumors may be involving the pterygopalatine fossa, zygomatic arch, zygomatic salivary gland even though the lesion in the oral cavity may not be particularly large. Asymmetry, exophthalmos, oral and nasal discharge, halitosis, and masticatory muscle atrophy may be present. Diagnostic imaging (CT, MRI) is mandatory to determine the extent of the lesion. Biopsy, presence of metastasis, and extension of the lesion should be considered before surgical resection.

**Temporomandibular Joint Disorders** – Dogs and cats with luxation or fracture of the TMJ usually present with a history of trauma and acute signs. Oral examination in the conscious patient provides important information, but an anesthetized oral examination and diagnostic imaging (radiographs, CT) will much more likely lead to a diagnosis. The most common TMJ luxation occurs in rostrodorsal direction. On oral examination, the lower jaw shifts towards the opposite side of the luxation, and the patient will not be able to fully close the mouth due to contact of maxillary and mandibular teeth on that opposite site. Manipulation of the lower jaw elicits pain, but opening the mouth is possible. TMJ luxation needs to be differentiated from open-mouth jaw locking (believed to be a result of TMJ dysplasia) where the coronoid process of the mandible locks ventrolateral to the ipsilateral zygomatic arch, leaving the mouth wide open without contact of maxillary and mandibular teeth. Fracture of the TMJ may be difficult to diagnose by means of radiographs due to superimposition with other structures. CT scan of the head has been shown to diagnose more lesions than radiographs. Trauma may cause degenerative disease and ankylosis. Signs of those are usually progressive and chronic. Ankylosis can be classified as being true or false. True ankylosis occurs when there is an intraarticular consolidation of the TMJ, and false ankylosis is present when the restriction of the movement is due to extracapsular lesions such as fusion of the ramus of the mandible with the zygomatic arch.

**Craniomandibular osteopathy** – Craniomandibular osteopathy is a non-neoplastic proliferative disease that affects the mandible, the temporal, parietal and occipital bones. It occurs in immature and young adult dogs (usually less than 8 months of age), and it can be self-limiting. The disease starts with pain and fever, and obvious bony lesions may not yet be visible on diagnostic imaging or they are very subtle at the time of initial presentation. But if the proliferation is extensive, opening the mouth might be restricted because of contact of proliferations at the caudal mandible with proliferations at the temporal bone. Diagnosis is based on physical examination and radiographs/CT.

**Ear disease** – Opening the mouth may cause pain in the presence of ear disease due to compression of the affected area. Signs of otitis or ear masses are present, and the unwillingness or inability to open the mouth is secondary to pain or mechanical impediment. Restricted mouth opening indicates advanced disease, and it is often associated with recurrence after surgery in cholesteatomas.

**Pharyngeal abscesses and foreign bodies** – Pharyngeal abscesses may occur due to penetration and migration of foreign bodies through the oral mucosa. Foreign bodies may advance deeper into masticatory muscles, causing cellulitis and abscessation. The abscesses can drain through small openings into the oropharyngeal mucosa or external skin, but the oropharyngeal wound usually is closed by the time when the abscess has developed. Surgical exploration is required for removal of foreign bodies and drainage of abscesses, followed by treatment with antibiotics based on culture and sensitivity testing and anti-inflammatory drugs.

**Salivary gland disease** – The zygomatic salivary gland is located ventral to the eye in the pterygopalatine fossa. Zygomatic salocele, salaloditis, salaldenosis, necrotizing salometaplasia, and neoplasia may interfere with normal mouth opening due to pain or mechanical impediment. Exophthalmos may be present as well as decreases retropulsion of the eyes into their orbits. Necrotizing salometaplasia usually affects both mandibular salivary glands, and the patient shows signs of systemic disease (lethargy, vomiting).

**Masticatory myositis** – Masticatory myositis is an inflammatory myopathy that affects the temporal, masseter and (medial and lateral) pterygoid muscles. This disease causes swelling of these masticatory muscles during
the acute phase and their atrophy in the chronic phase. One common finding in affected dogs is partial or total inability or unwillingness to open the mouth during the conscious examination. Under anesthesia, there may be some improvement in mouth opening compared to the conscious examination, but tracheostomy is sometimes needed for intubation. Diagnosis is based on the determination of the 2M-fiber antibody titer in serum and histochemical identification of immune complexes in sampled muscle tissue. Other causes of myopathies should be rule out. Imaging diagnosis (CT, MRI) is indicated in order to identify areas of inflammation and rule out other disorders that cause decreased range of mouth opening. Other inflammatory and non-inflammatory myopathies may affect the masticatory muscles, but they also involve other muscular groups or organs.

References are available upon request (anacaste@vet.upenn.edu).

Fractured teeth – What’s next?

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Teeth that have been fractured should be categorized based on the damage to the tooth. If only the enamel is damaged, this is an enamel fracture (EF). Crown fractures are divided into pulp-exposed and not pulp-exposed. A tooth that has the pulp exposed is considered a complicated crown fracture (CCF). If the pulp is not exposed, but the dentin is, this is an uncomplicated crown fracture (UCF). If the fracture also involves the root of the tooth, the terms are uncomplicated crown-root fracture (UCRF) or complicated crown-root fracture (CCRF).

Fractured teeth are a commonly identified problem in small animal medicine. One study of patients anesthetized for non-oral reasons at the University of Pennsylvania showed that 27% of dogs had at least one fractured tooth that needed evaluation. 10% of dogs in the same study had fractured teeth with pulp exposure. This implies that one out of every 4 patients walking through the door of an average veterinary practice has a fractured tooth that may be causing discomfort or infection.

Once a fractured tooth has been recognized, it is important to schedule an anesthetized examination with dental radiographs to determine if further treatment is necessary. Although all fractured teeth should be evaluated, not all fractured teeth require treatment. If the pulp has been exposed (a complicated crown or crown-root fracture), the only acceptable treatment options are root canal therapy or extraction. However, if the pulp has not been exposed, the treatment recommendations are less clear. If the radiographs confirm that the tooth is non-vital, the recommendations are the same as for a tooth with pulp exposure (root canal or extraction). If the tooth is radiographically vital, some veterinary dentists recommend dentin bonding or restoration, to seal the tooth. In some cases, dentin bonding may cause more discomfort by opening dentin tubules. However, all veterinary dentists agree that regular radiographic evaluation is appropriate to ensure that a tooth with an uncomplicated crown or crown-root fracture does not become non-vital over time.

The categories of fractures apply to both dogs and cats. However, as we are all aware, cats are not small dogs. Their oral anatomy is similar to dogs, but with variation. The dental anatomy of cats reflects their primary diet, which is carnivorous. They have fewer molars than dogs, which are more omnivorous. The molars in dogs are primarily flat on the occlusal surface, reflecting their diet which includes vegetation and variety. In cats, all of their teeth have sharp occlusal surfaces, which are used primarily for cutting rather than crushing and grinding. Because cats are obligate carnivores, their dental structures are designed to best fit this lifestyle.

The canine teeth in cats are the most commonly associated with dental fractures. Unfortunately for cats, the pulp chamber in the crown is very close to the surface. There is only about 1-1.5mm of enamel and dentin between the oral cavity and pulp chamber in the coronal tip of the canine teeth. Therefore, even a very small chip fracture is likely to cause exposure of the pulp chamber. When this happens, treatment is required.

The treatment options for a fractured tooth with pulp exposure in a cat are also root canal therapy or extraction, just as with dogs. However, in many cats, identifying and confirming the pulp exposure can be
difficult. The small size of the exposed pulp chamber makes visual exam unreliable in cats, although this is
commonly used for identifying problems in dogs with fractured teeth. Sometimes the pulp exposure can be
seen radiographically. Nevertheless, it is important to probe the fractured surface for the exposed pulp cham-
er, even if it does not appear to radiographically reach the fracture. Because the exposed pulp chamber is
typically extremely small, the normal Shepherd’s hook at the end of the periodontal probe will be too large
to confirm pulp exposure in cats. The most effective tool for this is a size 8 iso or size 10 iso endodontic file.
These are easily and inexpensively obtained in a general practice and can be reused for multiple patients.

References available from the author

Intraoral mandibular fracture repair: The good, the bad, and the ugly

Barron P. Hall

The mandible is made up of mirrored left and right halves that are firmly united rostrally at the inter-
mandibular joint, known as the mandibular symphysis. This fibrous joint is a synchondrosis. The body of the
mandible is the portion that contains eleven teeth. The mandibular canal lies within body of the mandible
containing the neurovascular structures supplying the mandibular bone, teeth, and soft tissues. The ramus of
the mandible is the distal portion that does not contain any teeth. The neurovascular complex enters through
the mandibular foramen located on the lingual aspect of the caudoventral mandible. Its dorsal extent is the
coronoid process and its most distal extent is the coronoid process. The condyloid process is part of the
temporomandibular joint, a synovial joint. A thin articular disc within a loose joint capsule completely divides
the joint cavity into dorsal and ventral compartments separating the articular cartilage covered surfaces of
the condyloid process and the fossa of the temporal bone.

In order to repair a fracture and stabilize the segments, forces placed on the bone need to be mitigated.
The muscles of mastication place a variety of forces on the mandible. These forces may help or hinder
fracture repair, so these muscles should be understood. There are five muscles of mastication. The four
used to open the mouth are innervated by the trigeminal nerve, while the two bellied muscle used to open
the mouth is innervated by both the trigeminal and facial nerves. The masseter muscle originates from the
ventral border of the zygomatic arch extending caudolaterally to insert on the ventral surface of the
mandible (masseteric fossa) with some fibers extending around the ventral and caudal border to insert on
its ventromedial surface. The temporalis muscle is the largest and strongest of these muscles. It originates
primarily from the parietal bone and to a lesser extent from the temporal, frontal, and occipital bones. The
muscle lies within the temporal fossa as fibers extend dorsally and ventrally beneath the zygomatic arch to
insert on the coronoid process with some fibers reaching the ventral margin of the massteric fossa were they blend with the masseter muscle. On the medial aspect of the mandible they blend with the pterygoid muscles. The lateral pterygoid muscle is smaller and shorter than the medial pterygoid muscle. It originates from a small fossa on the sphenoid bone extending ventrolaterally and slightly caudal to insert on the medial aspect of the mandibular condyle just ventral to its articular surface. The medial pterygoid muscle originates from the lateral surface of the pterygoid, palatine, and sphenoid bones extend caudolaterally to insert on the medial and caudal surface of the angular process of the mandible. The digastricus muscle is the only muscle of mastication used to open the mouth. It originates from the paracoronydral process of the occiput extending rostrally to attach on the ventral border of the mandible. The muscle appears to be a single bellied muscle, but a tendinous intersection divides the muscle into a rostral (trigeminal) and caudal belly (facial) with their own innervation.

As with other orthopedic injuries, mandibular fracture repair can be very rewarding or very frustrating.
There are usually more than one option for fracture stabilization based on your training and the equipment
you have. The way you approach a fracture can vary on the way that you were trained. Those trained from the dental/oral surgery side usually opt for intraoral fixation using the teeth, wires, composite, and acrylic. Those surgically trained are more likely to use an extraoral approach with IM pins, External Skeletal Fixation (EXF), or plates and screws.

There are multiple factors that need to be considered when planning on how to repair a fracture: patient, fracture, owner, and veterinarian.

1. The patient’s age, breed, neutered or not, size, skull type, dentition, oral health, overall health, and other health issues all need to be considered.
2. How did the fracture occur? Is the dentition involved? What is the periodontal health? Was the fracture pathologic? What is the bone health? Is there bone missing? Bilateral or unilateral?
3. What can the owner afford? What are the owner’s expectations? Do they comprehend their part in this multiple week process? Where will the pet recuperate? Are there other pets in the home? Will the pet be left alone?
4. This may be the most difficult. You need to be honest with yourself and your client. Are you qualified? What advanced training have you had in the various methods of fracture repair? How many fracture repairs have you done? What equipment do you have? What is your comfort level with all of the above? ***Education:Equipment:Experience

A salvage procedure would be some type of mandibulectomy. This type of procedure is indicated when the fracture cannot be repaired or is a non-union. Based on answers to the above questions a salvage procedure may be the best option for all parties involved.

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**Developmental dental disorders and their clinical significance**

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**Introduction**

Developmental dental disturbances are relatively common in dogs, less so in cats. They may be inherited, but they may also be acquired or idiopathic. Developmental disorders of teeth include variations in tooth number, shape and size, structural defects and disorders of eruption and shedding. Clinical importance of any defect varies from insignificant and mainly cosmetic, to extremely significant, e.g. leading to abscesses or cysts. Good quality radiographs are mandatory for diagnosis: only radiographs will tell the clinician what a tooth, including its root, is truly like. In this lecture, the most common developmental disorders and their clinical significance will be discussed.

**Variations in tooth number**

*Decrease in number: anodontia – oligodontia – hypodontia*

Anodontia (congenital absence of teeth) and oligodontia (only a few teeth present) are rare conditions, often associated with generalised disorders such as ectodermal dysplasia. Hypodontia (one or a few teeth missing) is a common condition. Hypodontia in the permanent dentition is more frequent than in the primary dentition. Premolars and incisors are the most frequently affected teeth.

Hereditary factors are often involved in the congenital absence of teeth, but teeth can also be missing as a result of disturbances during the initial development phase as a result of trauma or infection.

Radiography is essential to differentiate missing teeth from impacted teeth.
Hypodontia is mainly a cosmetic issue. Differentiation between possible hereditary and proven traumatic causes is important for breeding dogs.

**Increase in number: supernumerary teeth – hyperdontia**

Extra teeth can occur in the primary and/or the permanent dentition. Supernumerary teeth may be inherited, but this condition can also be caused by disturbances during tooth development. They are more prevalent in the incisor and premolar region.

Supernumerary teeth may cause disturbances in eruption, crowding and deviation of adjacent teeth. In these cases extraction needs to be considered. Radiographs are mandatory before extraction of any of these teeth. When the condition doesn’t cause clinical problems, treatment is unnecessary. The owner needs to be advised of the possible heritability of the disorder.

**Alterations in size**

Alterations in the size of teeth are of limited clinical importance in dogs and cats.

Macrodont teeth are teeth that are larger than normal. Teeth that are smaller than normal are referred to as microdont. Alterations in tooth size are usually only cosmetic problems, although a macrodont tooth may need to be extracted because of interference with a comfortable occlusion.

**Alterations in shape**

**Gemination – Fusion – Concrescence**

Gemination is defined as an attempt to make two teeth from one enamel organ. Gemination is seen most often in the incisor region. Fusion is the joining of two tooth germs, resulting in a single large tooth.

The aetiology of germination and fusion is unknown, but trauma has been suggested as a possible cause, though a familial tendency has also been suggested.

Concrescence is the fusion of adjacent already formed teeth by cementum. It may take place before or after eruption. It is thought to arise from trauma or crowding of teeth.

Gemination, fusion and concrescence do not require treatment. When affected teeth do need treatment (e.g. for periodontal or endodontic disease), pre-operative radiography for planning of treatment is essential. Geminated or fused teeth may have a different number of roots and root canals than expected.

**Dilaceration**

Dilaceration refers to a sharp bend, curve or angulation in the root or crown of a tooth. The cause is usually acute mechanical trauma during the development of the tooth. The trauma may change the position of the mineralised portion of the tooth, and the remainder is then formed at an angle. The curve or bend may occur anywhere along the length of the tooth. Hereditary factors are supposed to be involved only in a small number of cases.

A dilacerated crown may be an aesthetic problem. Often the surface of a dilacerated crown is irregular, leading to a highly plaque retentive surface. Extraction or endodontic treatment may be difficult in the case of a dilacerated root, hence the need for preoperative radiography before extraction of any tooth. Severely dilacerated teeth may be unable to erupt.

**Dens invaginatus – Dens in dente – ‘Tooth within a tooth’**

Dens in dente is refers to an invagination of enamel and dentine from the tooth surface. This invagination can be superficial (crown) to deep (crown and root). The aetiology of the condition is unknown. The clinical significance of dens in dente depends on the severity of the lesion, varying from higher caries susceptibility to pulp necrosis and periapical inflammation.

**Supernumerary roots**

Accessory tooth roots can be seen in dogs and cats. In the dog, the upper third premolar is most commonly involved. In the cat accessory tooth roots are seen most frequently in the upper second and third premolar. Radiographic recognition of supernumerary roots is very important when endodontic treatment or extraction of the involved tooth is necessary.
Structural defects

**Hereditary enamel defects: Amelogenesis imperfecta**

Amelogenesis imperfecta is a hereditary form of enamel defect that affects both dentitions. The incidence in dogs and cats is unknown, but it has been reported in the Standard Poodle.

**Environmental enamel defects: hypoplasia, hypocalcification, hypomaturation**

Environmental enamel defects are a common structural defect seen in dog's teeth. They are extremely rare in the cat. Enamel defects occur as a result of injury during the formative stage of enamel development (up to four months of age); once the enamel has mineralised, no such defect can be produced.

Enamel develops in 2 stages: a secretory stage (matrix production and early mineralization) and a maturation stage (increase in mineral content by withdrawal of water and protein). In enamel hypoplasia, the enamel is quantitatively defective (i.e. insufficient amount but with normal hardness, the disturbance affecting matrix formation). Qualitatively defective enamel (normal amount but hypomineralized, the disturbance affecting initial mineralization and maturation) is referred to as enamel hypocalcification. Some disturbances affect both matrix formation and mineralization.

The extent of the defect(s) depends on the intensity of the aetiologic factor, the duration of the factor's presence and the time at which the factor occurs during tooth development. Any serious nutritional deficiency or systemic disease is potentially capable of producing enamel dysplasia in the areas of the teeth that are being formed at that time. Aetiologic factors may occur locally or systemically. Examples of aetiologic factors include: vitamin deficiencies (Vitamin A, Vitamin D or rickets), epitheliotropic viruses (e.g. distemper virus), hypocalcaemia, excessive fluoride ingestion, local infection, local trauma. Sometimes no apparent cause can be identified (idiopathic).

Clinical presentation varies. In a mild form, one or a few small grooves, pits or fissures are seen on the tooth surface. In more severe generalised forms, horizontally arranged rows of deep pits may be seen across the tooth surface. In localised forms, a part of the crown may have no enamel at all, or have defective, brittle enamel. In all cases, tooth colour may vary from white opaque to yellow to brown. Teeth with enamel dysplasia may appear normal at the time of tooth eruption. With time they become discoloured as the porous enamel takes up pigments, or the defective enamel flakes off with use.

Poorly protected or exposed dentine is painful, due to the existence the dentinal tubules. With time, sensitivity will disappear as a result of reparative dentine laid down by a healthy pulp. However, in severe cases the pulp may become chronically inflamed from infection via the poorly protected or exposed dentin tubules, be unable to lay down reparative dentine, and periapical disease may develop. Therefore, radiographic examination of all teeth affected by enamel defects is indicated, and should be repeated at regular intervals throughout the animal's life, to detect complications such as pulp and periapical disease.

Treatment options include restoration of the defect (in localised forms) and sealing of the dentine tubules to protect the pulp. Since affected teeth have a very irregular, plaque-retentive surface, good oral home care (daily toothbrushing) is very important. Teeth affected by periapical pathology need more extensive treatment, i.e. extraction or endodontic treatment.

**Other structural defects**

Very few reports exist in veterinary literature regarding dentine defects. The inherited condition Dentinogenesis imperfecta has been described in the dog. The dentitions have a blue-to-brown discolouration often with a distinctive translucence. The enamel separates easily from the underlying dentin, and the teeth are more sensitive to fracture and abrasion than normal teeth.

**Disorders of eruption and shedding**

**Persistent deciduous teeth**

Persistent deciduous teeth, i.e. deciduous teeth that are still present when the permanent counterpart is erupting, are a very common condition in toy and small dog breeds. Persistence of deciduous teeth is likely to be inherited, at least in some breeds.

Persistent deciduous teeth may cause or aggravate malocclusion and promote periodontal disease due to crowding, and should therefore be extracted. Whenever a deciduous and a permanent tooth of the same type are present at the same time at the same location, the deciduous tooth should be extracted as soon as possible.
**Impacted teeth**

An impacted tooth is a tooth that ceases to erupt before emergence. Generally this is an acquired condition but it can be genetic. Impaction can be caused by lack of space, by trauma or simply because the tooth’s position in the alveolus is abnormal so that it is unable to erupt into its normal position. A tooth with a severely dilacerated crown may be unable to erupt.

Impacted teeth need to be differentiated from missing teeth. Radiographs are therefore indicated when a tooth is clinically missing. Impacted teeth may cause resorption of the roots of adjacent teeth. In man, periodic pain due to tooth impaction has been described. A dentigerous cyst may develop around the coronal portion of the tooth, and when left untreated such a cyst may become extensive, resorbing bone and tooth roots. On rare occasions, an ameloblastoma or a squamous cell carcinoma may arise from the lining of a dentigerous cyst. For these reasons impacted teeth should be treated or at least radiographically monitored on a regular basis.

Depending on the presenting problem, treatment may consist of removing the overlying gingival tissue (operculectomy), or extraction of the tooth.

**Dental abnormalities in puppies with a history of maxillofacial trauma**

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Information regarding tooth development in dogs that sustained maxillofacial trauma is sparse and based on case reports. This retrospective case series study evaluated the medical and dental records of dogs that had been diagnosed at immature age with mandibular fractures during a 16-year period (2001-2016). The dogs had a recheck examination of at least 90 days after the injury, and the last recheck examination occurred at 6 months of age. Nine dogs fulfilled the criteria for inclusion into the study. Seventy-two percent of teeth located in the mandibular fracture site showed continued eruption, but 68% had abnormalities in their development or became non-vital. Sixty-six percent of deciduous teeth present in the fracture line continued normal development and exfoliation. Maxillofacial trauma seems to affect more the developing permanent teeth than the deciduous teeth. Despite the high rate of developmental abnormalities or non-vital status of teeth involved, the owner did not recognize clinical signs of discomfort or pain. Periodic evaluations until completed eruption of the teeth in the growing dog are recommended. If there is any doubt of tooth vitality, oral examination and diagnostic imaging every 6-12 months might be necessary.

*References are available upon request (anacaste@vet.upenn.edu).*
Outcome of mandibular fractures in puppies

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Information in regards to outcome of mandibular fractures in puppies managed with non-invasive or minimally invasive methods is sparse. This retrospective case series includes immature dogs diagnosed with mandibular fractures during a 17-year period (2000-2016) that had been managed with non-invasive methods (tooth extraction, wound debridement, bone apposition with sutures, soft tissue closure, muzzling). Recovery of masticatory function, bone healing, and occlusion were evaluated. A total of 29 dogs with 53 mandibular fractures were included in this study. Trauma caused by another dog was the most representative cause (79%). The most common location of fracture was the mandibular body, followed by the non-articular structures of the mandibular ramus and the condylar process of the mandibular ramus. All patients recovered masticatory function without non-union or temporomandibular joint ankylosis. Skeletal malocclusion was evident in 11 dogs, but treatment to provide a comfortable masticatory function was necessary only in one dog. The results of this study showed that non-invasive or minimally invasive treatment of mandibular fractures in puppies has a good prognosis in regards to bone healing and maintenance of masticatory function in dogs. Monitoring of jaw growth is recommended in order to prevent or treat painful malocclusion.

References are available upon request (anacaste@vet.upenn.edu).

Stem cells therapy for feline chronic gingivostomatitis: What have we learned so far?

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Feline chronic gingivostomatitis (FCGS) is a severe inflammatory oral disease of cats that is often refractory to treatment. The condition is characterized by oral inflammation affecting the gingival and non-gingival mucosa. Affected cats typically display clinical signs related to oral pain, including inappetence, anorexia and ptyalism. The etiopathogenesis of FCGS is partially understood. Current treatment modalities include full or near-full mouth dental extractions, corticosteroids, antibiotics and analgesia. Extraction therapy provides the highest success rate with approximately 30% of cats exhibiting complete remission, 40% exhibit improvement and 30% of cats do not respond to extraction therapy. The cats that do not respond to extractions will often need lifelong medical management to maintain adequate quality of life. Adipose-derived mesenchymal stem cells (adMSCs) have regenerative and immunomodulatory capabilities and can be easily obtained in large numbers from harvested fat. Our studies in the past 5 years, as well as our ongoing clinical trials, focus on the safety and efficacy of adMSCs in treating refractory FCGS after full-mouth dental extractions has failed to achieve substantial improvement or complete remission. To date, we have found that approximately 70% of the cats with refractory FCGS demonstrated significant improvement 2-6 months after receiving adMSC treatment. A subset of cats that exhibited slow response to adMSC treatment demonstrated a delayed response with either substantial improvement or complete resolution within a year of treatment. Moreover, we demonstrated that adMSCs are capable of immunomodulatory effects in cats and those effects are seen in conjunction with clinical improvement. This lecture will focus on the work that we have completed since the beginning of the clinical trial and will outline the difficulties encountered and the future direction of adMSCs therapy in cats and humans.
Mandibular reconstruction: Clinical aspects in dogs

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Immediate reconstruction following segmental mandibulectomy

Utilizing a regenerative approach and specialized internal fixation for immediate reconstruction of critical-size bone defects following segmental mandibulectomy has been proven to be a viable and predictable method. Using a combination of extraoral and intraoral approaches, a locking titanium plate is contoured to match the native mandible. Following segmental mandibulectomy for treatment of malignant or benign tumors, the plate is secured and a compression resistant matrix infused with 0.5 mg/ml rhBMP-2 at a soak volume of 50% is implanted in the defect. The implant is then covered with a soft tissue envelope followed by routine intraoral and extraoral closure. Our experience over the past 6 years has demonstrated that dogs that had mandibular reconstruction healed with intact gingival covering over the mandibular defect and had immediate return to normal function and occlusion. Moreover, mineralized tissue formation was observed clinically within 2 weeks and solid cortical bone formation within 3 months. Computed tomographic findings postoperatively and in follow-up examinations demonstrated newly regenerated mandibular bone with a bone density and porosity comparable to the contralateral side. Hence, mandibular reconstruction using internal fixation and CRM infused with rhBMP-2 provides an excellent solution for immediate reconstruction of segmental mandibulectomy defects in dogs.

Regenerative approach to bilateral rostral mandibular reconstruction

Extensive rostral mandibulectomy in dogs typically results in instability of the mandibles that may lead to malocclusion, difficulty in prehension, mastication, and pain of the temporomandibular joint. Large rostral mandibular defects are challenging to reconstruct due to the complex geometry of this region. In order to
restore mandibular continuity and stability following extensive rostral mandibulectomy, a surgical technique was developed using a combination of intraoral and extraoral approaches, a locking titanium plate and a compression resistant matrix infused with rhBMP-2. Furthermore, the surgical planning consisted of computed tomographic scanning and 3D model printing. The regenerative surgical technique was typically done in 2 stages (i.e., delayed reconstruction). Bilateral rostral mandibulectomy is the first stage followed by a second stage in approximately 4 weeks to reconstruct the rostral mandibles. The main reason for the staging is that it allows for soft tissue healing over the rostral mandibles and prevents the occurrence of plate exposure through the mucosa. To date, all dogs treated have healed with intact gingival covering over the mandibular defect and had immediate return to normal function and occlusion. Follow-up computed tomography findings demonstrated that the newly regenerated mandibular bone increased in mineral volume with evidence of integration with the native bone. In summary, rostral mandibular reconstruction using a regenerative approach provides an excellent solution for restoring mandibular continuity and preventing mandibular instability in dogs.

**Regenerating mandibular bone as a treatment of defect non-union**

A regenerative surgical technique using internal fixation and rhBMP-2 infused in a CRM for reconstruction of critical-size bone defect non-union mandibular fractures has been demonstrated to be a viable option. In dogs with mandibular defect non-union the repair may be staged and extraction of teeth performed during the first procedure. Approximately 4 weeks later, reconstruction of the mandible is performed. Following pharyngotomy intubation and temporary maxillomandibular fixation, using an extraoral approach, a locking titanium miniplate plate is contoured and secured. A CRM infused with rhBMP-2 (same dose as described above), is implanted in the defect. The implant is then covered with a soft tissue envelope followed by routine closure. Our experience over the past 6 years has demonstrated that all dogs had healed with intact gingival covering over the mandibular fracture site defect and had immediate return to normal function and proper occlusion. Hard-tissue formation was observed clinically within 2 weeks and solid cortical bone formation within 3 months. Computed tomographic findings demonstrated that the newly regenerated mandibular bone had 92% of the bone density and porosity compared to the contralateral side. Long-term follow-up showed an excellent outcome. Therefore, mandibular reconstruction using internal fixation and CRM infused with rhBMP-2 is an excellent solution for the treatment of critical-size non-union defects in dogs.

**References**

Mandibular reconstruction: Biomechanical and kinematic aspects in dogs and cats

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Treating complex mandibular fractures and reconstructing large mandibular defects are important challenges facing the oral and maxillofacial veterinary surgeon. If left untreated, critical-size defects and severe fractures may result in severe functional deficiencies and disfigurement. Mandibular internal fixation by means of locking reconstruction plates or locking miniplates is most commonly used for mandibular reconstruction after resective surgery or for fracture fixation.

Important aspects of mandibular reconstruction are understanding the biomechanics of internal fixation and the kinematics of the mandibles in health, after resection (i.e., mandibulectomy) and following reconstruction. Fixation strength depends on a multitude of factors including plate positioning, configuration, and strength; screw geometry; and bone quality, biology, and load. Patient outcome is optimized by selection of a plate system with consideration of the mechanical and biological advantages relative to the fixation goals and fracture configuration circumstances.

Fixation failure is an important complication that can occur when bone quality is poor or mechanical load is unfavorable. Screw loosening, plate exposure through oral mucosal ulceration, and collateral damage to important adjacent anatomical structures are reported complications when a bone plate is positioned near the alveolar margin and sustains excessive stress.

In the past few years, the use of locking reconstruction plates and screws has emerged. The locking plate system was developed to provide additional mechanical advantage over conventional plates. Novel integration of a rigid interface between the plate and screws enhances the stability of repaired bone constructs and allows more flexibility in plate position and application. The system is characterized by the presence of threads on the screws and plates that allow the screw to be locked to the plate, enhancing both primary and secondary stability. Application and adaptation of the plate is somewhat less critical than with conventional plates.

Screw loosening is a relatively common complication in people after miniplate osteosynthesis, indicating that excessive stresses occur in the bone around the screw during function. This problem motivated our evaluation of locking reconstruction plates, which can offer better biomechanical behavior even in poor quality bone. Moreover, anecdotal reports in the veterinary literature in which miniplates were used along the alveolar margin in conjunction with a locking or conventional plate have resulted in exposure of the miniplate through the alveolar and gingival mucosa. Conversely, our clinical experience in the past several years using locking reconstruction plates for repair of critical-size defects and fracture management have demonstrated that a single locking plate placed in a buccal position just ventral to the tip of the roots and dorsal to the mandibular canal does not result in collateral damage to blood vessels and nerves or teeth apices, does not result in plate exposure through the mucosa, and is not associated with screw loosening, but instead provides a solid and reliable internal fixation.

To optimize patient outcome, consideration of the biomechanical and kinematic aspects of internal fixation should be made. Therefore, our group has taken a series of steps to study the biomechanical and kinematic aspects of bone fractures, regeneration and internal fixation. This is the second lecture in the mandibular reconstruction session and will describe our studies and clinical experience on the biomechanical and kinematic behavior of mandibular fractures and critical size defects in dogs and cats stabilized with locking reconstruction plates and locking miniplates.

References

2. Verstraete FJM, Arzi B, Huey DJ, Cissell DD, Athanasiou KA. Regenerating mandibular bone
Radiographic outcome of root canal treatment of canine teeth in cats: 32 cases (1998-2016)

Peter C. Strom1,5, Boaz Arzi2, Milinda J. Lommer2,6, Helena Kuntsi-Vaatovaara4, Amy J. Fulton Scanlan2,6, Philip H. Kass3 and Frank J.M. Verstraete2

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Objective: To describe the radiographic outcome of root canal treatment (RCT) of canine teeth of cats.

Design: Retrospective case series.

Animals: 32 cats with 37 canine teeth with complicated crown fractures that underwent RCT.

Procedures: Medical record databases of 5 referral veterinary hospitals were searched to identify cats that underwent RCT between 1998 and 2016. Only cats that had at least 1 follow-up examination during which radiographs were obtained of the treated tooth or teeth were included in the study. Dental radiographs obtained before and immediately after RCT and during all follow-up examinations were reviewed. Treatment was considered successful if the periodontal ligament space was within reference limits and preoperative external inflammatory root resorption (EIRR), if present, had stabilized. Treatment was considered to have no evidence of failure if preoperative EIRR had stabilized and preexisting periapical lucency was stable or decreased in size but had not resolved. Treatment was considered to have failed if periapical lucency or EIRR developed subsequent to RCT or preexisting periapical lucency increased in size or preoperative EIRR progressed following RCT.

Results: Follow-up time after RCT ranged from 3 to 72 months. Of the 37 treated teeth, the RCT outcome was successful for 18 (49%), had no evidence of failure for 12 (32%), and failed for 7 (19%). Preexisting EIRR and patient age ≥ 5 years significantly increased the risk for RCT failure.

Conclusions and clinical relevance: Results indicated that RCT was a viable treatment option to salvage endodontically diseased canine teeth in cats.
**Cause, presentation, signalment and distribution of facial fractures resulting from head trauma in a series of 45 cats presented to a private referral centre**

Peter Southerden

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**Objective:** To review clinical records and advanced diagnostic images of facial fractures in a series of 45 cats and to collate and analyse data relating to the signalment, cause, presentation and distribution of facial fractures in these patients.

**Animals:** 45 client owners cats that presented with head trauma and were found to have facial fractures using computed tomography were included in this study.

**Results:** 59% of cats were male, 59% cats were referred with the presenting problem of a mandibular fracture, the average age of these cats was 4y155d, 68% of these cats presented in the six months from April to September though the greatest number in any one month was in October. 75% cats were reported to be the result of a road traffic accident, one cat was injured when a garden gnome fell on it. All, except two cats, had multiple fractures including 60% that had nasopharyngeal fractures, 58% orbital floor fractures, 46% symphyseal or parasymphyseal fractures and 46% involved one or more condyle, condylar neck or dislocation.

**Clinical Significance:** Facial fractures occur most frequently in young cats in the summer months in the UK. Though most (59%) cats were referred for mandibular fractures, the majority (89%) also had maxillary fractures. Orbital and condylar fractures are common, requiring careful evaluation of these cases.

**Outcome of jaw fracture repair in 39 cats**

Peter Southerden

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**Objective:** To report the clinical outcome and complications associated with jaw fracture repair in 39 cats presented to a private referral centre and to determine whether this is affected by patient signalment, type of fracture and method of fixation.

**Animals:** 39 client owned cats that underwent jaw fracture repair.

**Procedure:** Patient records and advanced diagnostic images were reviewed and clinical data associated with signalment, fracture type, method of fracture fixation, duration of hospitalisation and incidence of complications was collated and analysed.

**Results:** A successful outcome was achieved in 92% of cases. Complications requiring additional anaesthesia and treatment was required in 26% of cases. The average period of hospitalisation was 12 days with the minimum being one day (splint) and the maximum 49 days (MMF). Patients treated with intraoral wire and acrylic splints had the shortest average period of hospitalisation and MMF had the highest.

**Clinical significance:** Jaw fracture is a common result of trauma in cats. Repair is successful in the majority of cases though these cases often require extended periods of hospitalisation and there is a high complication rate.
Measurement of the asymmetry of the maxilla in cats suffering head trauma

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Objectives: A high proportion of cats presenting for treatment of mandibular fractures also have undiagnosed maxillary fractures. This study aims to determine the significance of these maxillary fractures by measuring the distortion and deformation of the maxilla in cats that present with head trauma and to see if there is a correlation between the level of distortion and the development of post treatment malocclusion.

Animals: 48 cats that presented with for treatment following head trauma that had advanced diagnostic imaging.

Method: Computed tomography multiplanar reconstructions were used to measure the maxillary dental arcade width and shape by making a series of measurements from a consistent and fixed position on the basihyoid bone to the alveolar bone margin at the palatal aspect of the mid point of the left and right maxillary canine teeth and the furcation of the maxillary fourth premolars.

Both the individual and average measurements were compared to values obtained in a separate study of normal cats.

Results: The average width of the maxillary arcade is increased in cats with maxillary fractures. There is a greater variance (asymmetry) in the measurements recording the shape of the maxilla in cats following head trauma which may increase the likelihood of post injury malocclusion.

Clinical significance: Many cases of head trauma present with obvious mandibular fractures and undiagnosed maxillary fractures. The maxillary fractures rarely require stabilisation. This technique provides a way of measuring maxillary asymmetry which may be useful in giving an accurate prognosis for these cases.

Anaesthesia and perioperative management of the dental patient with cardiac disease (dog and cat)

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In any patient an anaesthesia-related anamnesis and clinical examination should be performed. The goal is to notice whether there are (among other diseases) cardiopulmonary changes, to determine an accurate diagnosis and the extent of the changes. Dental patients are often geriatric and cardiac disease may be associated with age and/or the dental disease. Obviously, there are more than three cardiac diseases in dogs and cats. However, only the most common ones are discussed in this abstract.

Hypertrophic cardiomyopathy (HCM) in the cat

HCM is a primary myocardial disease characterized by concentric hypertrophy of the chambers (mainly left ventricle). HCM is different from concentric hypertrophy secondary to other causes (e.g. systemic arterial hypertension or hyperthyroidism). HCM is the most common cardiac disease in cats but rare in dogs. Left ventricular hypertrophy results mainly in diastolic dysfunction.
Breed predisposition

Maine Coon, Persian cat, Devon Rex, Sphynx, Ragdoll and American and British Short Hair cats
Do’s and don’ts for anaesthesia of cats with HCM

• No stress
• Maintain stroke volume
• Aim for normal to rather low heart rate
• Aim for normal to rather increased vascular resistance
• Do not try to increase contractility, rather try to relax the myocardium

Dilated cardiomyopathy (DCM) in the dog

Pathophysiology

DCM is a primary idiopathic myocardial failure, which is characterized by decreased myocardial contractility. The main (chronic) compensatory mechanism of the body is expansion of circulating volume via water and sodium retention mediated by the renin-angiotensin system. This results in increasing preload and volume overload hypertrophy.

Breed predisposition

Boxer, Doberman Pinscher, Cocker Spaniel, Great Dane and other large breeds.

Mitral valve insufficiency in the dog

Pathophysiology

Mitral valve insufficiency is the most common valvular disease in dogs. Incompetent valves allow regurgitation from the ventricle to the atrium during myocardial contraction, which causes a reduction of the left ventricular stroke volume. Small older dogs have higher prevalence. Mitral valve insufficiency can be a consequence of DCM.

Breed predisposition

Cavalier King Charles Spaniel, Toy poodles, Shih Tzu, Yorkshire Terrier and others.
When associated with DCM: see above

Do’s and don’ts for anaesthesia of dogs with DCM or mitral valve insufficiency

Anaesthetic management is similar for both diseases.

• Improve myocardial contractility
• Reduce arrhythmias
• Reduce oedema
• Maintain or slightly increase heart rate
• Reduce vascular resistance (= tendency towards vasodilation, avoid vasoconstriction)

General comments

Sedation

In any patient with cardiac disease the aim of preoperative sedation is stress reduction, maintenance of myocardial perfusion, and delivery of oxygen to the tissues. The choice of drugs depends in the stage of the cardiac disease, the condition and the behaviour of the patient. Handle animals with cardiac disease carefully, intramuscular sedation may be the way of choice. Whenever it is possible, provide oxygen to the patient.

Induction of anaesthesia and maintenance

Balanced anaesthesia should be used for induction and maintenance of anaesthesia. Especially in dental
patients the use of local anaesthesia techniques allows a dose reduction of maintenance anaesthetics and therefore causes a decrease of negative side effects.

**Monitoring**

A thorough monitoring is especially important in compromised animals. Focus the attention on cardiovascular parameters: clinical evaluation (perfusion parameter). ECG, pulse oxymetry and blood pressure measurement.

**Complications**

Some of the most common complications in cardiac patients are hypotension, which may cause an oxygen deficit in the tissues with an accumulation of metabolic waste products. Arrhythmias can also cause hypotension indirectly by a reduced ventricular filling due to the irregular contraction of the atria in relation to the ventricles. A consequence of anaesthesia-induced hypoventilation and cardiovascular depression is hypoxemia, which may eventually cause cell death. Due to decompensation sudden death may be a complication in a worst-case scenario. Therefore, thorough patient owners education and informed owner consent prior to anaesthesia is mandatory.

**Postoperative care**

The degree and intensity of postoperative care depends on the severity of the disease in the patients. Ideally, oxygen should be provided continuously, volume status should be checked and corrected; minimum infusion rate with crystalloid solutions should be maintenance rate with 2-4 ml/kg/h. Physiological parameters like heart rate (continuous ECG) and blood pressure should be monitored and the recovery area should be quiet and stress free.

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**Advanced periodontal procedures: What is possible to perform and what is practical**

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**Introduction**

The extent of periodontal disease you might encounter in patients can vary from patient to patient and even from tooth to tooth in the same patient. From minimal inflammation and no attachment loss in Stage 1 Periodontal Disease to the beginnings of attachment loss (up to 25%) in Stage 2, then deeper pockets (up to 50% attachment loss in Stage 3) and even compromised teeth (greater than 50% loss) in Stage 4, you must be able to tailor the treatment to the problem. Beyond the dental cleaning, being able to provide advanced periodontal management for your patients is not only good medicine, but good business. By adding simple instruments, materials and skills to your dental armamentarium, you can identify and treat those teeth that may have been extracted in the past.

**Therapy goals**

When looking at periodontal disease, therapy is determined by a number of factors, such as the stage of the disease, the involved tooth, the client’s commitment and the desired outcome. There are several goals to set, including removal of all debris or biofilm (plaque, calculus), keeping the maximum amount of attached gingiva, minimizing attachment loss and minimizing the pocket depth. Certainly, all foreign material, from bacteria to desquamated cells must be removed from the tooth surfaces and pockets in order to attain healing. Since the attached gingiva is the first line of defense against bacteria, a minimum of 2-3 mm is necessary to
protect underlying tissues, as the looser alveolar mucosa doesn’t afford that protection. The inability to halt attachment loss will eventually lead to tooth loss. Minimizing pocket depth is related to attachment loss, but is a more specific parameter, because pocket depth in itself directly affects the ability for effective home care and maintenance, and deeper pockets can harbor more virulent strains of bacteria. There are even times where excessive gingiva will be removed to decrease pocket depth (hyperplastic gingiva) or the gingiva will be sutured further down the root (apically repositioned flap) for the same effect. Attachment loss without pocket formation occurs when gingival tissue and bone is lost at the same time, exposing the roots and even furcation areas.

The ability to take intraoral radiographs is essential, in order to determine the extent and characteristics of bone loss. With recession of gingiva and bone across several roots and/or teeth, a horizontal bone loss pattern will often result in exposed roots. With a deeper osseous loss down one root surface, an infrabony pocket may result from the vertical bone loss, and specific therapy may be needed to address that specific defect. These deeper pockets are more difficult to treat and maintain, and anaerobic infections may persist.

**Attachment Loss – Treatment Decisions**

In evaluating teeth at either end of the spectrum – minimal disease with stage 1 or 2 teeth, or extensive stage 4 disease – the decision process is pretty straightforward. With stage 3 periodontal disease affected teeth – there is more of a challenge to decide whether to extract or try to save. The extent and type of attachment loss is a part of the decision process, as is the consideration of the relative importance of the tooth itself. Major teeth (canines, carnassials) will often be considered for advanced procedures, and adjacent, smaller teeth that are contributing to the infection should be considered for extraction, as their removal will allow better access to the strategic tooth. By extracting the middle tooth in the middle of three rotated, crowded premolars can often enhance the health of the remaining two teeth.

If the attachment loss results in root exposure with minimal pocket formation, professional cleaning and home care may be easier. Any involvement of the furcation puts the tooth at higher risk, due to challenges of continued care. If a pocket is present, it should be thoroughly evaluated: how deep is it? is it suprabony or infrabony?

Patient health status is also evaluated: patients with systemic disease would like benefit more from extraction with the immediate removal of the infection, and a decreased anesthetic time. Clients also are involved in the decision: advanced periodontal therapy requires excellent home care and more frequent professional visits.

**Advanced periodontal therapy**

*Moderate Pocket Depths*

With suprabony pockets (soft tissue only) of up to 5 mm in depth, evaluate not only the pocket, but the amount of attached gingiva left. If there is 7 mm of attached gingiva due to inflammation or gingival enlargement, a simple gingivectomy/plasty can immediately reduce the pocket depth to a more manageable level. A 12-fluted bur on a high-speed hand-piece is extremely helpful with minor trimming. If there is minimal gingival enlargement and only 2-3 mm of attached gingiva, then closed root planing and placement of a periocutic can provide excellent care for the defect.

*Root planing/subgingival cleaning*

This is by far the most important aspect of periodontal therapy. If the debris is not thoroughly removed from the pocket depths, the disease will remain and intensify. The rounded tip of the curette, and it’s rounded back, makes it ideal for subgingival therapy, as opposed to the sharp tip and back of a hand scaler. Certain ultrasonic scalers are modified for subgingival treatments, but most are not. If root surfaces are exposed, or if the pocket depth is less than five mm, closed root planing and subgingival curettage may be performed. Using a curette subgingivally with overlapping strokes in horizontal, vertical and oblique directions, root planning removes calculus, debris and necrotic cementum to provide a clean, smooth surface. Root planning that is too aggressive can damage the root, so take some care. The curette can also be angled slightly to engage the gingival surface for removal of diseased or microorganism-infilitrated tissues, but again, not too aggressively. When pocket depth exceeds 5 mm, or other pathology exists, more invasive procedures are warranted.
**Periocetic therapy**

In moderate pockets of up to 5 mm in depth (and generally deeper than 2 mm), once the area is debrided, placement of a local periocetic gel containing doxycycline hyclate can not only provide a direct antibacterial affect against any remaining bacteria, but the anticallogenease activity can help “rejuvenate” the soft tissue of the pocket. The combination of the cleaning and therapy can often help reduce the pocket depth in moderate situations.

Once mixed, the tip of the cannula is gently placed to the depth of the treated pocket, and the material is slowly inserted into the pocket, until a small amount extrudes from underneath the gingival edge. By using light digital pressure on top of the gum, and by gently scraping the cannula tip on the tooth surface, the cannula can be removed without taking the gel with it.

The gel firms up on its own within a minute or two, or a drop of water can be placed on the material to speed up the process. Once firm, the visible material should be gently packed into the pocket, using an instrument such as a W-3, or beaver tail instrument. The owner should be instructed not to brush for about a week in the region (gels and solutions are recommended), nor to pick at the ridge of material that may become visible (light yellow-brown). The material is biodegradable and does not need removal. Sometimes periodontal sealants can be placed after a procedure.

**Surgical Periodontal Therapy**

Many standard pieces of equipment and supplies can be used, including scalpel blades (15C works well), scissors (sharp/sharp for gingival remodeling), and sutures (usually absorbable, from 3-0 to 5-0). It is important to have other equipment as well for unique oral situations, including periodontal curettes for scaling root surfaces and periosteal elevators (Molt No. 2 or No.4) for elevating gingival flaps. For minor gingivectomy/gingivoplasty, a 12-fluted bur on a high-speed hand-piece can be helpful.

When pocket depths exceed 5 mm but remain above the level of the bone, a simple envelope flap allows access and improved visibility for open curettage and root planing. That deep of a pocket will usually lead to a consideration of extraction, unless the tooth is a strategic one (canine tooth, carnassial tooth). Exposing the area with a gingival flap (scalpel blade inserted into the sulcus, sometimes with a releasing incision, and elevation with a periosteal elevator) allows thorough evaluation and debridement. The flap can then be sutured back into place, or to a position further apical on the root, more directly over the bone, to reduce the pocket depth.

If the pocket extends down between the root and alveolar bone (infrabony defect) inadequate therapy can lead to even further attachment loss and even tooth loss. Just cleaning the area will often lead to the soft tissues (gingival epithelium, gingival connective tissue) growing back into the defect faster than the more important supportive tissues of the periodontium (alveolar bone, periodontal ligament). Placing bone graft material and barrier membranes can actually help exclude the soft tissue and allow bone to grow back into the defect (guided tissue regeneration).

If an adjacent, smaller tooth is involved in the area of attachment loss, its extraction is sometimes the best way to get access to the larger, more strategic tooth’s surfaces. The releasing incision is made away from the tooth being treated, allowing a complete attached gingival coverage of the treated site. Extraction of the middle of three crowded teeth also allows better exposure and treatment of the remaining teeth.

**Specific conditions**

**Mandibular Canines and Incisors**

The mandibular incisors are frequently affected by periodontal disease and bone loss, especially in smaller dogs. It is tempting just to wiggle out a loose tooth, and that will remove the primary source of the disease, but leaving the involved, less healthy soft tissues can continue to impact adjacent teeth, especially the mandibular canines. The bone loss between the mandibular third incisor and canine can result in a persistent deep soft tissue pocket (with some intrabony extension) once the incisor is gone. A deep soft tissue pocket may also be present around the mandibular canine if the tooth is not fully erupted, as gingiva cannot attach to the enamel that is still below the gum line. Persistent pockets here can predispose the canines to additional periodontal disease with anaerobic plaque bacteria present.

In order to minimize these pockets, the soft tissue linings often have to been excised, and the level of the gingival margin may have to be moved further apically down the tooth. A wedge excision of the tissue from the mesial margin of the canine (the surface closest to the midline of the symphysis) helps remove the excess
and granulomatous tissue, and can minimize the pocket depth if the height is reduced (if sufficient attached gingiva remains). With partially erupted teeth, the wedge incision may not be enough: the attached gingiva may have to be elevated past the muco-gingival junction to release the flap at the level of the looser alveolar mucosa. This way the flap can be repositioned further apically on the tooth and secured with sutures, revealing more of the crown and decreasing the pocket depth. In other teeth, trimming the gingiva or securing the margin further apically will actually expose more root surface, but root exposure is simpler to keep clean that a root within a pocket.

**Mandibular first molar**

Any attachment (bone) loss at the mandibular first molar deserves attention. Advancement of bone loss at this tooth is one of the most common reasons for pathological fracture of the mandible. Bone loss at the mandibular fourth premolar or second molar, particularly if vertical bone loss has started at the first molar, is sufficient reason to extract the smaller tooth to provide access to treat the first molar more effectively. For best periodontal treatment, a releasing flap is made at the furthest margin of the adjacent tooth to be extracted, with the gingiva elevated to facilitate extraction, and thus exposure of the affected root of the first molar. Any pocket lining or granulation tissue in the region should be removed, and the area scaled until healthy root and bone is exposed. If there is an intrabony pocket around the first molar, a bone graft material can be placed, as well as in the alveolus of the extracted tooth. At the very least, the disease tissue should be removed, the root cleaned thoroughly, and the gingiva sutured closed around the first molar.

**Maxillary premolars**

In smaller dogs and brachycephalic breeds, maxillary premolars can often be crowded, sometimes with significant rotation that stack them up on each other. The lack of healthy bone in between these teeth predisposes them to additional periodontal attachment loss, and it can be challenging to keep them healthy. While some propose prophylactic extraction of any rotated and crowded maxillary premolars, in most patients, regular examination and cleaning can alert the practitioner to those that may require extraction. Often, the ‘middle’ tooth in a series of three teeth can be extracted to improve the condition of the two adjacent teeth. Special attention should be paid to the maxillary third premolar, for if the distal root is crowded between the two mesial roots of the fourth premolar, the third premolar may need to be sacrificed.

As a strategic tooth, it is often worth it to provide additional effort to preserve the health of the maxillary fourth premolar. In smaller dogs, it is critical to evaluate the status of the periodontal tissues around the palatal root. It is often so small, that a 3-4 mm pocket with bone loss can completely envelope the root, compromising the entire root. In fact, an infraorbital swelling in a small dog with an intact (not fractured) fourth premolar should lead a close examination of the palatal root.

**Maxillary canines**

Periodontal bone loss at the palatal aspect of maxillary canines can lead to oronasal fistulae, once a deep pocket extends past the level of the palatal bone. Once formed, the fistula is nearly impossible to correct, so extraction is necessary. Chronic fistulation can be challenging to close, as every breath puts tension on the sutured flap. Prevention of fistulation is critical, so careful evaluation of the palatal (and mesiopalatal aspect) of the maxillary canine is important. If a moderate pocket is formed, closed root planning and a periodontal flap may help stop the progression. If an intrabony pocket has formed, there may an opportunity to provide advanced periodontal treatment for guided tissue regeneration to build back the lost bone before the fistula is formed.
Current concepts of periodontal disease

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This lecture covers the most up to date information on the pathogenesis, progression, and severe local and systemic effects of periodontal disease. Following this we will discuss proper treatment of this condition. Including how to perform a thorough dental prophylaxis. Topics included: supra and subgingival cleaning, polishing, recognition of dental pathology, periodontal probing, and dental charting. This will culminate with a discussion of homecare options.

Fractured teeth in need of periodontal surgery prior to prosthodontic therapy

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Tooth fractures are classified based on the fracture location (crown, crown-root, or root) and whether the pulp is exposed (uncomplicated or complicated). Crown lengthening by means of apically positioned flaps is needed for crown and crown-root fractures of canine teeth that have little clinical crown available for placement of prosthodontic crowns. The periodontal surgery should be performed prior to endodontic therapy, though the pulp can already be removed, the root canal filled with calcium hydroxide paste, and the fracture/access site to the tooth restored with a temporary restoration. Root canal therapy is completed and the crown prepared for prosthodontic therapy about two weeks following periodontal surgery.

Apically positioned flaps are periodontal flaps with releasing incisions and accompanied by alveolec-tomy and alveoloplasty, thus exposing more of the tooth surface and allowing the flap to move apically. The surgical technique usually includes creation of mucoperiosteal flaps with one or more releasing incision(s), extraction of adjacent teeth if indicated, removal of tooth-supporting alveolar bone (alveolec-tomy) followed by recontouring of the alveolar margin (alveoloplasty), debridement of granulation tissue, restoration if indicated, root planing, polishing of the tooth surface, rinsing with lactated Ringer’s solution, and apical positioning and suturing of the flap(s). The use of envelope flaps and a gingival collar expansion technique have also been described.

The so-called “summer dress technique” (as per the author) involves creation of a labial flap and a palatal/lingual flap. When performed for the mandibular canine tooth, the third incisor tooth is extracted. When performed for the maxillary canine tooth, the first premolar tooth may need to be extracted if it is too close to the canine tooth. Both flaps have two diverging releasing incisions, but the palatal/lingual flap has extensions (“fingers”) made from interproximal gingiva that encompass the tooth towards the line angles on its labial side. Bone is reduced until the end of the fracture has been found and/or there is sufficient clinical crown height. This is accomplished with carbide round and diamond round burs and an assortment of hand instruments. The root surface is planed and polished with fine pumice. The flaps are debrided and slightly thinned at their connective tissue side. Then a small, half-moon-shaped piece of tissue is removed on the edge of the palatal/lingual flap. This is done to conform it to the wider circumference at the cervical portion of the root of the tooth. The fingers (distal first, mesial second) of the palatal/lingual flap are sutured to periosteum at the base of the labial flap, thus avoiding unwanted coronal pulling on that flap. Then the labial flap is sutured...
closed so that no bone is left exposed. The goal is to reach a clinical crown height of at least 7 mm labially and 5 mm palatally/lingually for future prosthodontic therapy.

**Prosthodontics – Beyond the crown prep**

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**Crown placement and cementation**

When the crown is returned from the dental lab it should be closely examined to insure it has been accurately cast. The clinician should always try in the restoration before cementation, and the restoration should be verified to fit contour and occlusion. An explorer is used to evaluate marginal integrity of the crown, and insure that the margins are closed and the crown is properly seated. Minor adjustment to the crown can be made. A spray articulation marking material can be used on the inside of the crown to indicate areas for minor adjustments. However, if the crown does not seat properly, or the shape and contour are incorrect, the preparation should be corrected and a new impression taken.

**Cementation using a resin based cement**

The procedure presented may be unique to a particular resin based cement 1 however, the basic steps will be similar for most resin-based adhesive cements. Manufacturer’s directions should be followed for each individual adhesive cement.

1. **Restoration inspection**

When the restoration is returned from the laboratory, it should be inspected for open or inadequate margins, bubbles, or debris located on the internal surface. The clinician should insure that the internal surface of the restoration has been etched or sandblasted.

**Troubleshooting**

- Debris or bubbles on the internal surface can be removed using a fine diamond bur as necessary to get the restoration to seat properly. If the restoration cannot be modified in a way that facilitates a proper fit, then the impressions should be inspected to determine whether they should be retaken.
- If the internal surface is not etched/sandblasted, then it should be sent back to the laboratory for internal etching. The clinician may need to request that the laboratory sandblast the crown with aluminum oxide with submission of impressions.

Fortunately, with the use of a reputable laboratory with experience in fabrication of crowns for dogs, restoration defects occur infrequently.

2. **Cleaning the prepared tooth**

The prepared tooth should be cleaned of all calculus and plaque prior to beginning cementation. The tooth should be polished with a non-fluorinated pumice paste (see Fig. 1). Standard fluoride prophylaxis pastes should not be used for several reasons. The fluoride mineral may partially occlude dentinal tubules, reducing bonding ability, or reduce the effect of acid-etching products on the prepared tooth surface. Additionally, most prophylaxis pastes use oils or waxes as binding agents that may also insulate the tooth against chemical bonds as well as physically occlude dentinal tubules, preventing bonding agents from entering.

3. **Trial fitting**

The crown restoration should be placed on the clean, prepared tooth of the anesthetized patient prior to cementation to check for a proper fit and seat. The restoration should fit on the tooth smoothly, resting firmly
on the margin finish line and without catching midway along the crown. It must not rock or move when in place. Using a Shepard’s hook or similar explorer will help to verify marginal integrity of the crown and ensure proper seating of the crown to the tooth at the margin. Minor imperfections or rough areas may be carefully smoothed using a fine diamond bur or silicone polishing point to provide for a proper seat. The clinician must ensure that occlusal interference with the opposing tooth does not occur. For example, an improperly cast restoration on the maxillary 4th premolar can cause occlusal interference between the palatal surface of the maxillary fourth premolar and the buccal surface of the mandibular first molar. Another area of potential occlusal contact is the mesial surface of the maxillary canine and the distal surface of the mandibular canine.

Troubleshooting

If the restoration does not rest firmly on the crown preparation margin of the tooth and the restoration should be inspected, and any debris should be removed to create an adequate seat. Imperfections or “catches” can be smoothed using a fine diamond bur. Use of an articulation marking spray will identify any minor contact points on the tooth preparation. Any minor contact points on the tooth can be adjusted to allow for proper fit. If the restoration cannot be easily adjusted to fit without rocking or seating properly, then new impressions should be made and submitted to the laboratory for fabrication of a new crown.

4. Application of the metal primer

A metal primer is a pretreatment agent used for conditioning metal and is used to insure the adhesive capability of resins and acrylic ester to gold, titanium, and other dental alloys. The primer enhances the cements chemical-bond strength to the metal surface. A thin coating of primer is applied to cleaned interior metal surface of the restoration with a disposable brush and allowed it to react for five seconds. The entire restoration surface is then dried sufficiently using a water-free airflow.

Troubleshooting

If the treated surface becomes contaminated with saliva or tissue exudates after the metal primer is applied, clean the restoration surface with a cotton pellet moistened with ethanol, dry, and apply the product again.

5. Application of an acid etchant

When cementing to enamel, a 40% phosphoric acid should be applied to the enamel surface for 10 seconds. The surface should then be rinsed thoroughly with water and dried. Dentin does need not be acid etched. Evidence exists that acid aggressively etching dentin may actually decrease the bond strength and durability of the bond.

Considering that the average thickness of enamel in cats is 0.1 to 0.3 mm and 0.1 to 0.6 mm in dogs, it is unlikely, after removing 0.5 mm to 1.0 mm of tooth structure for preparation, that full metal crown restorations would be in contact with anything other than dentin. The exception is that enamel may remain at the margin (chamfer) and possibly other small areas. It is worth noting that margins ending in enamel produce improved long-term bond strength with less nanoleakage compared to margins ending on dentin or cementum. When bonding to enamel and dentin, it has been suggested that selective etching of the remaining enamel and use of a two-step self-etching adhesive may produce the most effective and durable bond.

6. Application of primer to the tooth

The primer should be brought to room temperature before application. After removal from the refrigerator, the product must be left standing for 15 minutes or until it comes to room temperature; otherwise, bubbles will form in the liquid when dispensing and it may ooze after use. Mix equal amounts of the primer liquids labeled A & B. The mixture must be used within five minutes of mixing. It is noteworthy to point out that the manufacturer’s directions state to apply the mixed primer solution to the tooth surface and leave for 30 seconds. The author has had clinical success using a disposable brush tip and rubbing it onto the prepared tooth surface for up to 60 seconds.

After application, any excess primer is removed with a cotton pellet and then dried gently using water-free, oil-free airflow. Before drying, test the air syringe by blowing against one wrist to ensure no water will be expelled onto the prepared tooth surface. Do not rinse. If the treated surface of the tooth is contaminated with saliva or tissue exudates, it must be washed with water and dried, or cleaned with ethanol. When the tooth has been re-prepared, it must be treated with the primer again; otherwise, optimal adhesion will be impaired.
Upon contact with the cement, the mixed primer initiates setting of the cement. The cement becomes independent of light with primer use, thus for self-curing, the primer is essential for proper polymerization for the cement. Without use of the primer, the polymerization reaction has been shown to start only after approximately 500 seconds with a final degree of conversion of 50%, whereas a continuous increase in conversion was observed with use of the primer with a final degree of conversion of 74%. The principal ingredients of Liquid A are 2-Hydroxyethyl methacrylate (HEMA), 10-Methacryloyloxydecyl dihydrogen phosphate (MDP), water, N-Methacryloyl-5-aminosalicylic acid (5-NMSA) and accelerators. The MDP acts as a self-etchant. The principal ingredients of Liquid B are N-Methacryloyl-5-aminosalicylic acid (5-NMSA), water, catalysts, and accelerators.

7. Cement (paste) mixing and application

The paste should be brought to room temperature for 15 minutes or more after it is removed from the refrigerator. This will restore the normal viscosity of the paste and helps to prevent water contamination from possible refrigerator moisture. The paste contains a light-cure catalyst that is highly photo-reactive. Using a light-blocking cover over the mixing plate will help avoid exposing the material to an operating light or natural light (sunlight from windows). During this cementation step, the dental operating light should be adjusted away from the area or simply turned it off to reduce the intensity of light entering the oral cavity and prevent premature polymerization of the cement paste. Headlamps should also be turned off or a UV filter should be used over the lamp.

After the primer has been applied to the tooth and air-dried, equal and sufficient amounts of Pastes A and B are dispensed on to a mixing pad (see Fig. 2). Depending on the size of the crown, the author has found that it usually takes two to four rotations of each plunger to provide a sufficient amount of paste to cement a restoration. (Note: that the working time is 15 minutes after the paste is dispensed but not mixed.)

When ready, mix the pastes for 20 seconds. Unmixed paste will not set up on the pad but the clinician must be careful there is no water mist on the paper pad or spatula before using them as the presence of water could shorten the working time of the mixed paste. The mixed paste is then applied to the inside of the crown restoration and placed it onto the prepared tooth (see Fig. 3).

Once the cement paste is applied inside the restoration the restoration is placed firmly onto the tooth and pressed and rocked to achieve a proper seat. (see Fig. 4) Once the crown is seated in position additional rocking is not needed. The paste will begin to cure on contact with the primer applied to the tooth in step six. The working time after pressing the crown restoration onto the prepared tooth is 60 seconds.

While firmly holding the restoration in place a gauze square or a disposable brush tip is used to clean any excess paste from the margin. Once the paste that has hardened any small remaining amounts of cement can still be easily removed. A blue LED or halogen light curing light is used to cure the margin for 20 seconds. Alternatively, a plasma arc or fast halogen light can cure the cement in five seconds (see Fig. 5).

8. Application of the oxygen blocking gel

An oxygen blocking gel used to insure proper curing of the cement beneath metal crowns. The anaerobic curing properties of the cement do not begin until direct contact has been made between the cement coated restoration and the primed tooth and contact with oxygen ceases. The gel acts as oxygen barrier that helps the paste to polymerize completely when not light cured. The gel is applied around the restoration margins to insure the self-curing process of the areas not polymerized during light curing. (see Fig. 6) Wait for at least three minutes before removing the gel by rinsing and rubbing with a clean gauze square.

9. Clean remaining cement from the margin

An increase in marginal plaque accumulation has been shown to occur in crowns with marginal defects and when excess cement is not removed. The following is the suggested sequence of instruments for removal of excess set cement at the periphery of resin-bonded metal restorations: hand scalers or curettes, fine and very fine high-speed diamond burs, rubber points, polishing cup, and prophy paste. Alternatively, a silicone grease lubricated stone on a low-speed hand piece can be held at a 45 degree to the margin followed with polishing. The goal is to produce an imperceptible margin that cannot be detected by moving a sharp explorer across the crown-tooth interface.

Due to space constraints references, have been omitted. A complete list of references may be obtained by
request from the author.

**Suggested reading**

Product Information Insert PANAVIA™ F 2.0, Kuraray America, Inc., 33 Maiden Lane, New York, NY.

**Fig.1** – Polishing the prepared tooth with non-fluorinated pumice.

**Fig.2** – Unmixed Cement Paste Parts A and B.

**Fig.3** – Applying mixed cement to the restoration.

**Fig.4** – After initial placement of the crown.

**Fig.5** – Light curing.

**Fig.6** – Applying oxygen blocking gel.
The dangers lurking within your dental units

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Biofilms in themselves are a fascinating subject. They are almost ubiquitous, from the lining of long term IV catheters, to the innards of trans-continental oil pipelines. As we are aware from our knowledge of plaque, biofilms are difficult to effectively tackle. Possibly, partly because of this, the presence of biofilms within our dental equipment has been largely ignored. However, if the water from your high speed unit has potentially a higher bacterial content than the water in your toilet – shouldn’t you be taking action?

It is accepted that the use of sterile fluids through handpieces is the gold standard. However, there are very few practices that always achieve this aim.

With the generation of aerosols from your dental handpieces, potentially containing bacteria such as Legionnella, the risks are real to both your patients and to your team. Most countries have a duty of care to workers – are you fulfilling your statutory responsibilities at present?

The author’s practice has been studying the effectiveness of some regimes to try and limit the presence of bacteria within the pipelines over several years. There is no one answer, but this presentation hopes to provide some potential solutions.
Ectopic intranasal tooth revealed in an old dog

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Introduction

An ectopic tooth is an abnormal location or position of a tooth occurring congenitally or as the result of injury. The presence of an ectopic tooth in the nasal cavity is quite rare, and the exact aetiology remains unclear. However, it is important to identify these teeth, which can be supernumerary, deciduous or permanent, in order to avoid possible complications which include respiratory problems, nasal functions disorders, pain and infection.

Two different groups of causes have been proposed in a human study regarding intranasal teeth. The first being a problem in the tooth germ's development and the second in the tooth germ's migration. Other causes include genetic factors and developmental disturbances such as cleft lip and palate, displacement due to trauma, local infection, cystic lesions, crowding of the dentition, retained primary teeth or other mechanical barriers leading to tooth displacement. Radiographic examination of the patient and reading the entire radiograph is essential, otherwise ectopic teeth can be missed.

The specimen was an old dog with unknown age, breed, sex and clinical history, presented at the European School of Advanced Veterinary Studies (ESAVS) Dentistry course at The University of Luxembourg. The dog was euthanized according to welfare regulations in Switzerland. A complete oral examination was performed followed by full-mouth, digital indirect dental radiographs were obtained with bisecting angle and parallel techniques. Clinical assessment of the right maxilla found periodontal pockets in 103, 104, 105, 106, 108, 109, furcation involvement in 106, 108, 109, and missing 107. Radiographic evaluation performed with the use of indirect system Duerr Dental plates size 5 and 2 confirmed alveolar bone loss in periodontally affected teeth and two root remnants present at the area of missing 107. Dorsally from root remnants there was present radiopaque object which was the area of interest.

Based on radiography the location of the object was estimated to the ventral lateral part of the right nasal cavity at the level of the right maxillary third premolar (107). To remove the object, a palatal approach was proposed and performed. An access flap was made from lateral side to utilise existing incision after excetration and attention was paid not to injure palatal artery which was gently prepared and retracted from the access side. A fissure bur was used to make a square shaped fenestration above the object. The shape of the fenestration is highlighted with the grey arrowheads in appropriate figures.

The structure was attached to the ventral aspect of the palatal bone therefore to completely remove it from the nose a partial excision of palatal bone was necessary. After procedure a radiographic control was performed to make sure that entire radiopaque structure was removed.

The presence of the tooth in the nasal cavity could be caused by intrusion of this tooth into the nose by trauma or its ectopic eruption. Presence of the root remnants at the area of 107 suggest that these remnants could be part of the tooth. The ectopic tooth might also be supernumerary, and its abnormal eruption could be associated with trauma causing fracture of 107.

There is one case report from 1980-1990 of a young female Siberian Husky with a Ameloblastoma associated with an ectopic tooth in the right anterior maxilla at the level of the canine tooth. The specimen in the case of this report had an abnormal appearance of the alveolar bone, and overlying gingiva in the area of 107. However, no histopathology was performed, and it is not possible to determine if the changes could be attributed to certain pathology.

Nasal foreign bodies have been identified as the underlying cause in 1.3% to 8% of cases of nasal disease. The most common clinical signs in dogs with nasal foreign bodies are epistaxis, sneezing and snoring, with or without persistent unilateral nasal discharge. In human literature, there is also reports of the sensation of a foreign body in the nose, unilateral nasal obstruction, nasal or facial pain, headache, and epiphora. Diagnosis may easily be missed due to lack of clinical symptoms and obscure clinical presentation. Patients may be asymptomatic or present with variable symptoms, but could also be diagnosed on clinical or routine
radiographic examination\(^2\).

The literature reports presence of teeth in the canine nasal cavity associated with iatrogenic intraoperative complications leading to intrusion of the fractured root or other part of the tooth into nasal cavity. This complication used to be caused by applying excessive forces to extract periodontally compromised teeth or trauma\(^6,8,10\). In human literature there are many more reports about displaced and ectopic teeth diagnosed and removed from the nasal cavity, perhaps due to the ability to communicate pain and discomfort in comparison to dogs. Approximately 78 cases of intranasal teeth have been reported in the literature according to a study by Chen and Lee in 2005\(^8\).

Ectopic teeth have been reported to erupt into the maxillary sinus, areas of mandibular condyle, coronoid process, orbit, palate, chin and skin, and have also been found in the ovaries, testes, anterior mediastinum, retroperitoneal area, and the pre-sacral and coccygeal regions. However, teeth erupting into the nasal cavity are rare. Clinically intranasal teeth in humans patients occur most commonly on the floor of the nose\(^8\), which was also the case of described patient.

To the authors knowledge there are no reports on intranasal ectopic teeth in dogs which very likely was asymptomatic and chronic case.

In human patients some of these teeth were supernumerary with an atypical shape of the structure\(^11,12\). The object shape and appearance in the present study was typical for a two rooted premolar.

In humans, the recommended treatment is early removal of the intranasal teeth even if the patient is asymptomatic, or close follow up with radiography. This is to prevent complications and due to a high risk of morbidity, including rhinosinusitis, osteomyelitis, nasolacrimal duct obstruction, abscess or perforation, oronasal fistula, aspergillosis, and nasal deformity\(^8\).

Ectopic teeth may occur in the nasal cavity of the dog. Surgical access for removal of ectopic teeth is necessary when the teeth are fused with the surrounding bone. The described ectopic tooth did not cause visible pathologic consequences, still this could have affected the life comfort and functionality of the patient.

**References**

A longitudinal assessment of periodontal disease in Yorkshire Terriers

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Periodontal disease is the most common oral disease of dogs and the incidence and severity increases with age1-5. The disease is progressive involving two stages: gingivitis where the gingiva becomes inflamed and periodontitis where inflammation of the non-gingival periodontal tissues results in destruction of the periodontal ligament and alveolar bone, and ultimately leads to tooth loss6. Gingivitis is reversible whereas periodontitis is irreversible but often controllable7. Primarily, periodontal disease is initiated by plaque accumulation on the surfaces of the teeth but behavioural, environmental, systemic and genetic factors may also contribute to a dog’s susceptibility and the clinical expression of disease8. Several studies have shown that smaller breeds of dog are particularly prone to developing periodontitis compared to larger breeds2,4,9.

The purpose of the present study was to determine the extent of gingivitis and periodontitis in a population of Yorkshire terrier dogs housed at the WALTHAM Centre for Pet Nutrition. The extent of periodontal disease for every tooth in the mouth was assessed under general anaesthesia two to five times between the ages of 37 and 78 weeks. A gingivitis score between 0 and 4 was recorded for the mesial, mid-buccal, distal and palatal/lingual aspects of every tooth using a modified combination of the gingival index (GI) and sulcus bleeding index10. Clinical attachment was determined by recording probing depths, gingival recession and furcation exposure. Periodontitis stage 1 was classified as being up to 25% attachment loss and periodontitis stage 2 as between 25% and 50% attachment loss10. The study was approved by the WALTHAM Animal Welfare and Ethical Review Body and run under licensed authority in accordance with the UK Animals (Scientific Procedures) Act 1986.

From the 49 dogs assessed at 37 weeks of age, 98% had periodontitis and the average percentage of teeth in the mouth with periodontitis was 29.6% with 95% confidence interval (23.6%, 36.4%). The average percentage of teeth in the mouth with periodontitis was 2.74 (2.23, 3.37) times higher at 78 weeks of age compared to 37 weeks of age. The canine teeth had a significantly higher probability of periodontitis compared to all other tooth types at both 37 and 78 weeks of age (p<0.001). In addition, the incisors had a significantly higher probability of periodontitis compared to the molars and premolars (p<0.001).

Breeds of dog that are susceptible to developing periodontitis, such as Yorkshire terriers, require effective treatments for the prevention of periodontal disease from a young age. Although tooth brushing is still the most effective method when it comes to preventative homecare this is not always realistic, due to behaviour reasons, and therefore alternative ways to retard or prevent plaque accumulation that are practical for both dogs and their owners are required.

References
Our experience in canine prosthetics with dogs using CoCr one-piece pinlays

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Introduction

Quite often, when conducting the examination of an animal, a fracture of the tooth crown could be registered. In case it is a domestic pet, as a rule, the owners are planning only to perform the endodontic treatment; and rarely an owner is found who may be interested in dental prosthetics.

But when guard, gun or sports dogs appear at the examination, and they use teeth in the course of the daily activities, a dog could be written off in cases of teeth damage. It is clear that this creates a big problem for the owner, since a lot of time and money was spent on training the animal.

Etiology

It is often required to restore the crown part of the tooth; as a rule, this problem is rather acute in regard to guard, gun and sports dogs, i.e. to animals that need to use their teeth in everyday life. It often happens with the dogs of the above mentioned groups that their teeth are injured when capturing an opponent, victim, sleeve, stick, etc., since before the capture they make a rapid advance movement (lunge or jump) pulling the foreface; and at this moment the blow in the area of the cutting teeth and canines primarily of the upper jaw occurs. As a result, the fracture of the crown of the tooth (teeth) is registered. The graph below demonstrates that the majority of such injuries is observed with the 2 and 3 years old animals, i.e. with the animals staying at the peak of activity and strength.

![Graph showing the number of species age distribution](image_url)
Pathogenesis

When the tooth crown is mechanically damaged, the pulp exposure occurs and it appears to be a bleeding fibrotic fold of red color. Over time and in the course of the pulp infection, it acquires gray, brown, gray-yellow or black color. The dentin directly bordering the pulp obtains the same color. As a result, the gate of infection is created, which could result in inflammatory processes within the surrounding and underlying tissues around the injured tooth².

Diagnostics

Clinical indications. Decrease in feed palatability or rejection of feed is observed, large loss of feed occurs during feeding, the animal can quickly approach the bowl and abruptly move away from it, at this moment signs of aggression could be registered, as well as scratching the foreface, salivation, soreness when eating cold or hot food. Besides, the animal does not permit to examine the oral cavity. When examining the oral cavity, damage to the tooth crown (fracture), change in the color of the crown of the injured tooth (pink, magenta, gray or brown) could be visualized. The owner may observe the non-effective capture of a sleeve, stick and opponent during training, sometimes they stress that the dog takes a stick by turning the head to the right or left side (protecting the damaged side)²,7.

Radiography is recommended to identify the latent pathologies, clarify the intended endodontic and further orthopedic treatment (dental prosthetics). We must make sure that the root of the tooth and the underlying tissues are not destroyed due to a mechanical or inflammatory process, which makes treatment and dental prosthetics out of the question³,4.

Endodontic treatment

Radiography, as was already mentioned above, is recommended for the purpose of identifying damage to the root of the tooth and inflammatory processes in the underlying tissues.

General, conduction and local anesthesia. The general anesthesia combined with local (conduction, infiltration and intrapulpator) anesthesia should be used; this depends upon the specific pathology of the tooth, state of the animal and the individual sensitivity of the animal's organism to anesthetic drugs with the aim of reducing the use of general anesthetics. For local anesthesia, Lidocaine 2%, Ultracaine, Articaine, Alfacaine, Marcaine, Septonest, Ubistesin and others could be used⁴,6.

Tooth preparation. Before starting the preparation, an examination or instrumental examination should be carried out in order to reveal the depth of mechanical damage, as well as the tooth crown cracks. Atraumatic preparation of the tooth crown is carried out. During the preparation, the affected enamel and dentin are maximally removed. A bed in the crown part of the tooth for a future filling and an one-piece pinlay should be created¹,3,5,7.

The preparation is carried out in two stages and includes the endodontic treatment and the subsequent final preparation.

Tooth depulpation. During the depulpation, the tooth pulp is removed using the pulp extractor, it is important not to break the pulp, but to try to pull it out from the pulp chamber of the tooth completely. The pulp should be removed entirely without leaving even small parts in the pulp chamber, as this could lead to poor tooth filling, infection and inflammation around the apex of a tooth. As a result, the tooth could require to be treated repeatedly and possibly extracted. After the pulp extraction, it is important to stop bleeding; this problem is especially acute with younger animals, since a younger animal possesses the pulp chamber much larger compared to the adult and older animals. Besides, the difficulty in stopping the bleeding depends on the shape, size, function and location of a tooth in the dental arcade (tooth designation). In regard to such strong and large teeth as canines, it would be more difficult to stop bleeding after removing the pulp. It is then recommended to process the root canals using H-files and K-files of the appropriate size. The root canal of a tooth should be expanded using the K-files and H-files. This mechanical treatment is required to better clean the root canal from the pulp residues, as well as to ensure a slight expansion, which facilitates tooth filling².

After extending the root canal, it shall be washed with a solution of sodium hypochlorite.

Tooth filling with the use of gutta-percha points. Before filling the root canal, it is recommended to select a filling material that will correspond to the prevailing conditions characteristic for this particular clinical case (AH plus, gutta flow, etc.). Then choose the channel-filler of the appropriate size and length, reduce the speed of the micro motor in order to prevent the loss of the filling material and start filling the root of the tooth. In
order to ensure the root canal filling, employ the gutta-percha points, which are especially efficient if the root canal is wide.

The gutta-percha points possess the following qualities:

- easy to enter into the canal;
- filling the canal both in the lateral and vertical directions;
- not subjected to shrinkage;
- radiopaque;
- insoluble;
- bacteriostatic or do not create environment for the pathogenic microorganisms growth;
- sterile or retain all qualities and properties after sterilization;
- do not paint the hard tooth tissues;
- do not cause irritation of the periapical region tissues;
- if necessary, could be easily extracted from the root canal.

After that, cover the root part with the silicophosphate cement (Unifas, Silidont-2, Beladont, etc.) or with the photo polymerizing material, which will serve as a gasket between the partially filled root of the tooth and the pinlay.

**Final preparation of the tooth crown.** Further on, the tooth crown final preparation is carried out; at this stage the corners are smoothed out, the hole for the pinlay is prepared in the shape of an oval to avoid scrolling, and the bed is made as deep as possible. The deeper the bed is, the longer will be the pin part of the pinlay, which also contributes to the more reliable fixation. Then, the crown of the tooth is prepared for the CoCr one-piece pinlay crown. For this purpose, a ledge is made on the crown of the tooth using the 0.14-0.16 (medium-grit) burs and receding 1-2 mm from the gingiva and 0.5-1 mm in depth. Taken as a whole, the executed above mentioned measures contribute to the proper fixation of the CoCr one-piece pinlay; respectively, we could count on its long-term service1,3,5,7.

**Formation of the ashless acrylic post-and-core model**

For this particular purpose, the ashless Dura Lay or Pattern Resin LS acrylic could be used. These substances appear to be the acrylic of chemical hardening. When mixing the powder with activator, we obtain a liquid mass that eventually solidifies. Until it solidifies, it is necessary to pump it onto the crown part and partially into the prepared bed of the tooth root. As a result, a pin is formed in the root part, and on the outside a stump will appear, which is treated with a milling cutter giving it an anatomically proper crown form characteristic for the prosthetic tooth. The crown part of the ashless acrylic post-and-core should not be longer than the pin (root part), the ratio 2/3 is acceptable; otherwise the tooth prosthetics is doomed to failure. Afterwards, the crown part of the tooth is closed with a temporary filling in order to prevent the ingestion of particles of food, sand, etc. into the tooth. A number of tests are required to be performed to check the jaws closing; the absence of excessive contact points when closing should be monitored. Besides, it is required to check if the extraction is easy, and the fixation is stable1,5.

After that, the provisional ashless acrylic model of the on-piece pinlay is transferred to the dental technical laboratory, where the CoCr model is manufactured. This alloy (CoCr) is pre-specified in the order list for the pinlay manufacture, as it possesses sufficient strength and low value.

Be sure to warn the owner, that before fixing the pinlay it is required to avoid playing games with stiff objects, since the prepared tooth crown could be damaged or significantly worn out, which could lead to unstable fixation. In such a case, the CoCr one-piece pinlay should be reworked.

**CoCr one-piece pinlay fixation**

After receiving the pinlay from the laboratory, it should be fixed. The temporary filling is removed, the bed is degreased for the pinlay using the Hydrol or Orthophosphoric acid, the glass ionomer fixing cement (Fuji I, Aqua Cem, M3, etc.) is mixed, and the root part of the pinlay and the tooth bed are lubricated. After that the pinlay is being fixed, and the excessive cement is removed1,5.

Pinlay crown part grinding and polishing. The final stage is grinding the stump and the transition border between the pinlay and the tooth tissue, as well as its polishing. It is necessary to remove the remnants of hardened filling material; besides, sharp edges are grinded, which could injure the mucous membrane of the
tongue, lips and cheeks. After that, polishing is carried out, which produces not only a good aesthetic effect, but also prevents fixation of the soft dental plaque on the given tooth, which could further lead to formation of the dental calculus, pinlay tightness failure, its loss and inflammatory process.

Final radiography. When the treatment is completed, it is recommended to take an x-ray examination to ensure that the root canal of the tooth was properly filled and that the CoCr one-piece pinlay was fixed.

If necessary, antibiotic therapy and gingiva treatment could be carried out.

**Follow-up observation**

In two months period it is recommended to perform the repeated x-ray examination. The x-ray film would be most informative in such cases. It is also worth examining the oral cavity, the tooth that was treated, and paying attention to the adherence of the pinlay, presence of dental plaque, degree of the tooth mobility, presence of the gingiva inflammatory processes in areas adjacent to the tooth.

As a rule, the forecast is generally favorable; the animal could use the prosthetic tooth throughout its life.

**References**

Anesthetic effect of *Echinacea angustifolia* seed extract in gums surgery in rat

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Pain control is an important element for smooth treatment in common dental procedures. Thus, local anesthesia is commonly used in dental practice and infiltration anesthesia is most frequently employed among topical, infiltration, and conduction methods. The majority of currently used anesthetic agents are derived from or associated with natural products, especially plants, as evidenced by cocaine that was isolated from coca (*Erythroxylum coca*, Erythroxylaceae) and became a prototype of modern local anesthetics and by thymol and eugenol contained in thyme (*Thymus vulgaris*, Lamiaceae) and clove (*Syzygium aromaticum*, Myrtaceae), respectively; both of which are structurally and mechanistically similar to intravenous phenolic anesthetics. Echinacea is the most popular herbal remedy currently being used in the USA and UK. It is believed to improve the immune system through modulation of cytokine signalling and is used for the prevention and treatment of viral, bacterial, and fungal infections.

Pharmacokinetic data on echinacea are lacking and there are no available recommendations regarding their use in the perioperative period. There is no literature on anesthetic effect of Echinacea seed in oral cavity.

Fourteen male Wistar rats (10 weeks at age, body weight 273-308 g) were used for this experiment. After the induction of ether general anesthesia, the rat’s limbs were fixed with pins. The left mandibular first molars of rats were anesthetized by the local infiltration of 30 μl of 10% Echinacea extract; right mandibular first molars were injected normal saline. The site of injection was 2 mm from the gingival margin above the distal root apex of the first molar on the lingual side over the distal root apex of the first molar of both right and left mandibles. After recovery, pain test was done on both right (control) and left (test) sides, and compare visually. Results showed that Echinacea seed extract is able to anesthetize gum and dental roots. This review will give suggestion for novel anesthetic agent of plant origin usable in dental anesthesia in human and animals.

Dental home care in Swedish dogs

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Periodontal disease is the most common disease in dogs and it can be prevented by daily tooth brushing. However, studies are lacking on how dental health and dental home care in dogs are perceived and performed by dog owners and veterinary health practitioners. The aims of the study were to investigate the attitudes and practices concerning dental care in dogs, with the specific aim to evaluate how and if dog owners receive information concerning dental home care and if this information results in implementation of prophylactics. In order to establish validated methods for increasing dog owner compliance to prophylactic oral health regimes, it is first necessary to map how dog owners today receive and implement information about dental home care. Two target-group specific questionnaires were developed and validated according to general survey methodology guidelines (EVDF-17). During April 2017, the questionnaire surveys were distributed nationwide among Swedish dog owners, veterinarians and veterinary nurses. In total, 66434 dog owners (response rate
32%), 1161 veterinarians (32%) and 624 veterinary nurses (38%) responded. Preliminary findings show a discrepancy between dog owners and veterinarians perception of the degree of dental problems, as well as on the information given on prophylactic home care. The results of the study contribute important basic knowledge on the attitudes and practices concerning dental care, with focus on dental home care, in dogs.

A case of dentin dysplasia and diffuse pulpal calcifications in a Czechoslovakian wolfdog – Case Report

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Dentin dysplasia (DD) represents a group of rare inherited dentin disorders characterized by alteration of dentin structure. In humans, DD is classified into type I, II and III based on histological, radiographic and clinical features. It can cause pain and tooth loss. In human patients DD is one of the most common inherited dental disorders, while only a few reports have been described in veterinary medicine. Objective is to describe a case of DD and pulp calcifications in a dog. A 3 years old, male, Czechoslovakian wolfdog was presented for a recurrent right mandibular swelling. Generalized, dark brown dental discoloration was present. Teeth surface was irregular, with large enamel defects. Severe abrasion affected entire dentition. Intraoral radiographic exam showed a dentition with thin dentinal walls, increased radiopacity of pulp cavity and periapical radiolucencies at every root. DD, dentinogenesis imperfecta, regional odontodysplasia and enamel abnormalities were considered in differential diagnosis. The right mandibular swelling was considered to be secondary to endodontic disease. However, endodontic disease was generalized. A staged full mouth dental extraction was performed. Histological diagnosis was of DD with degeneration of enamel, pulp necrosis and suppurative pulpitis. Obliteration of pulp chamber by tertiary dentin was also found. Features resembled those described in some human DD type I cases. At follow-up an improvement in social activities were reported.

Dysphagia secondary to focal inflammatory myopathy and consequent dorsiflexion of the tongue in a dog

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Introduction

Canine myopathies can be broadly classified as non-inflammatory or inflammatory. Non-inflammatory myopathies include muscular dystrophies, endocrine and metabolic myopathies, congenital myopathies and congenital myasthenic syndromes. Inflammatory myopathies (IM) are a heterogeneous group of disorders and are classified as infectious, immune-mediated or paraneoplastic.

This report describes a unique case of dysphagia in a 14-month-old Pitbull terrier mix secondary to a focal IM with clinical signs restricted to the tongue. Inflammatory myopathy with severe tongue atrophy has been described in Corgi dogs; however, all affected dogs had a generalized IM with involvement of the tongue. This is the first report of a focal IM involving only the intrinsic lingual muscles in a non-Corgi breed,
and highlights the value of determining CK activity and obtaining biopsies of the tongue when warranted.

Case history

A 14-month-old intact female Pitbull terrier mix was presented for dysphagia and intermittent dorsiflexion of the apex of the tongue of 8-months duration. The owner had acquired the dog at 8 weeks of age from a breeder and did not appreciate an abnormally shaped tongue at the time of acquisition. Approximately 8-months prior to presentation, the owner witnessed the dog gnawing at a marrowbone and the dog was noted to abruptly stop chewing, as if in pain. An oral examination by the referring veterinarian revealed no abnormalities. Shortly thereafter, the owner noticed that the dog’s tongue was flipped back on itself intermittently, which was associated with dysphagia. The owner had to coercively flip the apex of the tongue and place the food in the back of the dog’s mouth to facilitate deglutition.

The dog was referred for further evaluation. Upon physical examination, the dog manifested lingual prehensile aberrancy without apparent odynophagia and a dorsiflexed lingual apex. The neurological assessment was unremarkable with the exception of the dorsiflexed tongue. A comprehensive workup including hematological and serum biochemistry testing with assessment of CK activity was performed. In addition, thoracic and cervical radiographs were obtained. Electromyography under general inhalational anesthesia included electromyography (EMG) (VikingQuest®, Natus Medical Incorporated, Pleasanton, CA) of standardly evaluated limb and epaxial musculature, as well as evaluation of the tongue, larynx and masticatory muscles. A videofluoroscopic swallow study was considered, but was not pursued as the risks of aspiration pneumonia outweighed the potential benefits. Biopsies of the tongue were obtained for histologic assessment.

The only abnormal laboratory finding was an increase in CK activity (703 IU/L; reference interval 55-257 IU/L). The EMG revealed fibrillation potentials at variable regions of the left side of the tongue, with no abnormalities noted in any other muscles. Two wedge-shaped, incisional biopsies of approximately 1-cm³ were obtained rostral and caudal to the flexure from the right lateral margin of the tongue. Rochester-Carmalt forceps (Integra®, Plainsboro, NJ) were placed to control hemostasis and the tongue was incised with a surgical scalpel. The biopsy sites were closed by opposing the ventral and dorsal mucosa with an absorbable monofilament suture (4-0 Monocryl® (poliglecaprone-25), Ethicon, Cincinnati, OH). Biopsy specimens were flash frozen in isopentane pre-cooled in liquid nitrogen and stored at -80°C until further processed. Cryosections (8 µm) from the cranial and caudal portions of the tongue were evaluated by light microscopy using a standard panel of histochemical stains and reactions and the fixed biopsies were evaluated in paraffin sections. Fiber loss and fibrosis were extensive in both portions of the tongue, with most remaining myofibers atrophic (Fig.1). Fatty replacement was obvious in the caudal portion of the tongue. Mild and scattered mixed mononuclear cell infiltration was observed within the fibrotic tissue.

Immunofluorescence staining was performed on cryosections of the caudal tongue using monoclonal or polyclonal antibodies against the cell differentiation markers CD3, CD4, CD8, CD11c, CD21 and MHC-I against the regeneration marker developmental myosin heavy chain (dMHC) and against markers for the basal lamina (laminin α2) and collagen VI (Fig.2) Small numbers of CD3, CD4 and CD8 positive T-lymphocytes were scattered throughout the thickened perimysial connective tissue. B-lymphocytes were not observed. Inflammatory cells strongly expressed MHC-I. Regeneration was prominent as determined by staining of myofibers with the antibody against dMHC. The modified trichrome stain and staining pattern with the antibody against collagen VI showed marked fibrosis. The basal lamina was appropriate with the antibody against lamina α2. The final pathological diagnosis was chronic and severe immune-mediated glossitis with extensive fibrosis and fiber loss.

The dog was managed with a tapering course of prednisone (Roxane Laboratories Inc., Columbus, OH) starting at a dosage of 0.75mg/kg BID per os, and tapered gradually over a 12-week period. There was no improvement in the dog’s lingual function and assistance is still needed when drinking water via elevation of its bowl. However, it is able to eat kibble without assistance.

Discussion

Lingual disorders in dogs are most commonly associated with traumatic, metabolic, idiopathic, infectious, immune-mediated, and neoplastic causes. The lingual disorder in this dog was associated with dysphagia secondary to abnormalities in the oral preparatory and oral phase of the swallowing reflex. The clinical signs were limited to the lingual disorder with no evidence of generalized weakness, pharyngeal dysphagia or megaeosophagus, supporting a focal condition. Serological testing for protozoa (Toxoplasma gondii and Neospora
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caninum) would have been optimal; however, the tests were not performed. Histopathological assessment of the dog’s tongue did not support an infectious cause. A case series involving 7 Corgis showed clinical features similar to this case; however, all dogs also exhibited diffuse muscle involvement affecting ambulation.

Inflammatory myopathies in dogs may be focal or generalized. In focal IMs, clinical signs are restricted to the affected muscle group with sparing of other muscle groups. The most common focal IM is masticatory muscle myositis (MMM) where clinical signs are restricted to the muscles of mastication and include jaw pain, reluctance or inability to open the jaw, enophthalmos or exophthalmos depending on the stage of disease, and muscle atrophy. In addition to generalized weakness and gait changes, dysphagia and megaeosophagus represent two of the more common manifestations of generalized IM in dogs. The reason(s) for the focal involvement of this dog’s tongue is not well understood; however, focal myositis involving a number of unusual locations (upper eyelids, tongue, hand, gastrocnemius muscle) has also been well documented in humans. A previous trauma was reported in 20% of cases which raises the important question of whether the dog’s gnawing on a marrowbone with an episode of abrupt cessation of chewing in light of apparent pain 8-months prior to diagnosis might have been associated with the myopathy. Chronic radiculopathy was suggested as responsible for the development of neurogenic muscle hypertrophy and focal myositis. Recently the literature has focused on focal myositis as the result of specific environmental exposures in genetically susceptible individuals, although this has not been well documented to date.

Evaluation of a suspected myopathy case should include assessment of CK activity, thyroid function, and an acetylcholine receptor (AChR) antibody titer for acquired myasthenia gravis. Persistently elevated CK activity (2,000-20,000 IU/L) is consistent with a generalized IM, whereas markedly elevated CK activities >20,000 IU/L support a necrotizing or dystrophic myopathy. Normal or minimally increased CK activity does not rule out a myopathy, particularly when the myopathy is focal (masticatory muscle myositis) or in the chronic stage of disease. Dogs with focal IMs have lower CK activity resulting from the limited amount of muscle mass affected and consistent with the finding in this dog.

Electrodiagnostic testing including EMG is helpful in evaluating the functional integrity of the muscle and nerves, and can identify the distribution of the myopathy. In our case, EMG showed fibrillation potentials only in the tongue without abnormalities of other muscle groups, consistent with previous reports.

Histologic assessment of muscle biopsies is essential to confirm the diagnosis and help determine prognosis. In our case there was extensive myofiber loss and fibrosis indicative of a chronic and severe myopathy. The long-term prognosis for return of muscle mass and function in this case is poor in light of the extensive fibrosis of the tongue. A similar loss of function also occurs in end-stage MMM. It is hard to draw a firm conclusion regarding the immunophenotyping of cellular infiltrates due to the end-stage nature of the pathological changes. However, T-lymphocytes and macrophages with prominent staining for MHC-I confirm the inflammatory and probably immune-mediated cause of this condition. The presence of macrophages and dendritic cells in greater numbers than T-lymphocytes was a consistent finding observed in canine focal IMs. The lack of B-lymphocytes is different from that of the focal MMM. MMM is very steroid responsive in the early stages of the myopathy and becomes less so as extensive fibrosis develops. Immunofluorescent staining using the antibody against dMHC demonstrated the presence of numerous regenerating fibers. However, fibrosis was extensive as indicated by the expanded perimysial and endomysial connective tissue using the antibody against collagen VI, which could limit the success of muscle regeneration and return of muscle mass.

The dog was placed on a tapering regime of prednisone starting at 0.75 mg/kg BID per os; however, the owner elected to discontinue the drug prematurely in light of adverse effects, including abdominal distension, polyuria and polydipsia, and the lack of improvement. The owner declined therapy with alternative immunomodulators including cyclosporine. Follow-up was conducted periodically via phone interviews, with the last follow-up occurring 13 months following diagnosis. Unfortunately, the CK activity was not repeated following initiation of immunotherapy. The owner reported no significant changes to the tongue, and the dog demonstrated persistently impaired deglutition when drinking, manageable by elevating the water bowl or administering water via syringe. The dog is able to eat kibble unassisted, although completion of the meal is prolonged.

**Conflict of interest**

None of the authors of this article have a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.
References


Fig. 1 – Haematoxylin & eosin stained cryosections of the cranial (1a) and caudal (1b) portions of normal tongue from archived tissue of the Comparative Neuromuscular Laboratory are shown for comparison to the affected dog. Images from the cranial (1c) and caudal (1d) portions of the tongue showed extensive myofiber loss and fibrosis that widely separated remaining atrophic muscle fibers. Excessive adipose tissue was also noted in the caudal portion of the tongue. Scattered inflammatory cells were present within the expanded connective tissue and confirmed by immunofluorescence. Bar in image d=50 µm for all images.
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Fig. 2 – Immunofluorescence staining of cryosections from the caudal tongue using antibodies against the T-cell antigens CD3, CD4, CD8 and CD21, the macrophage and dendritic cell marker CD11c, major histocompatibility antigen marker MHC-I, developmental myosin chain (dMHC) as a marker for regenerating fibers, and laminin α2 marker for muscle basal lamina, and collagen VI as a marker for perimysial and endomysial connective tissue. Macrophages and dendritic cells were present in greater numbers than T cells. Staining for MHC-I, dMHC and collagen VI were prominent.

Nasal dermoid sinus in a crossbreed dog

Barbara Möhnle

Dermoid sinus is a congenital defect and can be found mostly in the back and neck of ridgeback’s but also other breeds can be affected. It is a defect which occurs during the embryonal development. The ectoderm separates not completely from the neural tube and a blind ending tubular structure of skin with different types of openings and depth can be found.

Most time the opening shows pigmented hairs and skin. The tubular is more or less thick and can mostly be palpated. It is lined with squamous epithel.

The dermoid sinus in the neck and back is classified into five types.

Typ 1 ranges directly to the lig. nuchae or lig. supraspinatum
Typ 2 ranges up to the muscles and is connected fibrous with the lig. supraspinatum.
Typ 3 reaches only the subcutaneous tissue
Typ 4 is connected under the lig. supraspinatum with the dura mater
Typ 5 is a sinus without an opening (it can build up an dermoid cyst)

The dermoid sinus can be found in different breeds, mostly in Ridgebacks, but also in Bullterrier, Boxer, Chow Chow, Yorkshire Terrier, Sibirian Husky, Rottweiler and Golden Retriever. The DS will be found often
when the sinus is inflated with epithelial cells, hairs, sebum and is infected.

The nasal dermoid sinus is developing embryonally during the neurulation and can be seen in the nasal skin as well as intranasal and going intracranial. This defect is described in humans, affecting children and young adults but is a rare defect.

Also in dogs it is a rare occurrence. It usually starts with a nasal swelling. Often a small hole at the nasal speculum can be seen. Discharge comes out and a catheter can be inserted.

Case

A dog was presented with a swelling of the nose between both eyes. The veterinarian has given antiinflammatory drugs and antibiotics. But the swelling was growing and tumour was suspected.

A CT scan was performed and biopsies were taken. The CT scan revealed an area like a cyst reclining from the outside of the bone inside the nose. The result of pathology was “inflammed tissue”. At this time a small hole was seen at the nasal specula. The owner describes it like a spot, where, with pressure, soft material comes out.

In this slot a small cat catheter was inserted. This reaches up to the swelling on the nose and ends in the nasal defect.

The nasal skin was opened and altered tissue resected. The defect goes through the nasal bone and builds up a cavity in the nose. The cavity was opened with piezo-surgery and the tissue was scraped with a parodon-

tal tip. Everything was removed and forwarded to pathology.

The result of the pathologist was a dermoid sinus of the nose.

The prognoses of this defect is good after complete removal of altered tissue and tubular structures. A CT scan or MRT can be helpful to plan surgery especially if it is a deep process in the nose.

References

Feline inductive odontogenic (ameloblastom/fibroameloblastoma) tumour (FIOT)

Barbara Möhnle

The FIOT is a benign epithelial odontogenic tumour. The epithelial odontogenic tumours are classified in two groups. In tumours without inductive properties on connective tissue (ameloblastic fibroma, dentine, ameloblastic odontoma, complex odontoma and compound odontoma) and tumours which have inductive properties (ameloblastoma, calcifying epithelial odontogenic tumour).

Ameloblastic fibroma (or fibroameloblastoma) was observed in cats only. The inductive fibroameloblastoma can be seen in young cats (up to 1,5 years of age, 7-18 month), whereas ameloblastic fibroma can be seen in old cats.

The FIOT is a rare tumour. It shows no specificity for age, breed or gender. The tumour is typically a submucosal swelling located at the rostral maxilla.

An odontogenic tumour shows typically an expansive growth with local destruction of the bone. It has no tendency to metastasise.

There are two options of treatment: surgical excision or radiation therapy. Wide surgical excision is the treatment of choice and is mostly successful. Recurrence is possible after incomplete surgical excision.

This is a really rare tumour and only short reports, case reports or descriptions of the pathologic findings can be found in the literature.

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Osteonecrosis of the jaw

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Osteonecrosis of the jaw (ONJ) is a rare disease described in dogs. This disease has significant potential he-
thalth consequences, given by chronicity of the disease with longterm bone exposure to infectious oral environ-
ment. Osteonecrosis is described to occur as consequence of radiation therapy and use of bisphosphonates.
A case report of two scottish terriers with formerly known chronic paradental ulcerative stomatitis (CUPS).
A retrospective study was published in 2015, summarizing incidence (altogether 14 cases) of osteonecrosis
without history of previous radiation therapy within 18 years period in three large university clinics. Parame-
ters of preoperative examination of blood did not show any significantly abnormal values, biochemistry find-
ings were non-specific. Urinalysis showed iso/bacteriuria in half of the patients. Oral examination revealed
exposed necrotic alveolar bone covered with plaque and debris and varying amounts of granulation tissue.
Most common radiographic finding was bone osteolysis (loss of bone presented by moth-eaten structure),
bone sequestrum presence and periostal reaction (mostly solid type), the true extent of the lesion very often
exceeded visual finding affecting not only alveolar bone, but also proper maxillary bone. Intraoral radiogra-
phy correlated well with intraoperative extent of lesions as well as CT findings in cases of mandibular ONJ,
contrary to maxillary radiography, where CT correlated much better, presumably due to summation effect
which does not interfere with interpretation on mandible. Histological findings were available in half of the
cases, describing necrotic bone and osteomyelitis. Microbial cultivation revealed polymicrobila cultures of ae-
robic and anaerobic cultures, representing oral microbial flora affected by previous antibiotic treatment. The
results had only minimal influence final decision making. All patients were treated surgically with curretage,
debriding the bone to healthy bleeding bone, lavages, one patient was treated with incisivectomy. All patients
got antibiotics in the range of 2 weeks to 2 months. Most affected breeds were cockerspaniel and scottish
terrier (together half of all cases). The therapy was succesfull in all patients, concluding good prognosis of
combination of surgical therapy and antibiotic therapy. All dogs suffered form dental disease and except one
there was dental extraction history.

In veterinary literature osteonecrosis is defined as exposed bone present in maxillifacia region, not healing
for minimum of 6-8 weeks in patients without radiation therapy in history. Definitive diagnosis is made based
on combination of history, clinical examination, diagnostic imaging results, micorbiological and histopato-
logy findings. The disease can lead to fatal consequences, therefore only aggressive therapy of combined
surgery and antibiotic medication should be chosen, although in human medicine also conservative treat-
ment with antibiotics, analgetics and local antiseptics is described for mild cases. The goal of canine patients
therapy should be to prevent further disease progress and relief the patient from infection and pain.

**Case reports**

First case report was a seven years old male american cockerspaniel Ben brought for “dental treatment” in 2010, the main owners complaint was profound halitosis. Clinical examination revealed painful swelling of left caudal mandible. Oral consious examination revealed painful swelling of left caudal mandible. Oral consious examination revealed all caudal madibular left teeth covered with massive calculus and debris layers, raising suspicion of severe periodontal-disease-related osteomyelitis. Lymph node at the site of swelling was enlarged, the dog did note have any systemic signs of illness. Owner did not wish to perform any blood test nor histology or microbiology test because of financial concerns.

Preoperative medication included preemptive analgetics injection (meloxicam 0,2 mg/kg i.v.) and amoxicillin-clavulanate (22 mg/kg s.c.). The dog was sedated with acepromazine (0,05 mg/kg) and fentanyl (0,01 mg/kg) induced with propofol i.v. until effect. After intubation inferior alveolar block was performed with articain 4% in total volume of 0,6 ml. Anesthesia was conducted with isoflurane/O\(_2\) (0,5 l/min) 1,5% and continuous rate infusion of fentanyl 8 μg/kg/hour.

Oral examination followed revealing severe periodontal disease of all molars bilaterally and necrotic alveolar bone present at molar region of right madible slightly exposed around mobile molars roots. Left side did not show any signs of bone involvement except alveolar bone loss related to periodontal disease.

Intraoral radiography showed presence of well-demarcated bone sequestrum with periostal reaction in the area of right mandibular molars. After extraction of affected teeth necrotic bone was present. After triangular flap elevation sequestrectomy was performed, debriding necrotic bone with attempt to reach bleeding bone, but due to serious concerns of mandibular integrity this could not be reached in all areas. Wound was closed with absorbable monofilament suture material (Glycolide and ε-Caprolactone, 1 EP ). Contralateral side teeth were treated with extractions, other teeth with routine prophylaxis.

Dog recovered well, ate well, was normothermic. Clindamicin 11mg/kg BID p.o. was instituted and meloxicam 0,1 mg/kg SID p.o. Recheck 13 days after surgery confirmed healing, except small erythematous lesion with mucopurulent secretion in the centre, suspicious of draining tract. Because patient was drinking, eating. We decided to postpone any further action based on rechecks expecting positive reaction to antibiotic therapy. Owner was instructed on oral hygiene. He was willing to brush teeth. Clindamicin was given for 38 days in total and meloxicam for 7 days.

Next recheck after 5 weeks from the surgery was the dog without any signs of illness, tolerated only the finger toothbrush. We sedated the dog i.m. with medetomidine 0,005 mg/kg and butorphanol 0,02 mg/kg to recheck the healing. On palpation significantly reduced swelling of the mandible was present, wound was healed completly. Owner was advised to add daily food additives based on algae (A. nodosum), water additive with chlorhexidine, brush teeth and flush with chlorhexidine daily. Regular rechecks every 6 months were recommended.

At 3 years later profylactic treatment there was no bone swelling present. The dog reached 14 years of age with no problems on chewing or eating with continuous oral hygiene. Dog died according to owner due to unspecified neoplastic disease (mass in flank ).

Second patient was 8 years old Charlie, mixed breed male dog, referred by colleague after 10 months of treatment of exposed maxillary bone with unsatisfactory results. Referring vet extracted both maxillary fourth premolars, she even tried to remove some bone. According to her the teeth did not show any pathology. Swelling and bone necrosis did not subside even after repeated antibiotic treatments based on multiple cultivations, treatments had only short time effect. There was intermitent leukocytosis with repeated blood pannels. CT of the skull was performed and board certified diagnostic imaging specialis reviewed it, but without any specific findings or recommendations. The CT scans weren’t available to review at the time of surgery because of technical reasons.

Dog was painful on touching his head, especially at swelling sites, he lost weight.

On clinical examination the dog was cachectic, with normal temperature and enlarged mandibular lymph nodes bilaterally. There was evident swelling under both eyes, more advanced on right side. Present halitosis was extreme. Blood pannel did not show any specific findings.

Preoperative medication included preemptive analgetics injection - meloxicam (0,2 mg/kg i.v.) and amoxicillin-clavulanate (22 mg/kg s.c.). The dog was sedated i.m. with medetomidine 0,005 mg/kg and butorphanol 0,02 mg/kg, induction was provided by propofol i.v. until effect. After intubation caudal maxillary blocks were performed bilaterally with bupivacaine in total volume of 0,6 ml per site. Anesthesia was con-
ducted with isoflurane/O$_2$ (0.5 l/min) 1.5%. Patient was receiving continuous rate infusion of fentanyl 8 μg/kg/hour.

Intraoral radiography showed radiolucent regions within maxillary alveolar bone suggesting osteolytic changes in area of upper maxillary fourth premolars bilaterally, but without specific margins, lesion extent was not clear. On oral examination there was necrotic bone covered with debris, plant material and hair. Multiple extractions of mobile teeth were performed together with extensive bone debridement to reach bleeding healthy bone on both sides, gentamicin collagen sponge was used in both defects which were closed using monofilament absorbable polyglicapron 1,5 EP material. Postoperative analgesia was provided by morphin 0.3 mg/kg s.c. and metamizole 30 mg/kg s.c. Postoperative treatment included clindamicine 11 mg/kg p.o. BID 8 weeks, meloxicam SID 7 days and tramadol 2 mg/kg q6h firts 24 hours, locally BID chlorhexidine gel. Microbiological findings were: aerobic cultivation: moderate concentration – *Escherichia coli*, low concentration – *Proteus mirabilis*, anaerobic: *Bacteroides pyogenes*, sensitive to all antibiotics including clindamicin.

Histology results were suppurative necrotising osteomyelitis.

After week the dog ate more, gained weight, lymph nodes reduced their size, wounds were healing without dehiscence.

After 4 moths prophylactic treatment was performed, which was not performed within first session due to long anesthesia time. All tissues were healed and radiographically defects wee healing with new bone.

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**Root filling material and obturation techniques in endodontics – a brief review and report of three cases**

S. Hashemi

Obtaining a hermetic seal and 3D obturation of radicular space is mandatory for successful endodontic treatment. Calcium silicate materials are the material of choice in case of open apices or root perforation, because of biocompatibility and good sealing properties. Gutta-percha is the most popular root filling material, its bio inert properties and good adaptation to root canal irregularities made the material suitable for obturation of radicular space. The most disadvantage of the material is non-adhering to root dentinal walls. So in every technique using the gutta-percha as root filling material, using root canal sealers is mandatory.

A variety of root canal sealers with different base materiel marketed till now. ZOE base, Ca(OH)$_2$ base, Resin base, Silicon base and Calcium silicate base sealers are some examples. True knowledge about their specific properties and indication/contraindications is mandatory for every clinician interested in endodontic treatments. Cold lateral condensation, Warm vertical condensation, thermoplastic injection and cold injection of guttaflow are some popular techniques had used for 3D obturation of radicular space for many years. In this review we will discuss advantages, disadvantages of each in some selected cases.
Comparison of the analgesic effects and oxidative stress produced after administration of NASID or Rostral Nerve Block on post-operative pain following pulpotomy in dogs

A. Tavakoli, M.E. Tazik, A.R. Abbasi

Introduction

Dental procedures that tend to cause pain can be resolved through local nerve blocks within the pained area in Humans. However according to the American Veterinary Dental Society act the use of general anesthesia is still considered a necessity. Majority of Different anesthetic products used in all forms of surgery still have the tendency to feel pain. Therefore, use an analgesic regimen in anesthetic protocols is recommended. Also due to inflammation of the oral tissues, using NSAIDs drugs in post-operative management is effective but its not always successfully effect.

Nerve blocks during dental procedure adjunct to anesthesia facilitates providing regional analgesia and have some post-operative analgesia as well. Also it decreases the demand that the patient needs to keep it under anesthesia, means decreasing the mac of the inhalant anesthetic to keep patients much lighter. We like to keep our patients really in light level of anesthesia and wake up extremely quickly. It not only maximizes cardiac out-put and blood pressure, but also the patient is much safer and all physiologic parameters are keep in their maximum levels. Another advantage of nerve blocks in dental procedure is that by keeping the patient in lighter levels of anesthesia while pain free, hypothermia is prevented. Aguiar in 2015 showed that the use of rostral nerve block is effective in pain control following dental extractions in cats. Other studied indicated the effectiveness of adjunct regional nerve block in decreasing post-operative pain after orthopedic procedures in dogs. In addition, it is shown that the use of NSAIDS like meloxicam ketorolac, etc in pain relief after dental surgeries is effective and even superior than that of tramadol.

Therefore, we aimed to to compare the analgesic effects of rostral maxillary nerve blocks using the combination of lidocaine and bupivacaine with pre-operative administration of meloxicam in dogs undergoing dental pulpotomy in the rostral maxilla to test the superiority of either of the technique to alleviate pain.

Material and methods

After the general health checkup, the 12 mixed breed healthy dogs with healthy teeth were included in this study. A control blood sample was taken prior to surgery to assess the level of cortisol hormone, and indicators of oxidative stress including Total Antioxidant Capacity (TAC) and value of Malondialdehyde in hemolysis of red blood cells (MDA). Then, general anesthesia performed using intramuscular injection of acepromazine (0.01 mg/kg) as premedication and the intravascular injection of the combination of ketamine and medetomidine (8.5 mg/kg and 30 μg/kg) for induction of anesthesia. The anesthesia maintained by inhalation of isoflurane in Oxygen following intubation.

The oral chlorhexidine solution 1.2 % was used for aseptic preparation of the oral cavity. Prior to the procedure, each dog was randomly assigned to either group A to receive rostral maxillary block by the injection of 0.4 ml of combination of lidocaine 2% and bupivacaine 0.5% (equal volume) by 20 gauge needle or group B, receive intravascular injection of meloxicam (0.2 mg/kg). Both subjective and objective indicators of pain were used in this study including score of pain and serum level of cortisol. Also changes in oxidative stress by measuring serum levels of TAC and MDA were recorded. The score of pain was recorded using University of Melbourne Pain Scale (UMPS) by a single trained observer in dogs in both groups at 1, 3 and 24 hours following the procedure. Blood samples were taken in the EDTA tubes prior to pulpotomy and at 30 min, 1, 3 and 24 hours after the procedure. The samples were analyzed by an Immunoanalyser (Cobas® e 411 S/N 071227, Roche Diagnostics, Mannheim, Germany). Also the commercial kit was used to measure values of TAC (TAC test kit, Randox laboratories Ltd. G.B ) and Malondialdehyde (Thiobarbituric acid technique) in
hemolysis of red blood cells.

Single point measurements, at any particular times, were analyzed using repeated measure ANOVA. Kruskal-Wallis test was implemented as a post hoc test using SAS. Changes in parameters over time were analyzed using GLM procedure in SAS, including repeated measures in the model. Data were presented as Mean±SEM. A value of P < 0.05 was considered significant.

**Results**

All of the animals recovered from anesthesia uneventfully. Obtained result are classified as follows:

**Comparative results of recorded UMPS score at different time intervals following pulpotomy**

All of the animals suffered from pain. There was no significant difference in score of pain prior to surgery between the groups (P>0.05). The highest score of pain was recorded at 5 hours after pulpotomy, that was significantly higher in group B in comparison to group A (P=0.026). Also the trend of the changes of UMPS during the study indicated that the score of pain significantly decreased at 24 hours following the procedure in the both groups. (P<0.05) (Table 1).

**Comparative results of recorded serum level of cortisol (mmol/L) at different time intervals after pulpotomy**

The increase in level of cortisol was occurred in all of the dogs in both groups of this study in 30 min after the procedure, however, the increase was higher in group B (Table 2). Mean± SD of the level of cortisol was significantly higher in group B at 30 min, 1 and 3 hours after pulpotomy in dogs of the group B compared to group A (P<0.05), but no significant difference was found at serum level of cortisol at 24 hours after pulpotomy between the groups. (P>0.05) Also serum level of cortisol returned around its baseline values in both groups 24 hours postoperatively (Table 2).

**Comparative results of measured level of TAC (mmol/L) and MDA (nmol/ml) at different time intervals after pulpotomy**

Mean±SEM TAC values at different time intervals showed significant difference between the two groups of the study. TAC values were significantly lower in group A compared to group B. (P<0.05). However, Mean±SEM values of MDA were significantly higher in group A at different time intervals in comparison to group B. (P<0.05). (Table 3)
Discussion

Pain management following dental procedures prevents patient's discomfort and provides rapid recovery and early return of the patient to oral feeding. Care should be taken to select an effective analgesic regimen according to the degree of pain that the patient is supposed to suffer. Musculoskeletal and dental pain is produced because of the inflammation of the tissues due to the manipulation during the procedure. Therefore, in this study we aimed to determine if there is superiority in the use of local nerve block rather than NSAIDS in controlling the pain following pulpotomy in dogs. Classically NSAID and opioids are used to manage the post-operative dental and oral pain. NSAID produce their analgesic properties by inhibiting the synthesis of prostaglandin through inhibition of the Cyclooxygenase enzymes. Therefore, all of the pain indicators used in this study showed increase after the dental surgery and the highest pain recorded at 5 hours after post-operatively. The highest pain score was reported to be at 5 hours after the premolar dental surgery. We did not administer any additional rescue dose for analgesia after 24 hours following the procedure in all of the patients, since most of them clinically appear to be pain free. We did not observe significant different in degree of pain using the University of Melbourne Pain Scale at 3 and 24 hours after the procedure between the groups in this study.

Serum cortisol concentration is recognized as one of the most objective criteria for pain assessment in animals and found to have direct relation with post-operative pain in dogs. The increase in serum level of cortisol explains that all of the patients in this study suffer pain, however, significant increase in the values of cortisol hormone observed at 30 min, 1 and 3 hours after pulpotomy in the group B (P=0.035). An hour after pulpotomy Mean cortisol levels started to decrease in group A and remained in the almost same levels until a day after. It has been shown that the analgesic effect of lidocaine starts about 1-2 minutes after the injection and lasts for 6-8 hours. Therefore, first lidocaine and then bupivacaine elicit their analgesic effects.

Our results indicated that the both drugs work properly to alleviate dental pain and stress occurred after pulpotomy. NSAIDs are effective in management of periodontal, postoperative dental and endodontic pain. Nekooifar et al in 2003, used meloxicam and reported that they were successful to control postoperative pain in patients undergone endodontic treatments. Also Paracetamol which like meloxicam is believed to be a Cox-2 selective NSAID was reported to be effective in controlling post-extraction pain of the 3rd molar teeth in human patients and also its analgesic effects are comparable to those of Ibuprofen. Isiordia et al in 2012 during a pilot study compared the effectiveness of perioperative tramadol and meloxicam after 3rd mandibular molar extraction in human patients. The results showed that meloxicam was more effective to lower the intensity of pain than tramadol. However, in the present study, by considering the changes in score of pain and cortisol levels in two groups, we found that local nerve block could represent more analgesia than NSAIDs used prior to the dental procedure.

Adverse effects of the NSAIDs should be taken into account during their use, especially when multiple

<table>
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<tr>
<th>Measured variable</th>
<th>Group</th>
<th>T0</th>
<th>T30 min</th>
<th>T 60 min</th>
<th>T 3h</th>
<th>T 24h</th>
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<td>MDA (nmol/ml)</td>
<td>A</td>
<td>78050.8*</td>
<td>74630.2*</td>
<td>86253.6*</td>
<td>93780.4*</td>
<td>110180.6*</td>
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<tr>
<td></td>
<td>B</td>
<td>41534</td>
<td>40549.6</td>
<td>56253</td>
<td>49036.8</td>
<td>53755.8</td>
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<td>TAC (mmol/ml)</td>
<td>A</td>
<td>10.7</td>
<td>11.5</td>
<td>11.6</td>
<td>11.04</td>
<td>10.08</td>
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<tr>
<td></td>
<td>B</td>
<td>12</td>
<td>15.1*</td>
<td>14.7*</td>
<td>14.2*</td>
<td>14.08*</td>
</tr>
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</table>

Table 3 – Mean of MDA and TAC in group A and B prior to surgery, and at 30 min, 1, 3 and 24 hours after pulpotomy.

Data with *superscripts showed significant difference within columns at the 0.05 significance level.
doses are needed. Acute renal failure and even death have been reported after repeated doses of meloxicam in cats. However, it does not have adverse effect on glomerular filtration in short term usage\(^\text{11}\). NSAIDs inhibit prostaglandin production; this means that they are most effective when used prior to production of prostaglandin due to inflammation and the subsequent pain. Therefore, in order for meloxicam to have maximum effect in managing postoperative pain after dental surgeries, it should be used prior to surgery.

Indicators of oxidative stress are considered in many anesthetic procedures. TAC decreases when more oxidative stress is predicted during a procedure. Our results showed that the amounts of TAC were significantly higher in group B at different time recorded after pulpotomy, while MDA amounts which is the final product of lipid per-oxidation were significantly in the dogs of group B during the study. These results supports that meloxicam could produce less oxidative stress in comparison to local nerve block.

In conclusion both meloxicam and tramadol are effective to control post-operative pain during after dental pulpotomy in incisor teeth of dogs, however, local nerve blocks applied by the combination of lidocaine and bupivacaine seems to be more effective than pre-operative meloxicam in managing pain after the first few hours and during a day after the procedure. In contrast meloxicam produced less change in the indicators of oxidative stress. Preemptive analgesia is recommended when considering NSAIDs for managing pain of dental surgeries.

References

Comparative study of the regenerative property of platelet rich fibrin and Mineral Trioxide Aggregate (MTA) used as capping material in pulpotomy in incisor teeth of dogs

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Introduction

The vitality of the pulp is very important to the tooth health and plays a significant role during decision making to manage pulpal pathologies. Pulpal viability is not only critical in the treatment of pulpal exposure in permanent teeth of the young patients subsequent to caries, but also in primary molar teeth. Pulpal exposure may occur following dental caries, traumas and malformation of the teeth. It has been proven that pulpotomy is effective treatment for preserving pulpal viability after pulpal exposure and in the presence of inflammation. The vitality of the pulp is maintained by the healing potential of the remaining radicular tissue and the biocompatibility of pulpotomy agents as well. Therefore, pulpotomy is effective in treatment of reversible pulpal injuries through sealing of the pulp. Subsequently the tertiary dentine formation occurs. Calcium hydroxide ($Ca(OH)_2$) and $Ca(OH)$ compounds has been used since 1920 and currently are considered as the gold standards of pulp capping. Many studies have been performed to introduce alternative biocompatible pulp capping materials. Among them Mineral trioxide aggregate (MTA) has been shown to be the material of choice for pulpotomy procedures. Many animal study results indicated the superiority of MTA to $Ca(OH)$ when used as a direct pulp capping agent.

Among the newly introduced approaches to tissue regeneration platelet rich plasma (PRP) and platelet rich fibrin (PRF) are shown to have significant effect in healing in different surgical fields such as head and neck surgery, orthopedic surgery, cardiovascular surgery, and maxillofacial surgery. PRP and PRF are non-expensive, easy to be prepared, and produce less inflammation during healing. A natural blood clot contains mainly red blood cells, approximately 5% platelets and less than 1% white blood cells. PRP is derived from the centrifugation of autologous blood. In order to be prepared in a gel formulation, PRP is mixed with thrombin and calcium chloride. Therefore, a high concentration of platelets, the associated growth factors and fibrinogen are included in PRP gel. The important difference in composition between PRP and PRF is the presence of a high concentration of platelets and native concentration of fibrinogen in PRP. Preparation of PRF does not require thrombin and calcium chloride for activation and the process is even easier and less time consuming than preparation of PRP gel. Thus, the preparation of PRF is strictly autologous. PRF was first described by Choukroun et al., and it is called the second generation platelet concentrate. It has several advantages over traditionally prepared platelet-rich plasma (PRP).

The PRF clot forms a strong natural fibrin matrix, which has almost all the platelets and growth factors of the blood harvest and shows a complex structure as a healing matrix, including mechanical properties no other platelet concentrate offers. PRF can be considered as a natural fibrin-based biomaterial favorable to the development of a microvascularization and able to guide cell migration into wound area. In the study of Dr. Seema Pathak et al., use of the PRF in a carious pulp exposure of a young permanent tooth with pulpitis made a successful result over 6 months. In the study of Prof. Utpal Kumar et al. he used the PRF as pulp capping material over a permanent tooth of a 21 years old male and after 6 months the patient had no pain or radiograph changes.

Pulp cells residing in pulp clinically diagnosed with pulpitis might still have stem cell potential similar to...
healthy pulp cells and therefore might be a resource for autologous pulp regeneration which suggest opportunities for biologically based therapeutic approaches to dental tissue repair as well as providing valuable insights into how natural regenerative processes like PRP or PRF may be operating in the tooth. Therefore, we designed a study to investigate the healing effects of PRF following vital pulp therapy in the incisor teeth of the dogs.

**Material and methods**

After approval was received from the University Research Committee, Azad University of Garmsar the procedure was started according to animal ethics guidelines. 10 ml blood sample of jugular vein was taken. Adult healthy male mixed breed dogs weighing 18 ± 3 kg were entered the study. The food was restricted for 8 h in all subjects prior to surgery. The blood collected in a tube without anticoagulant agents like EDTA. After one minute of resting, the tube centrifuged for 12 minutes at 10000 /rpm. The white jelly part above the clot (Fig. 2), which is PRF, was isolated. Then, general anesthesia performed using Acepromazine (0.01 mg/kg) as premedication and the combination of ketamine and diazepam (IV, 8.5 mg/kg and 0.2 mg/kg) for induction of anesthesia. The anesthesia maintained by inhalation of isoflurane in Oxygen following intubation.

The oral chlorhexidine solution 1.2 % was used for aseptic preparation of the oral cavity.

After anaesthetizing the dog and infiltration of one carpule of lidocaine with epinephrine, a cervical cavity with an inverted bur was made in the three incisors of both upper and lower jaw (Fig. 1). When the pink color of pulp was seen through the thin layer of dentin, teeth were isolated with cotton rolls and, a No.2 explorer was used to expose the pulp. Cavities were washed with normal saline. 20 incisor teeth were prepared in this way. After preparation of the cavity the teeth were assigned into two groups. In group A no treatment was performed and the cavities were filled by only zonalin cement. In group B, a 1x2 mm of PRF was brought to the exposure sites and placed over it and a zonalin cement covered the whole cavity (figure 3.). The teeth were checked weekly for any signs of discoloration and inflammation. After two months the teeth, all teeth in both groups were extracted under general anesthesia. The teeth were fixed in 10% buffered formalin and processed in a tissue processor after decalcification was performed. Paraffin-embedded tissue sections were stained by Harris hematoxylin and eosin (H&E) method. The stained sections were viewed under light microscope at 4X and 10X magnifications for examination. A single veterinary pathologist viewed the slides and graded them according to degree of inflammation, formation of hard tissues and dentinal bridge and necrosis. Inflammation was graded as non-existent (0), mild infiltration of inflammatory cells, Neutrophils and Leukocytes (1), moderate infiltration of inflammatory cells, Neutrophils and Leukocytes (2) and severe infiltration of inflammatory cells, Neutrophils and Leukocytes so that more than 2/3rd of the pulpal canal is involved (3). Formation of dentinal bridge was graded as non-existent of dentinal bridge (0), mild sedimentation of hard tissues underneath and surround the used regenerative material (1), moderate sedimentation of hard tissues and thin layer of dentin bridge underneath and surround the pulp capping material (2) and full formation of dentinal bridge under the exposure area (3). Necrosis was graded as no necrosis (0) and existence of denatured proteins and autolysis in pulp tissue (1). Means of the measured variables were compared between the groups using ANOVA. P values less than 0.05 were considered statistically significant.

**Fig.1** – Inverted cone bur used for preparation.

**Fig.2** – White jelly on the top is PRF.
Results

Results of this study are illustrated according to histopathological parameters including degree of inflammation, formation of dentinal bridge and necrosis were used in this study to evaluate the regenerative property of PRF.

Inflammation degree

Different degrees of inflammation, from mild to even severe degrees were observed in pulpal tissues in groups A and B (Figs. 4, 5, 6). However, results indicated that mean degree of inflammation was significantly higher in group A (2.25) in comparison to group B (0.75) (P=0.00). Results are illustrated in Table1.

Dentin bridge formation

Dentinal bridge was not observed in group A. However, different degrees of dentin bridge formation were observed in group B (1.67) (Fig. 7). Results are illustrated in Table 1.

Necrosis

Necrosis in the subjects in group A was obvious, and was significantly higher when compared to the necrosis in group B (P=0.001). Necrosis was observed in all pulpal tissues in group A, however, it was found in 2 pulpal tissues in group B as well.

Table 1. Mean degree of inflammation, dentinal bridge and necrosis in group A and B.

<table>
<thead>
<tr>
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<th>Group B</th>
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<tr>
<td>Inflammation degree</td>
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<tr>
<td>Dentinal bridge</td>
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<td>1.67</td>
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<tr>
<td>Necrosis</td>
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<td>0.16</td>
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Table 2. Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. The significance level is .05.

<table>
<thead>
<tr>
<th>Sample1</th>
<th>Sample2</th>
<th>Test Statistical</th>
<th>Std. Error</th>
<th>Std. Test Statistical</th>
<th>Sig.</th>
<th>Adj.Sig.</th>
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<tr>
<td>Control-PRF</td>
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<td>-18.000</td>
<td>4.000</td>
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<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>
Fig. 4 – Minor inflammation without dentinal bridge formation in tooth group A (x40 magnification). Fig. 5 – Minor inflammation with PRF (250x400 magnification). Fig. 6 – Angiogenesis and fibroplasias in tooth treated by PRF (250x400 magnification). Fig. 7 – Islands of hard tissue in group B (x40 magnification). Fig. 8 – Moderate dentinal bridge formation in tooth group B (x40 magnification).

Discussion

Pulpotomy is an accepted treatment for teeth with pulpal exposure and it is reported that the success rate of endodontic treatment is lower than that of initial treatment.\textsuperscript{13,14,15} Since the preservation of the dental pulp is essential to maintain the teeth, attempts have been done to preserve the vital pulp and/or facilitate regeneration of the pulpal tissue. Thus, different materials and biomaterials have been examined for pulpotomy and pulp capping. Pulpotomy considered being successful when apoptosis of odontobalsts and pulpal cells occurs initially and finally reparative dentinogenesis takes place.\textsuperscript{16,17} The purpose of this study was to evaluate the regenerative property of PRF as a pulp capping material in pulpotomy of the incisor teeth in dogs.

Different histological parameters regarding pulpal wound healing following pulp capping with PRF were recorded in this study, including degree of inflammation of the pulpal tissue, formation of dentin bridge and existence of necrosis. Results of the present study showed that inflammation was occurred in the both groups of the study. However, the inflammation was more evident in group A, that no treatment was applied. PRF produced mild to moderate inflammation in the subjects of group B. PRF includes dense fibrin network with leukocytes, cytokines, glycoproteins and growth factors. Basically leukocytes present in PRF have a key role in releasing of growth factors and anti-infectious activity. This explains, the relative existence of moderate inflammation of the pulpal tissue following pulp capping using PRF.

Dentin bridge was not formed in any of the subjects of group A due to severe inflammation. In contrast the bridge and reparatory dentine were observed in all of the subjects of group B. It is shown that the associated growth factors with PRF are released in the tissue during 1 to 4 weeks after applying of the PRF.\textsuperscript{19,20} So as we expected, the regenerative property for PRF when used as pulp capping in group B was observed. Also the expected time for pulpal repair is during the first 3 weeks\textsuperscript{21} which was in agreement with result of the this study. Therefore, the observation of reparative dentin in the pulpal tissue is an optimistic sign of pulpal regeneration that was occurred in group B following pulpotomy. Huang et al in 2010 reported that PRF causes
proliferation of human dental pulp cells and increase the protein expression of osteoprotegerin and alkaline phosphatase activity. Therefore, in the presence of low amount of vital pulpal cells, odontoblast like cells will be produced and pulp-dentin complex will form\(^{19}\). In addition Wang et al.\(^{(2010)}\) reported that the pulp cells residing in pulp might have potential of stem cells and help the pulp for regeneration.\(^{38}\) We obtained similar results in the present study.

The effectiveness of PRF in accelerating wound healing of different tissues have been studied and proved previously.\(^{18-22}\) Growth factors are critical in signaling the formation and repair processes in dentine-pulp complex and they signal many of the important events in tooth morphogenesis and differentiation, also recapitulation of these processes may lead to tissue regeneration.\(^{34}\) In addition microvascularization develops in the fibrin network of PRF promotes cell migration.\(^{24}\) In current case an effort was made to use such growth factors in order to help healing the pulp after exposure. Animal incisors were used in many DPC studies.\(^{32-34}\) For cavity preparation only class V cavities were prepared in this study, as the procedure was easy and functional loads during biting could be avoided.\(^{35}\)

As we expected the pulp with only zonalin coverage cavities led to necrosis in group A. However, necrosis occurred in 2 of the pulpal tissues in group B. This probably occurs due to organization of the inflammation and subsequent infection of the pulpal tissue. If the inflammation existed in the pulpal canal conquers the infection, regeneration will occur subsequently.

As discussed earlier PRF was prepared with the dog’s own blood and was placed in the exposure site of the teeth. The process of preparation of PRF is very easy, quick and unlike PRP activation with bovine's thrombin is not needed. Also PRF is considered a potent autologous material, therefore, the risk of transported infected and blood borne diseases are reduced when PRF is used compared to other allograft, xenografts and biomaterials that are used as pulp capping agents.\(^{24}\)

**Conclusion**

As mentioned above, the formation of dentin bridge is essential in maintaining the viability of the pulp. The reparative dentin is formed in residual dental pulp. Therefore, in the absence of bleeding, PRF supplies growth factors and potential network for regeneration of the pulp.\(^{23}\) It is concluded that mild to moderate inflammation and dentin bridge formation occurred in the pulpal tissue of the dog’s incisor teeth capped with PRF, which shows promising effects in healing of the wounded pulp. Also necrosis reported in 2 subjects of the groups treated with pulpotomy. These findings suggest biologically based treatment approaches to dental tissue healing and provide an insight how natural regenerative processes can be done in teeth. Further research on this subject is required with regard to operate on human teeth and more follow up time.

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31. Raja VS, Naidu EM. Platelet-rich fibrin: evolution of a second-generation platelet concentrate. In-
Radiological, histological and clinical side effects of incisor trimming in rabbits

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Introduction: Dental diseases are the first cause of veterinary consultation by rabbits’ owners and the incisors malocclusion is a common problem, especially by dwarf rabbit. Because the growing rate of the incisors is 2 to 2.4 mm per week, the non-wear of the teeth leads very quickly to an overgrowth and a crown reduction has to be made every 3 to 6 weeks.

Objective: The goal of this study is to evaluate the eventual side effects on dental and periodontal tissues of rabbit incisors trimmed with a nail cutter in comparison to a diamond-coated cutting disc or a diamond bur. The three methods were compared using radiographs, micro-tomography images and histological slices.

Methods: The left mandibular incisor of 28 New Zealand young rabbits was trimmed either with a nail cutter, a diamond-coated cutting disc or a diamond bur four times during a fattening period of 51 days. After they were killed for meat, the mandibles were collected and incisors were investigated on dental radiographs, micro computed tomography scans and histology preparations. The presence of bone or tooth modifications, fractures and inflammation was evaluated.

Results: At the macroscopic level, the nail cutter caused unsharp shortening of the incisor with multiple splits. The cutting disc was less precise that the diamond bur because the neighbour incisor was also touched in 8 of 24 shortenings. The radiographic analysis highlights a significant increase of the bone modifications and fractures occurrence on the nail cutter-trimmed incisors in comparison to the other methods, even if slight changes were also found with the disc and the bur. Furthermore fractures and anomalies of the teeth
shape were found on those same incisors with the tomographic analysis. At last, the histological study showed irregularities of the enamel and fractures predominantly in the nail cutter group. The fractures were in the majority of cases correlated with a local severe inflammation of the periodontal tissues.

**Conclusion and clinical relevance:** This study allows a more accurate overview of the possible short-term side effects of the three cutting methods. The most severe were found in the nail cutter group (fractures, enamel and bone modifications, inflammation) but slight changes were also observed with the disc and bur. We concluded, for animal wellbeing reasons and good clinical practices, that the use of a nail cutter can’t be recommended for the teeth trimming. The diamond disc and bur have to be handled with care and further studies are needed to show long-term effects of these methods.

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**Oral examination and treatment in 6 spotted hyenas (Crocuta crocuta)**

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Hyenas remain rare dental patients and opportunities to examine and treat their oral cavity are uncommon. Six captive hyenas kept in a park in South Africa were anesthetized for the purpose of examining and treating their dentition. Periodontal disease was minimal but all the patients suffered from uncomplicated and complicated crown fractures. Treatments consisted of extractions and endodontic therapy.

**Anatomy:** The dental formula of hyenas is as such: I 3/3, C 1/1, P 4/3, M 0-1/1, total 32 to 34 teeth. The morphology of those teeth is similar to the one of cats. Each quadrant supports an extra tooth compared to the cat. That tooth, on both maxillary and mandibular arcades, is pyramidal in shape, designed to crush.

**Oral examination:** There was only marginal gingivitis present. Pathology was mostly associated with crown fractures. Some wear was also present.

**Treatment:** Teeth with uncomplicated fractures were left alone. Teeth with complicated fractures were either extracted or underwent standard root canal therapy. The details of the treatments will be covered during the presentation.

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**Cheylitis in pet guinea pigs**

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**Summary**

Cheylitis is a relative common disease in guinea pigs. The inflammatory process may include the perioral skin, the vermilion border, nasal philtrum and labial mucosa. In guinea pigs, gingiva at the dentogingival junction of the maxillary incisors is also commonly affected. This article describes aetiology, clinical symptoms, diagnostics and therapy of this disease.
Definition

Cheilitis is a well recognized disease and many aetiological factors can contribute to the onset and progression of the disease (sun exposure, contact dermatitis, malnutrition, hypersensitivity/allergy). Also in guinea pigs, it seems that cheilitis is a multifactorial disease.

Aetiology

In human medicine, the cheilitis is a well recognized disease and many aetiological factors can contribute to the onset and progression of the disease. In guinea pigs, this multifactorial disease can be difficult.

Clinical symptoms and signs

Clinical symptoms are associated with primary disease or with pain during feeding. Lower intake of food or anorexia and/or progressive weight loss are common for most of the guinea pigs presented to the clinic.

Diagnostics

Diagnosis is based on clinical signs. Primary cause need to be thoroughly investigated (history included – e.g. leaking drinking bottle) as, if the primary cause is not solved, cheilitis will not resolve. Skin scrapings and impression cytology is a gold standard in the first diagnostic approach. Bacteriology and mycology will find the exact pathogens involved in the inflammation and antibiotic testing can show further steps in medical therapy. Culture of swabs taken from the lesions of the mouth may reveal S. aureus, other staphylococci and Candida albicans. Skin biopsy is not usually necessary, but in cases nonresponsive to therapy is recommended. Thorough oral cavity examination, skull radiography and/or computed tomography examination are necessary to rule in or rule out the dental disease.

Therapy

Therapy consists of the adjustment of housing and local and systemic treatment. As a substrate, paper towels or Asan litter which is the substrate without any dust or airborne allergens. Diet and vitamin C administration need to be evaluated and discussed with a client, as many owners already adding relatively high levels of vitamin C to their guinea pigs. Abrasive food or acidic fluid should be removed from a diet.

In case of local therapy crusts are removed under the anaesthesia and topical creams/ointments are applied to the lips. Necrotic gingiva/interdental papilla need to be excised and space in between the ma-
xillary incisor carefully debrided.

Authors have, as a first topical drug applied, with potassium permanganate (KMNO₄), which has antifungal and antibacterial effect. Ointments/better creams are applied frequently (i.e. more than 4 times a day) to the lips and nasal philtrum in a thin layer. Ointments which contain drugs (beta-lactamines, linkosamides, etc.) contraindicated for the peroral use in guinea pigs should be avoided. Authors have good experience with the combination of cream containing Natrii hyaluronas and Sulfadiazinum argenteum and dexpanthenol. Local antimykotics are applied after the cultivation and commonly terbinafine is applied once per day (or once per week). Some cases can also respond to local mupirocin treatment and vitamin C supplementation.²

Systemic treatment includes administration of meloxicam (0.2-0.4 mg/kg PO twice a day). Supportive care consisting, if necessary, of force-feeding (Recovery Supreme, Emeraid Herbivore Critical care, Oxbow Critical Care, etc.) and fluid therapy (preferably IV access, otherwise subcutaneous administration).

In case of skin necrosis, surgical excision is the option.

Length of the treatment can be in days till 3 months in dependence on case.

References

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The dental and temporomandibular joint pathology of three bear species

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Polar Bear (Ursus maritimus)

Museum specimens (maxillae and/or mandibles) from 317 polar bears (Ursus maritimus) were examined macroscopically according to predefined criteria and 249 specimens were included in this study. The specimens were acquired between 1906 and 2011. There were 126 specimens (50.6%) from male animals, 93 (37.3%) from female animals and 30 (12.1%) from animals of unknown sex. The ages of the animals ranged from neonate to adult, with 125 adults (50.2%) and 124 young adults (49.8%) included and neonates/juveniles excluded from the study. The number of teeth available for examination was 7,638 (73.5%); 12.3% of teeth were absent artefactually, 0.8% were deemed absent due to acquired tooth loss and 13.4% were absent congenitally. With respect to tooth morphology, 20 teeth (0.26% of available teeth) in 18 specimens (7.2% of available specimens) were small vestigial structures with crowns that were flush with the level of surrounding alveolar bone. One supernumerary tooth and one tooth with enamel hypoplasia were encountered. Persistent deciduous teeth and one tooth with enamel hypoplasia were encountered. Persistent deciduous teeth and one tooth with an aberrant number of roots were not found. Relatively few teeth (3.7%) displayed attrition/abrasion, 90% of which were the maxillary and mandibular incisor teeth, in 41 polar
bears (16.5%). Nearly twice as many adult specimens exhibited attrition/abrasion as those from young adults; significantly more males were affected than females. Dental fractures were noted in 52 polar bears, affecting 20.9% of specimens and 1.3% of the total number of teeth present. More adult polar bears had dental fractures than young adults. There were 21 specimens (8.4%) that displayed overt periapical disease, affecting a total of 24 dental alveoli (0.23%). Some degree of periodontitis was seen in 199 specimens (79.9%); however, only 12.6% of dental alveoli had bony changes indicative of periodontitis. Lesions consistent with temporomandibular joint osteoarthritis (TMJ-OA) were found in 23 specimens (9.2%). TMJ-OA was significantly more common in adults than in young adults and in males than in females. Although the clinical significance of dental and TMJ pathology in the polar bear remains elusive, the occurrence and severity of these lesions may play an important role in the morbidity and mortality of this species.

**American Black Bear (*Ursus americanus*)**

Museum specimens (maxillae and/or mandibles) from 371 American black bears (*Ursus americanus*) acquired between 1889 and 2006 were examined macroscopically according to predefined criteria, and 348 were included in this study. Of the 348 specimens, 126 (36.2%) were from male animals, 106 (30.5%) were from female animals and 116 (33.3%) were from animals of unknown sex. Specimen ages ranged from young adult (n=63, 18.1%) to adult (n=285, 81.9%), with juveniles excluded from the study. The number of teeth available for examination was 12,019 (82.2%); 7.0% of teeth were absent artefactually, 0.4% were deemed absent due to acquired tooth loss and 9.7% were absent congenitally. In 43 specimens (12.3%), 82 teeth (0.68%) were small vestigial structures with crowns that were flush with the level of surrounding alveolar bone. The remaining teeth (99.3%) were of normal morphology. Only three supernumerary teeth and three instances of enamel hypoplasia were encountered. Persistent deciduous teeth or teeth with an aberrant number of roots were not encountered in any of the specimens. Approximately one-third of the teeth examined (4,543, 37.8%) displayed attrition/abrasion, affecting nearly all of the specimens (n=338, 97.1%). Incisor and molar teeth accounted for 52.5% and 34.3% of the affected teeth, respectively, with significantly more adults affected than young adults. Dental fractures were noted in 63 bears, affecting 18.1% of specimens and 1.0% of the total number of present teeth. The canine teeth were most often fractured, with adults having significantly more complicated crown fractures of these teeth than young adults. There were 11 specimens (3.2%) that displayed periapical lesions, affecting 12 (0.1%) dental alveoli. There were 179 specimens (51.4%) displaying bony changes indicative of periodontitis, affecting 816 (6.8%) dental alveoli. The proportion of adult bears affected by periodontitis (57.9%) was significantly greater than that of young adults (22.2%). Exactly half of the specimens (n=174) possessed lesions consistent with mild temporomandibular joint osteoarthritis. The occurrence and severity of the dental pathology encountered in this study may play an important role in the morbidity and mortality of the American black bear.

**North American Brown Bear (*Ursus arctos*)**

Museum specimens (maxillae and mandibles) from 393 North American brown bears (*Ursus arctos*) from Alaska were examined macroscopically according to predefined criteria and 204 specimens were included in this study. The specimens were acquired between 1905 and 2012. There were 99 specimens (48.5%) from male animals, 87 (42.7%) from female animals and 18 (8.8%) from animals of unknown sex. The ages of the animals ranged from neonate to adult, with 92 adults (45.1%) and 112 young adults (54.9%) included and neonates/juveniles excluded from the study. The number of teeth available for examination was 6,525 (76.2%); 8.6% of teeth were absent artefactually, 0.8% were deemed absent due to acquired tooth loss and 14.5% were absent congenitally. None of the brown bears had supernumerary teeth, persistent deciduous teeth or abnormally formed crowns. Only four of the specimens in the present population were affected by enamel hypoplasia and one specimen contained two mandibular fourth premolar teeth with one root instead of two. All 204 specimens displayed at least some degree of attrition/abrasion, affecting 63% of all teeth, ranging from mild wear of the enamel to deep abrasion associated with pulp exposure. Ten-times more adult than young adult specimens had abrasion causing pulp exposure, while more young adults showed mild attrition/abrasion. Dental fractures were noted in one-third of brown bears and in 3.0% of the total number of present teeth. More adult brown bears had dental fractures than young adults. There were 11 specimens (5.4%) that displayed overt periapical disease, affecting a total of 20 dental alveoli (0.22%), with adults significantly more affected than young adults. Some degree of periodontitis was seen in 145 specimens (71.1%), affecting 13.6% of all dental alveoli. Nearly one-third (29.9%) of skulls displayed skeletal and/or dental malocclusion,
most commonly a level bite. Lesions consistent with temporomandibular joint (TMJ) osteoarthritis were found in 27 specimens (13.2%). Caries lesions were discovered in four specimens (2.0%), affecting eight teeth in total. Although the clinical significance of dental and TMJ pathology in the brown bear remains elusive, the occurrence and severity of some of these lesions may play an important role in the morbidity of this species.

References


Marine mammal oral trauma – 7 cases

Judy G. Force

Dentistry for Animals (private practice veterinary dental specialty practice)

California sea lions (Zalophus californianus) inhabit the west coast of Baja California, the coast of the western United States and British Columbia. Their dental formula is: I 3/2 C 1/1 PM 4/4 M 1/1. However all the teeth distal to the canine teeth have the same morphology and are commonly referred to as "post-canines".

The sea lions in this presentation were both stranded and presented to a marine mammal rehabilitation center. The goal for the two pups with mandibular fractures was to return them to the wild. Sea lions may also be encountered with dental or oral pathology that require veterinary care in zoological or marine parks.

The first case was a juvenile, male sea lion, approximately 8 months of age. He was found stranded on a beach in Southern California in an emaciated condition. On admission to the rehabilitation center, he had harsh lung sounds on auscultation and it was suspected that he had pneumonia, an abscess and malnutrition. He also had a firm swelling on his right mandible. He was not eating on his own and required tube feeding four times per day. He was started on ciprofloxacin and subcutaneous fluids. Although his lungs cleared and his labwork improved over the next five weeks, he had no interest in eating fish and the swelling on his jaw remained unchanged. General anesthesia was administered and skull and thoracic radiographs were performed. A right mandibular fracture was found at the level of the open apex of the canine tooth. There also appeared to be a non-vital tooth that was mobile on clinical examination (second premolar/post-canine). Left lung consolidation on the radiographs confirmed pneumonia.

Anesthesia was performed one week later to stabilize the mandibular fracture and extract the abscessed tooth. On clinical examination the mandibular fracture was very unstable. The mobile, non-vital 2nd premolar tooth (406) was surgically extracted. A culture was obtained from the fracture site/tooth alveolus. A granuloma and a calcified collar of cartilage was curetted out of the alveolus. The edges of the fracture were curetted and the fracture site was flushed with sterile saline. A suture of 0-prolene was placed subgingivally around the 3rd post canine tooth and through the buccal cortex of the mandibular bone adjacent to the fracture site. When the suture was in place the fracture was reduced, occlusion good and the site was much more stable, though there was still slight mobility. The gingiva was debrided and sutured with 3-0 vicryl in a simple interrupted pattern. No tension was present at the suture line.

The evening of the surgery, the sea lion began eating fish without help and was much less tolerant of the staff. He was manually restrained periodically over the next few weeks and carefully examined without manipulating the mandible.

The culture grew a mixed flora of bacteria with Pseudomonas predominating. His antibiotics were switched to gentamycin.
Four weeks later the sea lion was anesthetized for a recheck examination with intraoral radiographs. The fracture site was stable with good callus formation. The large suture material was protruding through the gingiva and was removed. There was no evidence of infection. The right mandibular canine tooth appeared denser on radiographs than the left. The rehabilitation staff decided to release the patient to the wild because the fracture and extraction site were healing well, the animal was getting fat and he was becoming more stressed in the rehab center environment. Although, the treatment was successful, the author feels that threading the large suture material through the bone, rather than subgingivally would provide better stabilization.

The second sea lion patient was also found in an emaciated condition stranded on a beach. He was approximately 9 months old. He had transverse fractures of both mandibles at the level of tooth 306 & 406 and the open apices of the partially erupted canine teeth. On the left side tooth 306 was mobile and had a slight discharge when examined. Radiographically, it had a small root fracture. The pup's fractures were radiographed at occlusal and lateral angles. The fracture site was mobile on the left side but minimally displaced. The fracture on the right mandible was stable and had more periosteal reaction than the left. Tooth 406 had an abnormal appearance but was thought to be vital. No apical lucency was identified and it is part of the healing fracture so it was left in place at that time.

The mobile tooth 306 was extracted and the cartilaginous collar and root fragment removed. A small granuloma was curetted out of the alveolus, the edges of the fracture were freshened by curettage and the fracture site was flushed with sterile saline. The gingiva was debrided and sutured with 3-0 vicryl in a simple interrupted pattern. No additional stabilization was performed at this time.

Anesthesia was performed 4 weeks later and radiographs revealed that the fracture sites were healing well. However the apex of tooth 304 was dark with apparent fluid density. Clinically there was a draining tract in the gingiva that led to the apex of tooth 304. When the tract was probed, the probe went in greater than 18 mm and there was purulent discharge. On the right side there was no mobility, the fracture site was healing very well, the apex had near-normal open apex architecture and there was no radiographic evidence of pathology.

Tooth 304 was surgically extracted and the abscess was flushed with copious sterile saline and the alveolus curetted. The gingiva was debrided and sutured in a simple interrupted pattern with 3-0 vicryl with no tension on the suture line.

Three weeks later anesthesia was performed again. Intraoral radiographs of the fracture and extraction sites revealed that the transverse fractures of both mandibles at the level of the mandibular second premolar had healed well. On the left side there was no mobility, the extraction site of tooth 304 was filling in with new bone and the intraoral radiographs revealed bridging of the fracture site with good alignment of the mandible. The gingiva had dehiscence that was very mild with no depth to the pocket. The remaining premolar appeared normal with a normal radiographic appearance. On the right side there was no mobility, the fracture site was completely healed and the apex of the remaining mandibular canine tooth (404) had normal open apex architecture and there was no radiographic evidence of pathology. Tooth 404 had begun erupting again.

This sea lion had been eating all along in spite of having bilateral mandibular fractures. However, after the abscessed canine tooth was extracted, he ate better, no longer tolerated the support staff, put on weight and became much more stressed in the rehab center environment. A decision was made to release him to the wild.

Both of these cases illustrate how minimal stabilization, extraction of infected teeth and supportive care can lead to mandibular fracture healing and return to the wild.

Three juvenile northern elephant seals (Mirounga angustirostris) were presented to a marine mammal rehabilitation center in California. Common causes for rehabilitation include maternal separation, malnutrition, and trauma, including shark bites. Several cases of fractured teeth secondary to traumatic events present to the center each year. All were initially stranded and underweight. They were found to each have a fractured canine tooth with pulp exposure. These were immature teeth with open apices. This species is too large and aggressive to be successfully kept in captivity and all rehabilitation efforts are aimed at returning them to the wild.

The fractured canine teeth were surgically extracted. Gingival flaps were raised, the root pieces elevated, curettage and flushing performed and the flaps closed without tension with 4-0 and 3-0 poliglecaprone 25 (PDS).

Upon recovery all 3 animals had successful rehabilitation and were returned to the wild.
The dentition of elephant seals differs from other phocid species in that the post canine teeth (premolars and molars) are basically non-functional, and there is pronounced sexual dimorphism. The post canine teeth are single or at times double rooted and become peg-like with wear and abrasion of the thin enamel. The difference between the premolars and molars can be minimal. Three different morphological types of post canine teeth in the maxilla and mandible have been described. Type I, are single rooted with rudimentary cusps, type II a,b,c, are single cusp, bicuspid, and tricuspid respectively, and type III teeth are similar to the molar tooth in other Pinnipeds. The first premolar of male seals is frequently absent, possibly due to the competition for space with the much larger canine tooth. The canine teeth of males are considerably longer and thicker than females, and this sexual variance is evident in newborn pups. The primary, or milk, dentition is minute and non-functional, and is lost soon after birth. The adult elephant seal has 30 teeth with a formula of I 2/1, C 1/1, PM 4/3-5, M 1/1. The pups have all 30 teeth by the time they are weaned. There is some variation in this formula with supernumerary teeth, persistent deciduous teeth, and absent post canine teeth.

The alveoli of the first premolars are generally confluent with the alveoli of the canines, thus requiring extraction of this first premolar when the canine tooth is extracted. The apices of the teeth remain open for 7 to 12 years. As very few adult and sub-adult elephant seals are ever maintained in captivity or rehabilitated, most dental work will likely be performed on stranded weanlings and yearlings with very thin enamel, thin dentinal walls, wide pulp canals and an open apex.

Both sea lions and true seals are breath holders and require special considerations when anesthetized. Injectable sedatives shorten the time required for intubation considerably. They do much better in sternal recumbancy than they do in dorsal or lateral recumbancy during anesthesia and they generally require positive pressure ventilation. It is important that they don’t get overheated during the procedure or during recovery. They are watched closely during recovery to make sure they are ventilating well and that they don’t traumatize their heads on hard surfaces during recovery.

The last two cases were sea otters with canine tooth fractures. The first was at a marine mammal rehabilitation center. He was an adult male, approximately 8 years of age. He had domoic acid toxicity (from algae bloom) leading to minor brain damage and was felt to be functional and appropriate for release back into the wild. He had one maxillary canine tooth and one mandibular canine tooth fractured with pulp exposure. Both had closed apices. One tooth was discolored with a much wider pulp chamber indicating it had fractured at least a few years previously. There was a moderate apical lucency at this tooth. The other had a much smaller pulp chamber and minimal bleeding and no apical lucency indicating it was a fresh fracture.

Root canal therapy was performed at both of these teeth and restorations were placed at the fracture and access sites.

The second sea otter was permanently placed at an aquarium. She was at times on display at the aquarium and at other times was a surrogate mother for sea otter pups that were rescued and rehabilitated at the aquarium. Her tooth had been fractured for a couple of months at the time of presentation. There were vertical as well as a horizontal fractures and this tooth was a poor candidate for root canal therapy. The tooth was surgically extracted and the alveolus curetted and flushed. The gingival flap was closed with 4-0 polica-prone 25 without tension and healed uneventfully.

The dental formula of a sea otter (Enhydra lutris) is: I 3/2, C 1/1, PM 3/3, M 1/2.

They have large flat molars to effectively chew on various crustaceans, moluscs and sea urchins, the main component of their diet. They also eat some species of fish. They have vibrissae on their muzzles. They have an exceptionally thick pelt, the densest in the animal kingdom, which is the reason they were nearly hunted to extinction between 1741 and 1911. Although they are now protected, they remain an endangered species.

Sea otters are much shallower divers. Both sea otters reported here were given injectable sedation of fentanyl and ketamine, intubated and kept on oxygen. After about an hour under anesthesia a small amount of isoflurane was introduced. Sea otters tolerate dorsal and lateral recumbancy much better than seals and sea lions. They are fanatic groomers however, and human scent, alcohol and dental products can keep them grooming themselves obsessively for hours after recovery.

References available upon request.
Dental and temporomandibular joint pathology of the Gray Wolf (*Canis lupus*)

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Museum specimen (skulls) from 392 gray wolves (*Canis lupus*) were examined macroscopically according to predefined criteria. Juvenile, neonates, and incomplete specimen were excluded. Two hundred and eight skulls were included in this study, encompassing 124 (59.62%) skulls of young adults and 84 (40.38%) adults. Thirty-five (31.25%) skulls were documented to be from male wolves, 105 (50.48%) were from females, and for 38 (18.27%) the sex was unknown.

Out of 8,736 possible teeth, 8,381 (95.94%) were present for evaluation. Fifty-five (15.49%) teeth were congenitally absent, 30 (8.45%) were lost during life, and 270 (76.06%) were artefactually lost post-mortem. Supernumerary teeth and teeth affected by odontodysplasia did not occur in either of the specimen. Retained deciduous teeth occurred in 2 (0.96%) specimen affecting 1 (0.01%) tooth each. Enamel hypoplasia occurred in 5 (2.40%) skulls and 8 (0.10%) teeth in total. An abnormal number of roots was found on 13 (6.25%) skulls, affecting 23 (0.27%) teeth. A combined anatomical/developmental and periodontal lesion – fenestration or dehiscence – was associated with 203 (2.42%) teeth on 72 (43.62%) skulls.

Periodontal disease, stages 2-4, was noted on 115 (55.29%) skulls. Exactly 1,000 (11.93%) teeth were affected by any of the periodontal disease stages 2-4. In proportion, significantly more adults (n=63, 75%) than
Oral and dental examination findings in a group of zoo squirrel monkeys (Saimiri boliviensis)

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Squirrel monkeys (Saimiri boliviensis) are one of the New World monkey species from the family Cebidae. They are diurnal and arboreal by nature and live in large troops of 10 to 55 individuals. They are omnivorous and their diet is primarily comprised of insects and fruits. Squirrel monkeys have 36 adult teeth with a dental formula: 2x (I2/2, C1/1, P3/3, M3/3). Data on their oral and dental health is scarce.

As a part of annual wellness check, we examined 7 adult (4 were 10 and 3 were 15 years old) males weighing between 700 and 1100 grams. No oral discomfort was observed in any of the animals prior to the procedure. Detailed oral and dental examination supported by dental radiographs (6 views with additional 2 parallel views of the mandible, where possible) was performed.

Of 252 maximum potential teeth, 244 were present and evaluated. One animal had a supernumerary right maxillary 3rd premolar tooth. All animals had gingivitis, but no periodontitis was diagnosed in any of the animals. Attrition/abrasion was the most common dental pathology (11.1% of all teeth). Dental caries was a common feature in the 3 older animals (18.3% of their 104 teeth). We found 8 fractured teeth in 4 animals. It was mostly impossible to evaluate root morphology, especially in the maxillary premolar and molar teeth, due to superimposition of structures on the radiographs or difficulty obtaining radiographs of the molar teeth with standard radiographic techniques. However, all incisor, canine and mandibular premolar teeth were single-rooted. Radiographs also revealed radiopaque tissue in the apical portion of the root canal in maxillary canine teeth, with no other radiographic signs of endodontic disease in clinically intact teeth. Further investigation is warranted to elucidate the importance of this finding.

References

Follow-up on simple (nonsurgical) extraction of fractured canine teeth in domestic ferrets (*Mustela putorius furo*)

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Fractures of (especially maxillary) canine teeth are a common problem of domestic ferrets (*Mustela putorius furo*). Treatment (either extraction or endodontic treatment) is warranted, especially when dental pulp is involved. This study investigated clinical, radiographic and histological signs associated with complicated crown fractures of maxillary canine teeth in ferrets and evaluated the outcomes of simple extraction of affected teeth. Eighteen adult ferrets (mean age 3.5 years; 5 females and 13 males) were treated (simple extraction) for 23 complicated crown fractures of periodontally healthy maxillary canine teeth. None of the animals were showing signs of oral discomfort prior to the procedure. Only two teeth were discolored on clinical examination. No radiographic evidence of endodontic disease was observed in 11/22 canine teeth, while either inflammatory root resorption, periapical lesion, widening of periodontal ligament space apically and/or failure of the pulp cavity to narrow were observed in others. Histological examination was performed in 8/23 fractured teeth, and pulp appeared normal in 5 of these cases (4/5 showed no radiographic evidence of endodontic disease), pulpitis was diagnosed in 2 (both without radiographic evidence of endodontic disease) and pulp necrosis in 1 case (radiographs revealed widening of periodontal ligament space apically and failure of the pulp cavity to narrow). All ferrets healed uneventfully by the 2-week re-check, although 8/18 developed post-extraction upper lip entrapment with mandibular canine tooth. However, ferrets showed no signs of discomfort and clients reported 7/18 ferrets to be more playful and eating better on 6 – 24 months follow-up over the phone.

References

Oral and dental examination findings in a group of zoo black-tufted marmosets (Callithrix penicillata)

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Black-tufted marmosets (Callithrix penicillata) belong to the family Callitrichidae and primarily reside as families of 2 to 14 individuals in the rainforests of the Brazilian Central Plateau. They have 32 teeth in adult dentition (2x (I2/2, C1/1, P3/3, M2/2)) and are specialized exudatvores; their diet is primarily comprised of plant exudates (sap, resin, gums, and latex) which are acquired by nibbling the bark with their lower incisors.

This report describes oral and dental examination findings in eight (five males, three females) one to seven years old black-tufted marmosets undergoing general anaesthesia for their annual wellness check. Detailed oral and dental examination supported by dental radiographs revealed that of 256 maximum potential teeth, four teeth were missing in two animals. One incisor tooth was affected by odontodysplasia. Gingivitis (PD 1) was diagnosed in all animals, but only the three individuals aged three years and above had periodontitis, affecting 19.4% of their teeth (PD 2/early periodontitis 55.6%, PD 3/moderate periodontitis 16.6%, and PD 4/advanced periodontitis 27.8% of the affected teeth), mostly premolar and molar teeth. Apart from radiographically identified non-vital mandibular canine tooth, no other endodontic disease or attrition/abrasion was observed in any of the animals.

Dental radiographs obtained using standard techniques were proven useful to evaluate anatomy and pathology of all incisor, canine, mandibular premolar and first molar teeth, while those of the rest of the dentition were either difficult/impossible to obtain or interpret. Based on these findings we believe that it is safe to conclude, that black-tufted marmosets are mostly affected by periodontal diseases. Therefore annual oral/dental examination with periodontal treatment is warranted, especially in animals older than three years.

References


**Tipps und Tricks zur Oralen Untersuchung bei der Katze und beim Hund**

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**Einleitung**

Tatsachen belegen, dass die häufigsten Erkrankungen bei Hund und Katze (ähnlich wie beim Menschen) in der Maulhöhle zu finden sind, aus diesem Grund sollte der detaillierten oralen Untersuchung besondere Aufmerksamkeit geschenkt werden.

Generell lässt sich die orale Untersuchung einerseits in eine extra- und eine intraorale Untersuchung gliedern, andererseits können bestimmte Einsichtnahmen am wachen Patienten schwierig bis unmöglich werden, sodass der detaillierte stomatologische Untersuchungsgang in Allgemeinanästhesie durchgeführt werden muss.

Bevor sich der Untersucher der Maulhöhle eines Hundes bzw. einer Katze im Wachzustand nähert, sollten folgende Fragen in Betracht gezogen werden:

- Ist mir das Tier freundlich gesinnt, oder wie kann ich darauf Einfluss nehmen?
- Das Öffnen des Fanges löst immer Panik aus, wann ist dafür der richtige Zeitpunkt?
- Wie sehr sollte ich den Besitzer in die Untersuchung involvieren?
- Wie beeinflusse ich mit meiner Untersuchung das zukünftige Verhältnis Tierbesitzer – Tier – Tierarzt?
- Wie bereite ich den Besitzer auf mögliche Folgebehandlungen nach der Diagnostik in Narkose vor?

**Untersuchung am wachen Patienten**

In der Praxis gliedert sich die orale Untersuchung in einen vor allem extraoralen Teil in der Ambulanz. Hier wird der Kopf des Tieres auf folgende Parameter untersucht und palpiert:

- Augenausfluss, Nasenausfluss, Speichelfluss
- Asymmetrien im Kopfbereich
- Kaumuskulatur
- Retropulsion der Augen
- Nasenrücken
- Lefzen
- Mandibeln
- Mandibuläre Lymphknoten
- Speicheldrüsen (Gl. mandibularis)
- Palpation des Kehlkopfes

In weiterer Folge kann beim genügsamen Tier auch die korrekte Verzahnung bzw. Okklusion durch Heben der Lefzen seitlich und von vorne begutachtet werden. Auf diese Weise kann auch die bukkale und labiale Lezenschleimhaut, Gingiva und Alveolarmukosa begutachtet werden.

Erst zuletzt sollte vorsichtig das Maul des Hundes oder der Katze geöffnet werden. Am besten greift eine Hand von dorsal (Nasenrücken) kommend hinter den Oberkiefercanini in den prämolaren Bereich mit Daumen und Mittelfinger und versucht vorsichtig den Oberkiefer nach dorsal zu bewegen. Gleichzeitig greift die anderen Hand den Unterkiefer zwischen den Unterkiefercanini im Inzisivus Bereich (Zeigefinger) und mit Daumen und Zeigefinger in den unterkieferprämolaren Bereich und zieht vorsichtig die Mandibeln nach ventral. Nachdem der Fang vorsichtig mit gleichmäßigem Zug geöffnet wird, gleitet der Daumen der Hand...
des Oberkiefers in den Bereich der Papilla inzisiva und löst dort einen Reflex aus, der es dem Hund untersagt das Maul zu schließen.

Bei der Katze kann das Heben des Kopfes zu einem geringen Öffnen der Maulhöhle führen und damit den Griff in den Unterkieferinzisivus Bereich erleichtern. Trotzdem sollte immer äußerste Vorsicht geboten werden, wenn die Finger des Untersuchers in der Maulhöhle zu liegen kommen sollten.

Im geöffneten Zustand kann nun die Anzahl und Stellung der Zähne, deren Zustand (Farbe, Abrasionen/Attritionen, Frakturen, Fissuren, Resorptionen), Plaque und Zahnsteinakkumulation und der Zustand des Parodonts (Farbe, Blutungen) beurteilt werden. Ist genügend Vertrauen zum Tier vorhanden, können Zähne auch bewegt werden, um etwaige Lockerungen zu detektieren.


Im Anschluss an die intraorale Einsichtnahme und nachdem dem Patienten eine kurze Pause genehmigt wurde, sollte nochmals der Öffnungswinkel und durch versuchte Lateralbewegung der Mandibeln die Schmerzfreiheit und Stabilität der Kiefergelenke untersucht werden. Um die gewonnenen Befunde für eine spätere Untersuchung in Narkose nicht zu verlieren, ist es ratsam schon im Wachzustand mit dem Ausfüllen eines sogenannten Dental Charts (siehe Beilage) zu beginnen.

Am Ende einer Untersuchung im Wachzustand steht meist das persönliche Gespräch mit dem Tierbesitzer. Hierbei sollten auf jeden Fall die vorliegenden Befunde und das weitere Vorgehen besprochen werden. Oft lässt sich der gesamte Umfang der folgenden Behandlung zu diesem Zeitpunkt noch nicht ganz klar umschreiben, sodass auf jeden Fall mögliche „Was wäre wenn“-Szenarien besprochen werden sollten. Der eigenen Erfahrung nach sollte überlassen werden, auf ein ständiges Vorgehen mit dem Tierbesitzer, das eine Verständigung aller Beteiligten erleichtert.

Untersuchung am anästhesierten Patienten


Unter Zuhilfenahme des Dental Charts werden in Narkose folgende fehlenden Parameter ergänzt (siehe Anhang für Hunde und für Katzen).

- Korrekte Zahn- und Kieferstellung
- Relation der Ober- und Unterkiefer, sowie deren Symmetrie
- Extraorale Veränderungen
- Regionale Lymphknoten
- Freie Mukosa
- Zunge
- Tonsillen und Pharynx


Fifty shades of grey? Beurteilung von Dentalröntgenaufnahmen bei der Katze

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Dentale und orale Erkrankungen bei Katzen gehen häufig mit einer unspezifischen Symptomatik einher. Wichtige orale Strukturen, wie Zahnwurzeln und Kieferknochen, sind zudem der klinischen Untersuchung unzugänglich.


Dentale Röntgenaufnahmen liefern zusätzliche klinisch wichtige Befunde an klinisch unauffälligen Zähnen bei 42% der Katzenzähne. An klinisch erkrankten Zähnen können bei der Katze in 32% der Fälle zusätzliche klinisch wichtige Befunde im Röntgen erhoben werden.


Vor der eigentlichen Befundung eines Röntgenbildes sollte immer die Beurteilung der Aufnahmequalität stehen. Folgende Kriterien sollten hierzu beurteilt werden:

- Bildqualität (Auflösung, Kontrast)
- Vollständige Abbildung des Objektes
- Abbildung des Objektes in Originalgröße und ohne Verzerrungen
- Artefakte

Nur Aufnahmen in ausreichender Qualität sollten befundet werden. Im Gegensatz zu konventionellen Röntgenfilmen erlauben digitale Röntgenbilder eine Nachbearbeitung nach Erstellung der Aufnahme, welche jedoch mit Bedacht erfolgen sollte, um keine Bildinformationen zu verlieren und andererseits auch keine Artefakte zu provozieren.


Die folgende Vorgehensweise bei der Bildbefundung wird empfohlen:

Befundung der Anatomie
- Milchgebiß, bleibendes Gebiß oder Wechselgebiß?
- Fehlende Zähne?
- Nicht durchgebrochene Zähne?
- Lageveränderungen von Zähnen?
• Anatomische Variationen (Wurzeldilazeration, Fusion, Gemination, überzählige Zähne oder Wurzeln etc.?)?

**Parodontale Beurteilung**
• Dem Umriß der Zahnwurzeln folgend wird die Weite und Gleichmäßigkeit des Parodontalspaltes (Raum zwischen der Lamina dura und dem Wurzelzement) beurteilt. Anschließend beurteilt man die Höhe des Alveolarkamms und den trabekulären Knochen interproximal und in den Bifurkationen.

**Endodontische Beurteilung**
• Die Weite und Form der Pulpenkammern und Wurzelkanäle werden verglichen. Anschließend wird die Knochendichte der periapikale Region des Kieferknochens beurteilt.

**Weitere Veränderungen**
• Resorptive Läsionen?
• Ankylose?
• Zahn- und Wurzelfrakturen?
• Veränderungen am Kieferknochen (z.B. durch Tumor, Osteomyelitis, Zysten, Frakturen, metabolische Erkrankungen etc.)?

Folgende anatomische Strukturen können sich im Röntgen abbilden und dürfen nicht mit pathologischen Veränderungen verwechselt werden:
• Mandibularkanal
• Foramina mentalia
• Foramen infraorbitale
• Fissura palatina

Im Laufe der Präsentation werden typische röntgenologische Veränderungen häufiger dentaler Erkrankungen und auch seltener oder überraschende Röntgenbefunde bei der Katze vorgestellt und diskutiert. Dabei liegt ein Schwerpunkt auf der Beurteilung resorptiver Läsionen, die einen Großteil der röntgenologischen Veränderungen an den Zähnen der Katze darstellen.

**Literatur**

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**Fifty shades of grey? Beurteilung von Dentalröntgenaufnahmen beim Hund**

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Auch beim Hund gehen dentale und orale Erkrankungen häufig mit einer unspezifischen Symptomatik einher. Wie bei der Katze sind auch beim Hund wichtige orale Strukturen, wie Zahnwurzeln und Kieferknochen der klinischen Untersuchung unzugänglich. Aus diesem Grund sind zusätzliche bildgebende Verfahren zur Ergänzung und Objektivierung der klinischen Befunde unbedingter Bestandteil einer vollständigen Un-
Untersuchung der Maulhöhle. Sie sind in sehr vielen Fällen die Voraussetzung für eine vollständige und korrekte Diagnose und Prognose und zur Erstellung eines adäquaten Therapieplanes. Besonders aussagekräftig und einfach in der Anwendung ist hierfür auch beim Hund das intraorale dentale Röntgen.

Dentale Röntgenaufnahmen liefern zusätzliche klinisch wichtige Befunde in 28% der klinisch unauffälligen Hundezähne. An klinisch erkrankten Zähnen können beim Hund in 23% der Fälle zusätzliche klinisch wichtige Befunde im Röntgen erhoben werden.

Die Beurteilung der Aufnahmequalität und die Bildbeurteilung erfolgt bei Dentalröntgenbildern des Hundes in der selben Weise wie für die Katze beschrieben. Folgende anatomische Strukturen können sich in Dentalröntgenbildern des Hundes abbilden und dürfen nicht mit pathologischen Veränderungen verwechselt werden:

- Mandibularkanal
- Foramina mentalia
- Foramen palatinum major
- Foramen infraorbitale
- Fissura palatina
- Chevron Aufhellungen


Literatur


Hilfe, mein Tier bekommt das Maul nicht zu! Überblick über Differentialdiagnosen

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Einleitung

Mögliche Differentialdiagnosen für Schwierigkeiten beim Verschliessen des Maules inkludieren die rostrodrosa Kiefergelenksluxation und die Kiefersperre mit offenem Maul, und weniger häufig auch Zahluxationen, Frakturen von Kiefer- und Gesichtsknochen, und neuromuskuläre Erkrankungen.

Kiefergelenksluxation


Bildgebende Techniken ermöglichen eine definitive Diagnose. Dorsoventrale Röntgenaufnahmen zeigen einen erweiterten Kiefergelenkspalt und eine rostrale Verschiebung des Caput mandibulae an der
betroffenen Seite. Laterale Aufnahmen, mit dem Kopf um 10-15° rotiert oder der Nase um 10° angehoben, sowie die Komputertomographie (CT), vor allem die dreidimensionale Rekonstruktion des Schädels, können auch gemacht werden.


Nach erfolgter Reduktion wird ein Schnauzenhalfter für 2-4 Wochen angelegt, damit die eingerissene Gelenkskapsel heilen und das Auftreten einer chronischen Luxation vermieden werden kann. Die chronische Kiefergelenksluxation wird mittels einer Konkylektomie behandelt.

### Kiefersperre mit offenem Maul


### Differentialdiagnosen

Weniger häufig treten auch Zahnluxationen, Frakturen von Kiefer- und Gesichtsknochen, und neuro-muskuläre Erkrankungen auf, welche ein vollständiges Verschliessen des Maules verhindern können.


Bei Frakturen von Kiefer- und Gesichtsknochen können Fragmente in einer Position sein, welche das Schliessen des Maules nicht mehr möglich machen. Bilaterale Frakturen der Mandibeln resultieren in einen Unterkiefer, der nach ventral hängt („dropped lower jaw“ in der englischen Literatur). Bildgebende Verfahren werden gemacht, um etwaige Fragmente zu lokalisieren und eine entsprechende Frakturbehandlung
Neuromuskuläre Erkrankungen, welche den Maulverschluss erschweren, sind normalerweise jene, die den Nervus trigeminus oder seine Äste befallen („trigeminal neuropathy“ in der englischen Literatur). Die Behandlung hängt von der Ursache ab (Trauma, Entzündung oder Neoplasie).

Hilfe! Mein Tier bekommt das Maul nicht auf! Bericht über ein Fallbeispiel

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Zusammenfassung


Einleitung


Die Therapie besteht in der chirurgischen Durchtrennung der Ankylose. Dies geschieht durch vorsichtige Resektion der Knochenzubildungen. Die Durchführung der Operation erfordert die Überwindung zahlreicher Hindernisse. So muss ein Trachealtubus gelegt werden, was deswegen kompliziert ist, weil das Maul kaum geöffnet werden kann und die Intubation mehr oder weniger blind durch die minimale Maulöffnung erfolgen muss. Der Einsatz eines Endoskops kann in solchen Fällen hilfreich sein.


Fallbeschreibung:
- Mischlingshündin, geboren am 18.7.2016; Gewicht 21 kg
Vorbericht:

Klinische Untersuchung:
• Abgesehen von der erkrankten Region ist der allgemeine Gesundheitszustand gut. Ausser dem aktuellen Problem der Bewegungseinschränkung im Maulbereich und einer geringgradigen Asymmetrie im Bereich des Jochbogens wurden keine anderen Symptome gefunden. Die präoperative Untersuchung vor der Narkose erfolgte gemäß unseres Protokolls.

CT Befund:

Therapie:
• Der chirurgische Eingriff erfolgte 14 Tage nach der CT Untersuchung.
• Anästhesie: Premedikation mit Domitor (Medetomidin) 0,25 ml und Butomidor (Butorphanol) 0,3 ml. Norofol (Propofol) bis eine ausreichende Bewußtlosigkeit erreicht wurde, anschließend weitere 5 ml Propofol. Es erfolgte die endotracheale Intubation unter endoskopischer Kontrolle. Anschließend wurde eine Inhalationsnarkose mittels einer Mischung aus Aerrane (Isofluran) und Sauerstoff eingeleitet. Wir verwendeten das präanästhetische Protokoll H1/1, weiters wurden als Antibiose 2 ml Synulox (Amoxicillin Clavulansäure 17,5 mg/kg) verabreicht.
• Unmittelbar nach der Operation konnte die Maulhöhle bis zu 50% der normalen Öffnungsweite geöffnet werden. Anschließend wurde der Patient zur weiteren Überwachung und Nachbehandlung in die ICU überstellt.
• Als postoperative Nachbehandlung wurden Plasma lyte infundiert, Quamatel (Famotidin, 1 mg/kg) 5ml und Solumedrol 420 mg i.v. verabreicht. Zur Schmerzbekämpfung wurde Fentanyl CRI 0,0015 mg/kg/h gegeben.
• Tag nach der Operation: Absetzen der Infusionstherapie. Weitere Verabreichung von Synulox (Amoxicillin Clavulansäure) 2 x täglich 500 mg als Tablette, Quamatel (Famotidin) 5 ml i.v., Vetalgin (Metamizol 50 mg/kg) 2 ml i.v. In weniger als 24 Stunden nach der Operation verbesserte sich der klinische und mentale Status derart, dass der Patient in häusliche Pflege entlassen werden konnte.

Diskussion
Generell betrachtet wird die Ankylose des Kiefergelenks selten diagnostiziert. Häufiger kommt es zu Laxationen, Unterkieferfrakturen oder Frakturen der angrenzenden Strukturen. Alle erwähnten Fälle haben ähnliche klinische Erscheinungen insbesondere Schmerz bei Bewegung oder Manipulation der Kiefer oder des Maules. Inappetenz oder Unvermögen Futter aufzunehmen und die Unfähigkeit das Maul zu öffnen sind


Zähne kürzen bei Heimtieren: Eine heiße Sache! Studie zum Einsatz rotierender Instrumente

Manfred Schumacher

Einleitung und Problemstellung


Rotierende Instrumente wie Fräsen, Diamantschleifer und -Scheiben erfordern einen höheren technischen und finanziellen Aufwand (Mikromotor). Jedoch sind diese Instrumente deutlich effizienter und besser geeignet, Zahnkronen zu bearbeiten (Schumacher, 2006; Gabriel, 2016). Der Einsatz dieser rotierenden Instrumente zur Zahnbehandlung ist mit einer Hitzeentwicklung durch Reibung verbunden. Thermische Einflüsse auf vitales Pulpagewebe können, je nach resultierender Temperaturerhöhung, zu reversiblen, aber auch irreversiblen Schäden führen.


Material und Methode


Literatur


Abschlussbeurteilung

Der oben besprochene Patient ist zur Zeit ohne klinische Probleme. Die chirurgische Intervention war erfolgreich und der Heilungsverlauf erfolgte ohne Komplikationen.
Tabelle 1: Rotierende Instrumente zur Zahnbehandlung.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Verzahnung</th>
<th>Kennzeichnung: Ringfarbe</th>
<th>Drehzahl in U/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fräse 59243</td>
<td>Grob</td>
<td>Grün</td>
<td>15000</td>
</tr>
<tr>
<td>Fräse 59213</td>
<td>Fein</td>
<td>Blau</td>
<td>15000</td>
</tr>
<tr>
<td>Fräse 59216</td>
<td>Sehr fein</td>
<td>Rot</td>
<td>15000</td>
</tr>
<tr>
<td>Trennscheibe F130</td>
<td>Diamantiert fein (Ø 13 mm)</td>
<td>-</td>
<td>30000</td>
</tr>
</tbody>
</table>


Bei 7 Patienten wurden die Zähne sowohl trocken als auch mit Kühlung bearbeitet. Bei den restlichen 13 Patienten wurden die Zähne nur mit Chlorhexidin als Kühlmittel geschliffen. Der Kühlvorgang erfolgte in der Weise, dass das eingesetzte Instrument vor und während des Schleifvorganges mit Chlorhexidin 0,12% mehrere Male beträufelt wurde.


Ergebnisse

Die Temperaturerhöhung an den Inzisivi in vitro betrug im Mittel 0,5 °C für feuchtes Trennen mit der Trennscheibe und 1,5°C im Mittel für die trockene Anwendung bei einer Raumtemperatur von ca. 20°C. Die gemessene Oberflächentemperatur vor dem Kürzen der Zähne in der Maulhöhle, lag für die Inzisivi in einem Bereich von ca. 25-30°C und für die Backenzähne in einem Bereich von ca. 33-35°C.

Beim Untersuchungen an den Patienten ergaben sich Temperaturerhöhungen für das trockene Bearbeiten der Zähne von 1,5-5,0°C und für das Schleifen der Zähne mit Kühlung Temperaturerhöhungen von 0,2-2,0°C. Somit wurde bei keiner einzigen Behandlung die kritische Temperatur von 42°C an der Zahnoberfläche erreicht oder gar überschritten. Das bearbeiten der Zähne mit Kühlung war mit einer deutlich niederen Temperaturerhöhung verbunden als das Kürzen der Zähne ohne zusätzliche Kühlung.

Diskussion


**Fazit für die Praxis**

- Bei sachgerechter Anwendung von rotierenden Instrumenten:
  - o Besteht mit Kühlung für die Pulpa keine Gefahr der thermischen Schädigung
  - o Besteht ohne Kühlung für die Pulpa durchaus die Gefahr einer reversiblen Hyperämie.
- Rotierende Instrumente und Zähne sollten immer gekühlt werden.
- Ein maximaler Temperaturanstieg von 2,0 °C mit Kühlung ist deutlich geringer als 5,0 °C ohne Kühlung.
- Intervallschleifen ist sinnvoll.
- Diamantierte Handfeilen sind ineffizient.
- Zangen und Knochenspeln sind absolut ungeeignet.

**Literatur**


**Happy End oder Tragödie? Was tun, wenn’s mal nicht nach Lehrbuch läuft? Diskussion von Fallbeispielen: Teil 1 und 2**

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Wichtig ist, aus Fehlern zu lernen, und jene nicht ein zweites Mal zu machen. Mehrere Fallbeispiele werden während diesem Vortrag vorgestellt, und die Zuhörer sind dazu angeregt, interaktiv mitzuarbeiten. Das Motto dieser Präsentation ist, dass jeder Spezialist einmal ein Anfänger war.
**Comparative studies on the histological characteristics of equine paranasal sinus mucosa considering topographic and age-related differences**

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**Background:** Since the evaluation of mucosal biopsies in diseased horses is becoming increasingly important, relevant knowledge on the physiological structures of the equine paranasal sinus mucosa (PSM) is of significance.

**Materials and methods:** PSM and nasomaxillary aperture mucosa (ANM) samples from nine different localizations (Fig. 1) in cadaveric horses (n=15) without sinus disease were collected, histologically processed and evaluated by light microscopy. The results underwent statistical analysis regarding age dependent and topographical differences.

**Results:** PSM (Fig. 2) had an average height of 75.72 ± 44.48 μm, the epithelium of 13.52 ± 4.78 μm. The epithelium was usually arranged in two rows. ANM had an average height of 820.28 ± 649.57 μm with usually three-rowed epithelium of 44.9 ± 12.71 μm. The amount of goblet cells in the ANM was seven times higher than in the PSM. Serous glands were found in only 4% of the PSM samples, however in 100% of the ANM samples.

Statistical evaluation revealed significant differences for mucosal height, epithelial height, vessel area and number of goblet cells between different groups of age and different localizations of the PSM.

Correlations were seen between total mucosal height and epithelial height as well as between epithelial height and number of goblet cells.

**Conclusion:** This study characterizes fundamental histological features of the PSM and detects unknown topographical and age-dependent differences which benefits future histopathological diagnosis and subsequent treatments.

**References:** Available from the authors on request.

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**Fig.1:** Medial view on the left half of an isolated equine skull after median sagittal transection and resection of the nasal septum. Five of the nine sample sites are shown.

**Fig.2:** Equine paranasal sinus mucosa (PSM) (x400, MA). 1: ciliated epithelium, 2: lamina propria mucosae, 3: periosteum, 4: bone tissue, 5: goblet cells, 6: vessel.
Odontomas – histological findings and etiological considerations

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Malformed occlusal surfaces of cheek teeth are sometimes detected during inspection of the oral cavity. Abnormally arranged and unusually sized enamel ridges as well as discoloured tooth surfaces are the most significant findings in these cases. Further investigations often reveal oversized and distorted reserve crowns and oddly numbers and shapes of roots. These findings automatically lead to the question whether irregular dental development caused a dental malformation or whether odontogenic cells showed unregulated proliferation resulting in odontogenic neoplasia.

Both, dysmorphic teeth and odontogenic neoplasia may cause similar clinical symptoms in terms of uneven alignment of the cheek tooth arcade, enlarged interdental spaces including interdental periodontal disease and mandibular/maxillary swellings. In most cases tooth removal is considered as the therapy of choice.

Ten cheek teeth showing a malformed occlusal surface and oversized and distorted reserve crown were macroscopically and histologically examined in order to investigate the underlying pathological mechanisms. Special attention was paid to detect active and proliferative odontogenic cells and or tooth substance with an irregular texture.

All investigated teeth shared a typical macroscopic and histological appearance. Although the dental hard substances, dentin, cementum and enamel did not feature an abnormal texture or signs of unregulated proliferation of associated cells, these tooth substances were arranged in an abnormal pattern of oddly distributed enamel ridges amongst patches of dentin and cementum. These irregular arrangements of the tooth substances were either present in only minor parts of a tooth or were detected in almost all parts of a tooth. The histopathological features described justified the diagnosis of either complex or compound odontoma.

According to a generally accepted classification of the World Health Organization (WHO), odontoma contain well differentiated tooth substances but their arrangement is different from that in normal teeth. In so-called compound odontomas a tooth-like structure is still recognizable. In contrast, complex odontomas show a chaotic arrangement of the tooth substances with no resemblance of a normal tooth. However, both types of odontoma are considered to be a hamartoma rather than a true neoplasia. Hamartomas are hyperplastic masses of normal tissue formed due to a developmental defect. Consequently, both odontoma types are benign and only locally expansive.

Literature on request

Oral endoscopy in donkeys (Equus asinus) with oro-dental disorders

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Introduction: The world has high populations of donkeys specially Egypt which has 1.6 million donkeys1. Oro-dental disorders in equine are very common welfare problems especially donkeys2. Donkeys are very stoic animals and a high populations of them suffer from various asymptomatic oro-dental disorders3. On the
last decade, there are significant advances in oral examination of donkeys, a complete visual examination especially the caudal oral structures remains difficult due to the long oral cavity, the small mouth opening, and large and powerful tongue. Recent diagnostic tools including radiography, sinoscopy, gamma scintigraphy and computed tomography have been used with some limitations for diagnosis of oro-dental disorders in donkeys. This research studies the possible role of endoscopy for diagnosis of oro-dental disorders in donkeys.

Materials and methods: Twenty five donkeys aged 1-8 years (20 males and 5 females) were admitted to the surgery clinic at Faculty of Veterinary Medicine, Cairo University, Egypt. All donkeys had common signs of oro-dental disorders including; loss of appetite, loss of weight, disturbed mastication, prolonged food intake, excessive salivation, halitosis, and quidding. Under general anesthesia, full visual and manual examinations, with the aid of a strong headlight, a long handled equine dental mirror and a mouth gag, were carried out for gingiva, teeth, hard palate, soft palate and tongue. Under the same general anesthesia, all donkeys were subjected to oral endoscopy after mouth washing several times with water for good images for detection of any abnormal lesion using videoendoscope, protected with a rigid metal sheath and recorded onto an analogue videotape. The endoscopic examination was begun with incisors, canines, hard and soft palates, the occlusal and caudal surfaces of the cheek teeth, gingiva, and tongue. Samples were collected from the oral ulcerative lesion for detection of Candida species using standard laboratory methods. All donkeys were treated either with conservative or surgical treatment as usual. The data were expressed as numbers and percentages in the present study.

Results: The results of the present study revealed that all of the presented donkeys (25) suffered from either single (N=3) or mixed oro-dental disorders (N=22). The recorded oro-dental disorders were collected in (Table 1) and Figures 1&2.

References

<table>
<thead>
<tr>
<th>Disorders</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodontal disease</td>
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<td>88</td>
</tr>
<tr>
<td>Dental tartar</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Diastema</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Dental carious</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Sharp teeth</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Wounds of hard and soft palates</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Oral candidiasis</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Gingival wounds</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Impacted deciduous tooth</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Tab.1: Prevalence of oro-dental disorders in the examined donkeys.
Fig. 1: Videoendoscopic images of the oral cavity showing the different recorded dental disorders in the examined donkeys. (a) Dental tartar, periodontal disease and sharp teeth (black arrows) at the lingual surface of mandiblar molars. (b): diastema with impacted food between decayed mandiblar molars (arrow) and between the mandibular and maxillary incisors (arrows. c). (d): Dental caries (white arrows), sharp teeth at the buccal surface of upper molars (black arrows) and severe dental tarter at the mandiblar molars. (e): Dental caries at the masticatory surface of mandiblar molars. (f): Impacted (unerupted) deciduous 3rd incisor (corner) tooth with swelling and ulceration at its site.

Fig. 2: Videoendoscopic images of the oral cavity showing the different recorded disorders of the soft tissues in the examined donkeys. (a) Videoendoscopic image showing hard palate candidiasis in a 3-year-old donkey showing brownish, ulcerative lesion (arrow). (b) *Candida albicans* showing green colour colonies on CHROM agar™ Candida medium. (c) Videoendoscopic images of the hard palate in the examined donkeys showing single recent wound (arrow), double recent wounds (arrows, d), old ulcerative wound (arrow, e) and gingival wound (arrow, f).
Assessment of the potential role of fissure fractures in the aetiology of Equine cheek teeth apical infection

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Four hundred and forty nine apically infected equine cheek teeth extracted from patients of the Equine Hospital at the Royal (Dick) School of Veterinary Studies were grossly examined, including after transverse sectioning, to determine the cause of their apical infection. These included 272 maxillary and 174 mandibular cheek teeth, and 3 of undetermined location. Anachoresis was the most prevalent cause of apical infection (45.4%), followed by idiopathic fracture (29.4%), periodontal disease (13.8%), dental dysplasia (6.5%), infundibular caries (2.4%) and patent infundibulum (0.9%). In 7 (1.6%) cheek teeth the cause of infection was not determined, mainly due to extensive damage caused by the extraction procedure.

Sixty six of the anachoretic cheek teeth with intact clinical crowns including 25 maxillary and 41 mandibular cheek teeth were examined for the presence of occlusal fissure fractures that were hypothesised to be a possible cause of apical infections of these teeth. Nine of these 66 teeth (13.7%) had fissure fractures on direct visual assessment, but 41 (62.1%) teeth had fractures on examination with a magnifying eyepiece. Computed tomography was performed to assess if fissure fractures could be imaged by this technique and if so, to assess their depth, but only one fissure fracture was identified using this modality.

The occlusal surfaces of the 66 cheek teeth were then stained with methylene blue to highlight the fissure fractures. The stained cheek teeth were transversely sectioned to examine the depth of the fractures and to assess if a connection was present between fissure fractures and adjacent pulp horns. Following staining fissure fractures were identified in only 18/41. Sectioned teeth showed stained fissure fractures subocclusally in 13 teeth with increased staining of pulp horn areas present in 9 of these 13 teeth. In maxillary cheek teeth fissure fractures ran through pulp horns Nos. 4 (in 50% of teeth) or 5 (in 50% of teeth) and in mandibular cheek teeth through pulp horns Nos. 1 and 2 (in 88.9% of teeth). The mean depth of fissure fractures was 12 mm (range 2-26 mm).

To compare fissure fractures in apically infected and asymptomatic horses, 50 cheek teeth with fissure fractures that were extracted from cadavers without apical infections, were examined using a magnifying eyepiece, stained with methylene blue and then sectioned transversely. In control maxillary cheek teeth 82.6% of fissure fractures were present in pulp horn No. 4 and in mandibular cheek teeth, 96.6% of fissure fractures ran through pulp horns Nos. 1 and/or 2. The mean depth of these fractures was 9.8 mm (range 4-25 mm).

Histopathology was performed in apically infected and control cheek teeth to assess if methylene blue staining could be confirmed in affected pulps. Fissure fractures in both infected and control cheek teeth contained stained plaque or vegetable material and one fissure fracture connected with an infected pulp. One control tooth had pale blue rod-like structures (likely to be bacteria) in dentinal tubules adjacent to a fissure fracture. Combined, these findings indicate that fissure fractures could potentially be a direct route for microorganisms to penetrate the pulp horns from the oral cavity, recording their presence in routine dental examination might be important to follow their progress and prevent further complications.
Analysis of 500 equine dental referral cases referred to a UK specialist clinic

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Reasons for performing study: Data analysis of dental referral cases could be a useful guide for first opinion practitioners presented with more advanced dental disorders. Analysing the frequency, range and distribution of dental disorders, how they were treated and with what outcome can also give information on the relative efficacy of different techniques employed. These results may help practitioners to decide which scenarios may be better suited to referral versus first opinion treatment.

Objectives: Report frequency, range, distribution (triadan number) of types of pathology presented, treatment techniques and outcome of 500 dental referral cases, analyse results and identify trends within advanced dental cases. Methods: 500 horses of mixed age, sex and breed that underwent dental referral were selected for analysis. The cases were selected randomly from within a 5 year period, from 2 sequential cohorts of 250 horses each over a 4-month period, separated by 6 months. Each horse underwent a standard clinical examination, external head examination followed by oroscopic examination under sedation. Further diagnostics were performed as necessary. For diastema treatment the ‘tooth treated’ was classified as the one mesial to the affected interproximal space (for numerical analysis only).

Results: 84% of horses were referred from the owner’s veterinary surgeon, 15% from an EDT, and 1% directly from the owner. All horses were treated under standing sedation only, using combinations of detomidine and an opiate (butorphanol or morphine). A continuous rate infusion of sedative was used for all dental extractions and sinus surgeries. 35 horses did not require any specific dental treatment, with 15 requiring just a remedial rasp. A total of 870 teeth were treated in the remaining 465 horses (average 1.8 teeth per horse). 254 horses underwent treatment for a single tooth (51%), 123 for two teeth (24%), 26 for 3 teeth and 62 horses for 4 or more teeth (mostly diastema or incisor extractions). For dental extractions the procedure was completed in all cases at one ‘sitting’. The most common presenting pathology was fractured teeth with 26% of horses having at least 1 fracture, with 75% of those being complicated crown fractures (CCF) with necrotic pulp canals, 21% sagittal infundibular caries related fractures, and 9% buccal slab fractures (pulp 1-2). Infundibular caries accounted for 21% of horses referred, diastema 11%, non-vital pulp exposures 11%, septic pulpitis 10%, diastema 9%, with other conditions such as dysplastic teeth, supernumerary teeth, EOTRH, sinusitis (non-dental), dysphagia and focal overgrowths the remainder. The most common procedures mirrored the presentations with dental extractions being the most common (329 teeth from 245 horses, 49% of cases), followed by restorative therapy (infundibular and pulp, 37%), diastema / periodontal disease treatments (9%) and others. For dental extractions, all were completed at 1 ‘sitting’ under standing sedation only. For cheek teeth (CT), 248 were extracted from 230 horses. Oral extraction was successful for 189 teeth (81% of CT extractions), with minimally invasive buccotomy accounting for 40 teeth (15%), minimally invasive repulsion for 13 teeth (5%), and sectioning for 6 teeth (2.4%). Many oral extractions were of teeth fractured at presentation however the teeth most likely to require surgical intervention or sectioning were the CCF, predominantly in maxillary 09 teeth (23/30 cases, 76%). For restorations, (maxillary) 09 teeth were the most commonly referred (62% of teeth restored).

Conclusions: Extraction of chronically diseased teeth is the most common dental referral in practice, with complicated crown fractures of maxillary 09 being the most common tooth to require surgical intervention. Many extractions can be performed orally (81% in this study) and an oral extraction attempt is recommended in virtually every case. Further analysis on this data is to be performed.

Declarations: Ethical animal research: not applicable; Competing interests: none; Sources of funding: none; Antimicrobial stewardship policy: not applicable; Informed Consent: requested and approved by owner during follow up retrieval of information.
A comparison of computed tomographic, radiographic, gross and histological, dental and alveolar findings in 30 abnormal cheek teeth from equine cadavers

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**Background:** Equine cheek teeth disorders, especially pulpar/apical infections, can have very serious consequences due to the frequent extension of infection to the supporting bones and/or adjacent paranasal sinuses. Limited studies have assessed the accuracy of computed tomographic (CT) imaging in the diagnosis of these disorders and no study has directly compared imaging and pathological findings of the alveoli of diseased equine cheek teeth.

**Objective:** To compare CT and radiographic imaging, gross and histological findings in abnormal cheek teeth and their alveoli extracted from equine cadaver heads to validate the accuracy of CT and radiographic imaging of cheek teeth disorders.

**Study Design:** Ex-vivo original study

**Methods:** Fifty-four cadaver heads from horses with unknown histories that had died or been euthanized on humane grounds that were obtained from a rendering plant had radiographic, CT imaging, and gross pathological examinations performed. Based on imaging and gross examination findings, 30 abnormal cheek teeth (26 maxillary and 4 mandibular) identified in 26 heads were extracted along with their alveoli where possible, and had further CT imaging, gross and histological examinations performed. Eight maxillary cheek teeth (including four with attached alveoli) from these heads, that were normal on gross and CT examinations were used as controls.

**Results:** Gross and histological examinations showed 28/30 teeth, including two supernumerary teeth, to have pulpitis/apical infection, including the presence of pulpar and apical cemental changes. A further supernumerary and a dysplastic tooth were also identified. Abnormal calcified tissue architecture was present in all three supernumeraries and the dysplastic teeth. CT imaging strongly indicated apical infection in 27 of the 28 (96.4%) apically infected teeth, including the presence of intra-pulpar gas (n=19/28), clubbing of apex (n=20), periapical halo (n=4), root lysis or fragmentation (n=7), periapical gas (n=2), alveolar bone sclerosis (n=20), thickening of the alveolar bone (n=3) and lytic/erosive changes (n=8). Radiographic abnormalities strongly indicative of apical infection including periapical sclerosis (n=8/28) and clubbing of apex (n=14/28) were found in 14/28 (50%) of apically infected teeth.

Alveolar bone showed histological changes in all 21 cases where it remained attached to the tooth, including disruption of the normal trabecular pattern, increased osteoclastic activity and the presence of islands of bone with a scalloped profile within the thickened attached periodontal ligament. No gross pathological or histological changes were present in the eight control teeth or their alveoli (n=4).

**Main limitations:** No history or breed-related information was available on these cases that suffered intercurrent systemic diseases.

**Conclusion:** There was a 96.4% correlation between a CT diagnosis and confirmative pathological findings in 28 apically infected teeth confirming the accuracy of CT imaging in diagnosing equine apical infections. There was a 66.7% correlation between CT and histological alveolar bone finding.
Microbiological and cytological examination of secretions from the paranasal sinuses in horses

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The aim was to assess the diagnostic value of microbiological and cytological examination of secretions from the paranasal sinuses in horses.

Fifty horses with unilateral paranasal sinus disease were examined. Secretions were transendoscopically aspirated bilaterally from the paranasal sinuses from the nasomaxillary aperture using a flexible, wire-guided catheter (Olympus SwingTipTM), and processed for cytological and microbiological examination. Depending on history, clinical signs and findings during the endoscopy further imaging diagnostic tools were combined to find an etiological diagnosis.

Microbiological examination revealed Streptococcus equi ssp. zooepidemicus in horses affected by primary sinusitis with some samples revealing pure cultures. Neither anaerobes nor Enterobacteriaceae were found. In horses affected by dental sinusitis samples revealed mixed cultures of anaerobes with Fusobacterium spp. and Enterobacteriaceae being isolated the most frequently. Sinus cysts, progressive ethmoidal hematoma and traumatic sinusitis revealed mixed growth of grampositive and -negative bacteria.

Cytology mainly revealed neutrophils from the diseased and epithelial cells from the non-affected side, but was not found to be a useful tool to distinguish between primary and secondary sinusitis.

Microbiological examination of transendoscopically collected secretions from horses affected with paranasal sinusitis may display a non-invasive and feasible diagnostic tool.
**Diagnosis and therapy of supernumerary teeth including heterotopic polyodontia in horses**

C. P. Bartmann and A. Bienert-Zeit

**Supernumerary teeth in horses** belong to the developmental dental disorders and are thought to arise from the splitting of dental buds during dentogenesis.

Typical or atypical polyodontia was diagnosed in 65 horses of different breed and age with or without a history of dental pathology or dysmastication.

Diagnostic procedures included clinical and radiological examination added by computed tomography of the head if judged to be useful.

A typical polyodontia was diagnosed in 16 of the horses with a distomolar as the most common finding. Of the 49 horses with an atypical polyodontia, an aural fistula with mucous exudation was present close to the ear in 21 horses. In those horses, a heterotopic polyodontia could be detected radiographically with dense, teeth-like structures close to the temporal bone. A definite determination of the number and localization of teeth and furthermore detection of secondary lesions could only be obtained with computed tomography.

Treatment always included correction of abnormalities of wear and extraction of typical supernumerary teeth in the horses with a good prognosis for a surgical benefit. Complete removal of the sinus formation and supernumerary teeth were the surgical procedures in horses with heterotopic polyodontia and aural fistula. Despite the good surgical results in this study, surgical therapy of atypical polyodontia remains a serious procedure with the risk of complications due to the complex anatomy of the area.

**Measurement of eruption rates in equine premolars: a longitudinal study**

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The lifelong eruption of equine cheek teeth is a functional adjustment to the highly abrasive food horses consume. This mechanism makes up for the substantial occlusal loss of hard substance, and smaller defects of the occlusal surface are compensated by erupting healthy parts of the tooth. Accordingly, data on the actual extent of the eruption movement are of particular interest. Based on abrasion data, the extent of eruption is as yet assumed to be 3-4 mm per year. Previous studies to determine the eruption rate, however, have been based on cross-sectional studies from which the eruption rate was calculated indirectly. The study presented here aimed to determine the eruption rates for a large number of horses by means of a longitudinal study. Additionally, factors influencing the eruption speed were evaluated.

Data were collected from 136 horses (50 female, 86 male, aged from 3 to 33 years). Owners were interviewed to establish the frequency of grazing. In a routine dental treatment, the mesial edges of the upper and lower 06s were accurately rounded all the way to the gingival margin (also known as “bit seat”). In follow-up
Equine dentistry examinations, two numerical values were determined:

a) The distance between the gingival margin and the apical end of the bit seat (millimetres).

b) The time between the initial creation of the bit seat and the follow-up examination (days).

Subsequently, the eruption rate per year was calculated from these data. Up to 6 measurements per horse were made with a maximum period of 3.5 years between two treatments.

The average eruption rate, calculated for the upper 06s was 3.4 mm/year. The mean eruption rate for the lower 06s was significantly higher (4.2 mm/year). Looking at the data with regard to potential determinants, the following results were particularly noticeable:

- There were no differences with regard to left or right side of the head.
- In the lower 06s mares had a significantly higher eruption rate (4.8 mm) than male horses (3.6 mm).
- The eruption rate declined significantly with increasing age for approximately 0.1 mm/year.
- Also the number of treatments was significantly correlated with the eruption rate (p<0.001). With each treatment the eruption rate decreased for 0.8 mm in the lower jaw and 0.5 mm in the upper jaw.

Daily grazing time had no statistically significant influence on the eruption rate.

With regard to clinical and prognostic considerations, an average eruption rate of 3.4 mm-4.2 mm may be assumed, keeping in mind that lower jaw cheek teeth are somewhat faster to erupt than upper jaw ones. With increasing age, the eruption speed decreases gradually 0.1 mm/year. On a cautionary note, however, it must be born in mind that these data were derived only from 06s. It is unlikely that other cheek teeth fundamentally differ from the data presented; gradual deviations, however, may well occur.

Literature on request

**Comparison of the effect of buprenorphine or butorphanol on quality of detomidine sedation for cheek tooth extraction and postoperative pain in horses**

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The aim was to compare effects of buprenorphine or butorphanol on detomidine sedation in cheek tooth extraction and postoperative pain behaviour in horses.

Forty horses were randomized into two groups. Horses were premedicated with meloxicam (0.6 mg kg⁻¹). Ten minutes after detomidine at 15 µg kg⁻¹ IV, a bolus of butorphanol (0.05 mg kg⁻¹ IV) (BUT) or buprenorphine (7.5 µg kg⁻¹ IV) (BUP) was administered and infusion of detomidine was started (20 µg kg⁻¹ h⁻¹). Mandibular or maxillary blocks with mepivacaine (2%) were performed. Heart rate, respiratory rate and head height were measured. Resistance towards manipulation and ataxia were scored (1 to 5). Resistance score > 3 resulted in a bolus of detomidine (3 µg kg⁻¹ IV) followed by an increase in detomidine infusion rate of 10 µg kg⁻¹ h⁻¹. Surgeon and anaesthetist were blinded to the protocol. The surgeon assessed quality of sedation and surgical conditions on a Numerical Rating Scale (NRS; 1-10). Postoperative pain was assessed by Composite-Pain-Scale, Horse-Grimace-Scale, EQUUS-COMPASS and EQUUS-FAP. Pedometers recorded locomotor activity. Data were analyzed by Wilcoxon-test (p < 0.05).

Quality of sedation (NRS) was significantly better in BUP (p=0.03). There was no difference in required detomidine dose between groups (p=0.22). Horses in BUP showed compulsive behaviour and increased locomotor activity, interfering with postoperative pain scoring.

Buprenorphine for cheek tooth extraction improved sedation, but undesirable side effects dominated postoperative behaviour at the dose used.
The use of plasma rich in growth factors after extractions in equine dentistry

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Introduction: Growth factors are naturally occurring substances capable of stimulating cellular growth, proliferation, cellular differentiation and most important healing. Platelet rich plasma (PRP) is rich in growth factors, target-specific polypeptides that play a role in cell proliferation and differentiation and can thus encourage wound repair.

Growth factors have been reported for the first time in 1987 (M. Ferrari) in human medicine, and since then there’s more than 14000 references for PRP. It has been used in human medicine for: dentistry (specially periodontics and dental traumatology), wound healing, traumatology, chiropody… with good results. There’s many studies in human dentistry that compare the healing time between PRP treated sockets and the ones that haven’t been treated with it. In these studies the conclusion is in most of them that PRP provides a safe and effective means of speeding alveolar bone repair in humans.

In small animals veterinary dentistry PRP have been used also with good results, and in equine veterinary their use in cases of traumatology is very extended, with studies showing the healing time is shorter with them.

Clinical cases: PRP has been used by the author (Manso C.) in cases of extractions of mandibular incisors, canines and molars to help the tooth sockets healing, specially in competition horses when they need to heal as soon as possible. It’s been realized that the healing was quicker than normal in similar cases, but haven’t been able to make a proper study comparing cases with and without it.

Conclusion and discussion: Autologous PRP was found to accelerate alveolar bone regeneration in humans, with beneficial effects in the treatment of periodontal defects. It could be beneficial to equine dentistry the use of PRP in cases of: extractions, periodontal regeneration and re-implantation. Studies on the effects of PRP in equine dentistry are needed to have more information, and it can open new horizons on the way of helping healing.

A long-term survey of equine cheek teeth post extraction problems

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A number of equine cheek teeth disorders (most commonly apical infections and fractures) are treated by extraction of the affected tooth. Extraction can cause collateral damage to adjacent structures, particularly of the supporting bones and sinuses, leading to a variety of potentially significant post-extraction problems. Previous studies have reported high complication rates associated with equine cheek tooth extractions, with oral extractions recognised to have lower complication rates compared to other techniques such as
conventional punch repulsions or the standard transbuccal technique.

The aims of this study were to document the type and prevalence of complications that occur following equine cheek tooth extraction at the Royal (Dick) School of Veterinary Studies (R(D)SVS) Equine Hospital, and to evaluate whether there are risk factors for these complications that could be used to predict their occurrence, and hopefully modified to reduce their prevalence.

Records of all cheek teeth extractions performed at the R(D)SVS Equine Hospital over an 11-year period between 2006 and 2017 were examined, including records of follow-up examinations at this clinic. Questionnaires were posted to all clients, including those whose horses were not believed to have had post extraction problems, to document the prevalence and nature of any post extraction problems, and their long-term outcome to treatment. Repeat questionnaires and then telephone follow through information requests were made to non-respondents and finally, referring veterinarians were contacted for information.

Horses undergoing cheek tooth extraction between 2006 and 2017 had teeth extracted by oral extraction where possible, or by Steinmann pin repulsion, minimally invasive transbuccal technique and/or intra-alveolar tooth sectioning. Risk factors for the development of post extraction problems are currently being evaluated including: age of horse (and thus reserve crown length); mandibular vs maxillary cheek teeth; dental disorder necessitating extraction; duration of the pre-existing apical infection; presence of crown fractures and extraction technique. The role of computed tomographic imaging in managing post-extraction problems will also be discussed.

Complication after anaesthesia of the maxillary nerve in a horse

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Introduction: The upper cheek teeth have sensory innervation by the maxillary nerve. Currently, most maxillary cheek teeth surgical interventions including extraction, endodontic and periodontal treatment are performed in the standing, sedated horse. Therefore an optimal intraoperative pain management protocol, including systemically administrated NSAIDs, an effective sedation protocol and local anaesthesia of the surrounding tissue and sensory nerve(s) should be undertaken. The technique for anaesthesia of the maxillary nerve has recently improved to help avoid the serious complications including meningitis, bleeding and blindness of previous techniques. Currently the extraperiorbital fatbody injection (EFBI) technique is accepted as a relatively safe and easily performed technique.

Case history: An eight year old Hanoverian mare was presented for extraction of Triadan 210 that had a sagittal fracture (through pulp horns 1 & 2) and apical infection. Following sedation, anaesthesia of the ipsilateral maxillary nerve by EFBI was performed with 12 ml mepivacaine using an aseptic technique through an aseptically prepared site. The nerve block and subsequent surgery were successfully performed without any complications.

Five days after surgery the mare was observed to be febrile (38.5°C) and had a decreased feed intake. The EFBI injection site developed a painful, slowly-increased swelling. Ultrasonographically, a hypoechoogenic area was noticeable in the periorbital fat body that increased in size over the next five days. An abscess in the periorbital fat body was suspected and a thrombosed vessel with thickened walls was also observed. The abscess was locally hot poulticed over five days and finally lanced under ultrasonographic guidance and then gently curetted. Malodorous, purulent material was then flushed from the abscess and continued for 21 days.

The fever resolved and her appetite returned and the mare was discharged from hospital 31 days after the dental extraction, and the wound was completely closed eight days later.

Conclusion: The EFBI technique for anaesthesia of the maxillary nerve is commonly performed for pain management in horses undergoing maxillary cheek teeth surgery. Complications are rare following EFBI, but
if they do occur, immediate and effective diagnostic and therapeutic management are required to prevent possible serious or even fatal consequences such as meningitis.

References: Available from the authors on request.

Oronasal fistulation due to cheek tooth malocclusion in six ponies

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Introduction: Oromaxillary or oronasal fistulae may develop as a result of incomplete healing of an extraction socket, predominantly following repulsion. Oromaxillary fistulae have also been described as a result of cheek teeth diastemata. Oronasal fistulae are sporadically described but are again most common following failure of an extraction socket to heal. Periodontal disease adjacent to axially rotated teeth has been described and extension of this may lead to oronasal fistulation.

Materials and Methods: Inclusion criteria for the report were animals with a diagnosis of oronasal fistulation between October 2015 – July 2017. Case data such as breed, age, previous dental history were extracted from the case records. Diagnostic techniques were recorded along with treatment methods and outcome was also recorded.

Results: Six cases met the inclusion criteria (4 Welsh section A, 2 Miniature Horses) with a mean age of 7 years. All cases involved the maxillary 08 teeth and 4/6 had bilateral displacements and rotation but only 2/4 cases were showing clinical signs. All cases presented with halitosis with 5/6 presenting with nasal discharge. At presentation 6/6 underwent oral endoscopy, 3/6 cases underwent nasal endoscopy with 4/6 being radiographed. Oral extraction was performed in all teeth 3/4 bilateral cases receiving double extractions at the first visit, with 1/4 receiving the second extraction at 4 weeks post first extraction. Non-healing alveoli were present in 4/10 extraction sockets, all of which were successfully treated with a semi-permanent PMMA prosthesis.

Conclusion: Oronasal fistulation can occur as result of ascending periodontitis adjacent to axially rotated and displaced maxillary cheek teeth. These can be successfully treated by oral extraction and sealing of the extraction space with a semi-permanent PMMA barrier.

References
The occurrence of thrombophlebitis in four oral-sinus surgery cases

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Thrombophlebitis (TPH) is a common complication in hospitalized equine patients. It is defined as vein thrombosis with mural inflammation\(^1,2\). The jugular veins are usually affected because they are the most commonly used site to access venous circulation\(^3\). TPH is an undesirable potentially serious, iatrogenic complication and is associated with venopuncture sites or indwelling intravenous catheters. Results of other studies have identified several risk factors for the development of TPH in humans and horses, including catheter material, length and diameter of the catheter, method of IV administration of fluids, type of fluid being administered, catheter placement technique, and duration of catheterisation\(^4\). Patient factors may also play a role. Several diseases have been found to be risk factors for the development of a hypercoagulable state. These include sepsis, endotoxaemia, genetic coagulation defects, neoplasia, protein-losing enteropathy, and protein-losing nephropathy\(^5\). Penetrating buccal ulcers have been reported as a rare cause of jugular TPH in a horse\(^6\). To the authors knowledge there is no reference in the literature on the possible association between TPH and oral-sinus surgery in horses.

Between April 2011 and January 2016, four horses (2 mares and 2 geldings), median age 10 years old (7-13 years), developed TPH following oral-sinus surgery. In all horses the same intravenous catheter was placed (8 cm x 12G polytetrafluoroethylene (PTFE)). All the horses underwent a standardised scrubbing procedure of the insertion site. All surgical procedures were performed standing by an experienced surgeon with a duration ranging from 60-180 minutes. Perioperative treatment included antimicrobials (ABs) (oxytetracycline 5 mg/kg IV) and NSAIDs (phenylbutazone 4.4 mg/kg IV). Signs of TPH were noticed between 4 and 18 days (median 8.5 days) after catheter placement. These included localised swelling in 4/4 cases and fever in 3/4 cases. In three horses ultrasonographic (US) examination were performed. A common feature was thickening of subcutaneous tissue, increased thickness of jugular vein wall, and increased turbulence on colour Doppler. All cases were treated medically with ABs, anti-thrombotics, NSAIDs and hot compresses of the affected area. Follow-up US examination was performed in three cases. In one case facial swelling developed on day 3 after diagnosis. Resolution of clinical signs occurred between 25 and 67 days (median 38 days) after recognition of TPH.

Oral-Sinus surgery is frequently described (depending on cited references) as a clean-contaminated surgery at best but more likely a “dirty” surgery\(^7\) and speculation about an increased risk of developing TPH has been made. This case series suggests that oral-sinus surgery may increase the incidence of TPH. The incidence of oral-sinus associated TPH in our practice is low compared to endotoxaemic or septic horses presented for abdominal surgery, but higher than those undergoing other elective surgeries when the same methodology of placement, technique, catheter management and material (PTFE) are used. Most causes are considered iatrogenic and there is a desire to prevent the complication rather than treat it. Prior to oral-sinus surgery care must be taken to inform the owners of this potential complication. It is advised to take precautions to reduce the incidence of this complication. Further studies are required to explore the association between oral-sinus surgery and TPH, and hypothesis regarding possible risk factors and causation.

References

Removal of impacted teeth in horses

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Impacted teeth occur during eruption of permanent dentition and are prevalent in certain breeds including pony breeds and miniature horses, and also can be associated with mal-erupted displaced or supernumerary dentition that occur sporadically in many breeds. Impaction due to an obstructed eruption pathway occurs while the tooth is still growing apically and the increase in length can result in apical vascular congestion, chronic pain, alveolar and cortical remodelling and further dental mal-eruption. Subsequent apical pulpitis can ensue and signs including further maxillary or mandibular swelling, discharging tracts dysmastication can be seen. Teeth in the mandible are most commonly affected and the caudal premolars are most prevalent. Conservative treatment can involve deciduous tooth removal, odontoplasty to increase patency of the interdental eruption path, in combination with antimicrobials if the pulp is deemed to be viable. In some cases this facilitates further eruption of the tooth enabling extraction per os with forceps. However many cases are chronic and pulp necrosis occurs necessitating attempts at extraction or endodontic treatments. Despite loss of vital pulp, eruption will continue if the periodontium is functionally intact unless the eruption pathway is obstructed. Where the crown is sub-gingival extraction per os with forceps can be challenging. Alternative options include that can be performed in the conscious horse with regional analgesia include dental sectioning, transcortical extraction techniques, or facilitated repulsion. Careful appraisal of the horse’s dentition including re-assessment of further eruption after odontoplasty is advisable before deciding the optimal approach. Oroscopic examination to appraise the deciduous dentition if present and the morphology of the crown is helpful for planning extraction treatments. Radiographs with markers including open mouth oblique views are useful to determine the mesiodistal space for eruption. Better if available are CT scans which can be reconstructed in a sagittal plane and frontal plane to more accurately ascertain the degree of impaction and the viability of dentition. Surgical treatments via a corticotomy and buccotomy if indicated can be planned more accurately and the outcome predicted. Repulsion techniques and MTE extractions are suitable if the impacted tooth is not wider than the eruption pathway. Where the impacted tooth is wider than the eruption pathway such techniques can result in dental mandibular or fracture or dental fracture when the MTE bolt or punch is struck. Dental sectioning can be performed per os using a long tungsten carbide burr to remove mesial or distal dental fragments that can facilitate removal per os of remaining fragments. However in contrast to small animals where sectioning to the furcation is possible, precise sectioning in the standing horse is painstaking and challenging. Nevertheless dental sections of an intact tooth can be mobilised more easily and after further periodontal separation can sometimes be extracted per os, or using MTE or MIP. Where this is not technically possible or where access to the clinical crown is inadequate, surgical removal via a buccotomy/corticotomy can be performed. This is performed under general anesthesia in most cases. The mandibular or maxillary cortex is approached via a curvilinear skin incision avoiding relevant vessels or nerves. The reserve dental crown is exposed after a corticotomy using an air saw, osteotome or burr and removal of bone over the buccal surface of the tooth, which can then be enlarged to expose the reserve crown. Further periodontal separation is achieved via the corticotomy using luxators and the tooth is then sectioned before extraction in segments via the incision or via the oral cavity. The alveolus is lavaged and curetted and then the incision is closed in three layers with a drain left in situ. The oral aspect of the alveolus is sealed with a PVS implant. The main complications are dehiscence of the incision due to contamination from the oral cavity – especially when the oral seal becomes loose. Remodelling of the mandible can take several months but the long-term prognosis is good.
References


Incisor tooth with open pulp canal, what is underneath?

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Introduction: During examinations of the masticatory system of horses, open pulp canals at the occlusal surface of incisors can be an accidental finding frequently. Also horses are presented because of symptoms related to incisor pulpitis or incisor fractures with exposed pulp. Radiologic examination of the apical aspect of the affected tooth is necessary to evaluate the situation of the tooth before planning a treatment.

Study: We have selected horses with open pulp canals on incisor teeth and differentiated according to radiologic changes and clinical symptoms.

Results: Because of different situations we put the teeth in different groups:

1. Acute pulp exposure because of incisor fracture or iatrogenic exposure
2. Subacute/chronic pulp exposure because of incisor fracture or iatrogenic exposure
   2.1. With pulpitis
   2.2. With pulp necrosis
3. Continuously open pulp canals to apical foramen
3.1. Without radiologic changes of the apical/periapical area
3.2. With radiologic changes of the apical/periapical area and/or gingival fistula
4. Occlusal surface with open pulp canal but dentin bridge to apical pulp aspect
5. Occlusal surface with open pulp canal with (radiological) obturation of apical foramen
5.1. Without fistula
5.2. With lesion in reserve crown connected to gingival fistula

Discussion: Radiological examinations of incisors with occlusal open pulp canals show different situations of protective mechanisms of the body to seal the exposed canal and to protect the vital tissue from bacterial infection.

According to the complete situation of an incisor with an open pulp canal, different therapeutic approaches are possible to support the intention of the body to seal the open canal to increase the chance of tooth conservation or alternatively an extraction of the affected tooth.

Therapeutic options are:
1. Pulp capping / Partial coronal pulpotomy
2. Total pulpectomy
3. Endodontic restoration of the pulp canal
4. Extraction

Take Home Message: Thorough examination of incisors with open pulp canals and radiologic examination show different protective mechanisms of the body.

According to the dental situation a therapy can be selected to prevent or to treat a periapical infection.

The goal of acute pulp exposure is to prevent bacterial infection of the pulp.

In incisors with complete or partly necrotic/infected pulp the treatment should stop bacterial destruction of dental material and the periapical area.

If the reserve crown is fractured or bacterial destruction is advanced, extraction is the therapy of choice.

Literature on request
Developing endodontic techniques for equine teeth comes with considerable challenges. The pulp system is complex, with apically enlarging pulp canals and a common pulp chamber at the apex (in young teeth). These teeth may be considered ‘upside down’ compared to human teeth. Added to this, the continual eruption and deposition of considerable amounts of secondary dentine over time result in progressively narrowing pulp canals with altered inter-pulp and apical communications. By 10 years post eruption of cheek teeth, there is often maximal pulpar separation to 2-5 individually separated pulp canals or groups. These anatomical changes are important considerations for endodontic therapy.

Septic pulpitis has been attributed ‘anachoresis’ with sometimes rapid development of pulp sepsis. In young cheek teeth, due to the communicating pulp system, this is likely to mean sepsis of the entire communicating pulp system, rendering the tooth entirely ‘dead’. Endodontic therapy at this stage requires evacuation and sterilisation of a large inter-communicating pulp system, with a common apical pulp chamber to access through a long reserve crown. The difficulties of this procedure in young teeth has prompted efforts at apical endodontic therapy, either surgically or by extraction, extra-corporeal endodontic therapy and re-plantation. These procedures are complex and have mixed reports of success. Another consideration in these teeth is that there has been little secondary dentine formation which after pulp removal leaves a large, effectively dead, poorly calcified structure with a large and communicating pulp system to obturate from occlusal access points smaller than the apical regions that need to be reached. These large cavities can mean that even with full resin composite, mineral trioxide aggregate (MTA) or other bioceramic restorations there is considerable risk of fracture within the short to medium term.

As teeth mature, and true roots form at the apex with smaller apical pulp channels, a pulp system that gradually separates into separate channels or groups, and increased calcification from secondary dentine production, the tooth becomes a potentially better candidate for endodontic therapy. Added to this, there is evidence that in cases of anachoresis or other means of bacterial pulp invasion, that reparative type dentine may form either within the pulp or at or near the apex. These reparative dentine bridges or seals appear to be a protective response to prevent further spread of bacteria beyond the apex and appear to occur frequently. A pulp canal or group that has died of sepsis and is sealed towards the apex will no longer produce secondary dentine and therefore with continued occlusal attrition will result in an occlusal secondary dentine defect. Non-vital pulp exposures allow the pulp canals to become deeply and tightly packed with ingesta as far apically as any barrier is reached. Progressive pulp caries ensues, enlarging the cavity and producing increasingly large numbers of bacteria that may penetrate adjacent pulp canals or bypass any apical seal. The progressive weakening of any parts of the tooth affected like this become increasingly fragile and prone to fracture. Multiple pulp canals infected in this way with resultant pathological complicated crown fractures are repeatedly implicated in failure of oral extraction procedures. Combinations of infundibular and pulp caries are likely to produce the most structural weakness.

There are numerous anecdotal reports of horses with signs of septic pulpitis either resolving spontaneously or after antibiotic therapy alone. It is likely in many cases the acute phase passes, apical and pulp reactions combine to seal the pulp at or near the apex, leaving a necrotic channel protected occlusally by sub-occlusal secondary dentine (SO2D). Identifying the extent of pulp necrosis at this stage and burring through the SO2D requires experience, skill and technical expertise and advanced imaging to both identify which pulp canal/s are affected and to access them through the SO2D (Lundstrom). Waiting a few years will inevitably result in progressively enlarging 2D fissures leading to full open non-vital pulp canals. Access of these at earliest stage of identification of 2D defects, in teeth that are relatively well calcified can potentially result in successful and stable pulp restorations protecting the tooth from further caries and progression of pathology.

This presentation will discuss the above hypothesis with numerous case examples. Early assessment of pulp restoration data over 5 years by the author has produced the following general recommendations and categorisation system:
1. Grade 1-2 2D defects (Tremaine, etc) with no apical radiographic change – no treatment, monitor
2. Grade 3+ 2D defects but with no or minor apical changes radiographically, no history of sinusitis or recent facial swelling – potential candidate for occlusal pulp restoration
3. Grade 3+ 2D defects with active apical change e.g. lucency and evidence of active modelling of apex – consider extraction, especially if multiple pulp canals exposed or recent complication of apical disease e.g. sinusitis. Expect trouble.

These 3 categories of pathological states of teeth are commonly used by the author for assessment of teeth referred for potential endodontic / restorative treatments. Category 2 teeth, with teeth with a minimal eruption age of 4 years, and with individual or single group pulp exposures, appear to perform the best long term.

References

Long term follow up of infundibular caries restorations 2006-2017

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Reasons for performing study: A recent epidemiological survey by Borkent1 and others identified a 45.5% prevalence of infundibular caries in UK horses. Further studies have shown that infundibular caries cause maxillary dental apical infections2-4 and dental fractures in particular midline sagittal fractures5.

Due to this clinical significance of infundibular caries it can be hypothesised that the identification and treatment of these caries by restoration and filling can prevent progression to severe disease.

Objectives: Follow up oroscopic examination of cases that had infundibular restorations performed 5 to 11 years previously.

Methods: 92 horses treated for grade 3 infundibular caries with restorations between 2006 and 2012 were contacted and 20 cases involving 35 restorations were then followed up and examined under sedation with oroscopy to assess the appearance of the restoration and tooth.

Results: 97% (34 of 35) of teeth previously restored were present and showed no evidence of fracture. There was a midline sagittal fracture of one tooth that had been restored 10 years previously. 15 of 35 teeth
A molecular microbiological study identifying bacteria associated with equine peripheral and infundibular caries, and a pathological study of equine dental caries

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Dental caries is caused by acidogenic oral micro-organisms which convert fermentable carbohydrates to acids that damage the tooth by causing a demineralisation and disintegration of the inorganic and organic substances of the tooth, respectively. In horses, two variants of dental caries occur: equine dental peripheral caries (PC) involving the periphery of teeth; and infundibular caries (IC) of the infundibulum of the maxillary cheek teeth.

A molecular microbiological study on equine dental caries using a linear discriminant analysis effect size (LEfSe) at genus or higher level, showed Gemella and Actinobacillus to be the genera most associated with the peripheral control group (no PC), and Streptococcus, Olsenella and Scardovia to be the genera most associated with PC. Additionally if LEfSe was performed at genus level only, then an additional genus shown to be associated with PC was Mitsuokella. Acidaminococcus was the genus most associated with IC, using LEfSe at genus or higher level, while Bacillus was the genus most associated with the infundibular control group (no IC).

A pathological study was performed examining PC-affected cheek teeth grossly, histologically and by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). Dental plaque, containing bacteria, covered the PC lesions. In the peripheral cementum PC lesions were categorised on cross sections of affected teeth by their shape including: flake-type, flap-like, or ellipsoid-shaped lesions or combinations of these. Bacteria also penetrated from surface lesions between Sharpey’s fibers of cementum.

Conclusions: Restorations of infundibular caries are an effective method to prevent progression of caries to sagittal fracture. Restorations appear to remain within the infundibular and are a long term solution.

Declarations: Ethical animal research: not applicable; Competing interests: none; Sources of funding: none; Antimicrobial stewardship policy: not applicable; Informed Consent: requested and approved by owner during follow up retrieval of information.

References

in a direction perpendicular to the peripheral aspect of the tooth, destroying the intrinsic fibers and the Sharpey’s fibers; or they penetrated in a direction parallel to the peripheral aspect of the tooth, undermining the intrinsic fibers, sometimes at the level of incremental growth lines; bacteria were also present in ellipsoid-shaped lesions and in lacunae.

In dentine affected by PC, bacteria were present within dentinal tubules and between damaged dentinal tubules, sometimes causing flake-type lesions as seen in cementum. Bacteria penetrated primary dentine and/or (regular/irregular) secondary dentine from the occlusal surface, or entered primary dentine through cementum and enamel from the peripheral aspect. Dental plaque containing bacteria were sometimes observed in dentinal fissure fractures.

References


**Cells of the equine periodontal ligament – molecular biological characteristics in view of their potential use in regenerative therapies**

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The periodontium is divided into the periodontal ligament (PDL), the alveolar bone, the dental cementum and the gingiva. The PDL is a fibrous connective tissue which attaches the intra-alveolar parts of the tooth to the alveolar bone. Simultaneously, it has the function to receive and transmit masticatory tension and compression forces. In this function, the PDL performs similar tasks as a tendon-like structure. The equine PDL (ePDL) is adapted to the very specific conditions of equine lifetime tooth eruption in response to constant occlusal wear (3-4 mm/year). Therefore, the ePDL requires high regeneration ability due to continuous remodeling of the surroundings. In this respect, the high cellularity and the high percentage of fibroblasts and fibrocytes is important to mention. The question arises whether ePDL cells were useful for cell-based regenerative therapies, i.e. for tendon diseases.

Gene expressions of collagen type 1 (COL1), collagen type 3 (COL3), scleraxis (SCX) and fibrocartilage markers were examined in the mature ePDL compared with immature and mature equine tendon tissue. Analyses of gene expression were performed using real-time quantitative polymerase chain reaction (qRT-PCR).

The mature ePDL is characterized through significantly higher expression levels of COL1 and COL3 compared to mature tendon. In the immature tendon COL3 expression levels were markedly lower than in the mature ePDL. The mean expression of COL1 in the immature tendon was higher than in the mature ePDL, but showed a high variability. The mature equine tendon showed expressions levels of COL1 and COL3 at a very basal level indicating a tendon characteristic limited turnover. Gene expression values for SCX in mature ePDL and immature and mature tendon tissue were on a similar level.

Mature tendon tissue is commonly described as a quite static tissue with low turnover rates and reduced ability for regeneration, which is supported by only basal expression levels in this study. In contrast, high expression levels of COL1 and COL3 indicated a high collagen production rate and a remarkable turnover in the mature ePDL. COL3, which is generally accepted to be more expressed in developing tissues, showed higher gene expression values in the mature ePDL compared to the immature tendon. Therefore, the ePDL can be characterized as a very high dynamic system with high collagen expression levels due to continuous remodeling. SCX a generally accepted specific marker to identify differentiated tenogenic and ligamentogenic cells as well as their progenitors. Thus, the ePDL possess marked characteristics of a typical equine tendon
Equine dentistry

The equine periodontium in health and disease

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Introduction

Periodontal disease is increasingly recognised as a common and painful equine oral disorder. With progression of periodontal disease, the tissues supporting the tooth are destroyed until eventually the tooth itself may be lost. In the early 1900s, several reports described its clinical features of equine periodontal disease and showed a high prevalence, especially in urban horses. Colyer also acknowledged its substantial welfare impact describing periodontal disease as “The scourge of the horse”. More recent studies have shown periodontitis to be present in up to 75% of UK horses with its prevalence increasing with age. Other recent equine studies have confirmed this disorder to be very painful, and it the most common equine dental disorder in the UK to cause quidding and weight loss. Donkeys are also commonly affected with disease, including 23.5% of working donkeys and 100% of diastemata in one donkey study had associated periodontitis.

Periodontal anatomy

The periodontium is a complex, dynamic structure comprised of four separate tissues, i.e.: the gingiva, peripheral cementum, periodontal ligament and alveolar bone that interact together to protect and support the tooth (Fig 1 courtesy of C. Stasyzk). The equine periodontium must also adapt to allow for the prolonged eruption of hypsodont dentition and cope with masticatory forces of over 1550 Newtons that are exerted on the caudal cheek teeth for up to 18 hours per day.

Throughout the life of the tooth peripheral cementum is continually produced by cementoblasts below the gingiva level and deposited at the apex and around the periphery of the reserve crown. Cementum is similar to bone with an organic content of around 50%, primarily collagen. Larger groups of fibres (Sharpey’s fibres) originate from the periodontal ligament and are incorporated into both the peripheral cementum and alveolar bone and flexibly anchor the tooth to the alveolus.

The equine periodontal ligament is a highly vascular and cellular structure which largely consists of collagen fibres, fibroblasts and ground substance interspersed with many nerves, blood and lymphatic vessels. It
contains unique vasculature which both nourishes and supports the tooth during mastication and its prolonged eruption and some specialised blood vessels act like a shock absorber during mastication, to protect the pulpar apical blood supply.

The gingiva is a firm, keratinised epithelium covering the underlying alveolar bone, periodontal ligament and reserve crown and acts as a physical barrier against oral microbial invasion of the periodontal tissues. The free gingiva is the most occlusal and mobile aspect of the gingiva and acts as an interface with the epithelium of the gingival (crevicular) sulcus which is a shallow pocket between the tooth and the free gingiva. Junctional epithelium at the base of the sulcus adheres tightly to the peripheral cementum on the tooth surface.

The gingival sulcus is 1-4mm deep in periodontally healthy horses and becomes much deeper with periodontal disease. Gingival crevicular fluid containing antibodies, enzymes and other inflammatory mediators and immune components is secreted into the sulcus, and together with gingival tissue play an important role in responding to immunological challenges from oral bacterial communities. In periodontal health, the gingiva provides a tight seal around the erupted crown and mechanically protects the underlying structures. However in periodontal disease, this barrier is damaged leaving underlying sensitives tissues exposed and open to both mechanical damage and bacterial colonisation.

**Aetiopathogenesis of periodontal disease**

*Plaque induced periodontal disease – brachydont species*

Periodontal disease is also of major importance in humans and brachydont species and consequently has been extensively studied in many brachydont species (especially dogs) usually as a model for human disease. In brachydont dentition, the initiating factor for gingivitis, which is the earliest and often reversible stage of periodontal disease, is the accumulation of dental plaque (thickened biofilm) in the gingival sulcus, which may eventually become calcified (i.e. calculus). The presence of plaque in the gingival sulcus initiates a bacterial–induced inflammatory reaction (gingivitis) that may or may not proceed to involve the deeper periodontal tissues, i.e. periodontitis. It is interesting that the most severe periodontal inflammation is actually usually due to the host’s response to the bacterial invasion, rather than the initial infection.

*Entrapped food induced periodontal disease – hypsodont species*

Plaque induced periodontitis is rare in horses, unlike in brachydont species, an exception being the canine teeth, where the presence of calculus can cause gingivitis, but rarely, more severe periodontitis.

In equidae, most periodontal disease is actually due to orthodontic problems, i.e. food trapping in anatomical defects, such as diastemata between adjacent cheek teeth. Equine periodontitis is particularly associated with diastemata which can be described as abnormal spaces between adjacent teeth – that should normally be in tight apposition at their occlusal surfaces. Equine diastemata may be classified as primary diastemata (where the teeth developed too far apart and/or with insufficient angulation to occlusally compress them) and as secondary diastemata, such as caused by displaced or rotated cheek teeth, dental overgrowths or supernumerary cheek teeth. In addition senile diastemata may form due to the tapering of equine cheek teeth towards their apices resulting in decreased surface area at the occlusal surface, along with age-related loss of angulation of the 06s and 11s. Diastemata have been documented in up to 50% of horses in a UK equine practice survey, with feed material becoming trapped in 91% of diastemata. In addition, 34% of diastemata had associated gingivitis and 44% were accompanied by periodontal pockets.

Impaction of feed material in periodontal pockets has also been recorded in 76% of cheek teeth diastemata in donkeys, with 71% of these donkeys also having concurrent dental disorders such as displaced cheek teeth, which likely initiated or contributed to diastemata formation. Malerupted (rotated) maxillary cheek teeth have also been described as the primary cause of diastemata formation and associated severe periodontitis.

*Feed Stasis and Bacterial Proliferation*

The above described trapping, stasis and subsequent decomposition and fermentation of food material in equine interdental spaces can as noted, abrade the sensitive gingiva, causing mechanical damage and gingival inflammation. Over time, impacted feed (a porous infected foreign body) acts as a bacterial nidus, further supporting the proliferation of bacteria which ferment the trapped feed.
**Inflammation of the periodontium**

The initial insult provokes a substantial inflammatory response within gingival tissue due to both mechanical abrasion of sensitive gingival epithelium and bacterial proliferation, as noted earlier. It is likely that in horses as well as in brachydont species, the host inflammatory response can worsen the situation. The initial host response is apparent clinically as gingivitis with hyperaemia and bleeding upon gingival probing. In man, a number of different pathogenic bacteria are implicated in the induction of a marked host inflammatory response which in turn leads to destruction of the periodontal ligament and resorption of alveolar bone and cementum which can leads to end stage disease, i.e. loss of the tooth. This exaggerated inflammatory response shown in human periodontitis cases is the result of prolonged cytokine production in gingival tissue leading to increased production of proteases, which although can break down invading microbes, can also damage the host’s periodontal tissues13.

Apart from the study of Cox et al.10 there appears to be no published work on equine periodontal disease histology. These authors showed the mucosal surface of equine periodontal pockets to be hyperplastic, with epithelial disruption and presence of large numbers of inflammatory cells including neutrophils in the lamina propria and adjacent connective tissues and destruction of the periodontal tissue including peripheral cementum in which the periodontal membranes were once attached.

Accumulations of food material which may be obvious clinically, has also been confirmed on histopathology, alongside large numbers of bacteria and micro-abscesses in the submucosa of equine periodontal pockets10. In absence of clinical intervention, the disease progresses and inflammation spreads to the periodontal ligament with infiltration of mononuclear cells. The periodontal ligament is gradually destroyed over time, as is the surrounding alveolar bone and cementum, decreasing tooth support and further deepening periodontal pockets. Teeth may become mobile at this stage. The increasing depth of the equine periodontal pocket provides the ideal environment for further invasion and proliferation of anaerobic bacteria and the cycle of inflammation and tissue degradation continues until tooth loss occurs.

**Oral microbiology**

The community of bacteria both commensal and pathogenic inhabiting the oral cavity is known as the oral microbiota. There are approximately 700 different species identified to date in human healthy and diseased oral cavities and recent work suggests there are possibly even more in horses. This oral bacterial community is incredibly complex and dynamic, with species interacting with each other and also with the host immune system. In order to survive in an environment being constantly washed with host saliva, and mechanical abrasion from masticatory movements, bacteria have found a method of adhering to the surface of oral tissue and so exist in a biofilm.

**The Oral Biofilm**

A biofilm is defined as ‘a biopolymer matrix-enclosed bacterial population, adherent to each other and surfaces’14. Multispecies bacterial communities existing within the oral biofilm are supported and protected by the surrounding matrix. Early bacterial colonisers initially adhere to the salivary pellicle (a layer of proteins and glycoproteins which permanently coats all normal oral surfaces). Adhesion and subsequent proliferation of early colonisers is followed by co-adhesion of genetically distinct bacteria to the existing attached population.

Bacteria within the biofilm matrix can be protected from exposure to host innate and adaptive immune mechanisms as well as to administered antimicrobial compounds. Front-line immune responses such as phagocytosis are ineffective in the biofilm matrix as bacterial cells cannot be readily engulfed at this site. Although ineffective in removing the bacterial biofilm, the immune response often has significant adverse, side effects on surrounding tissue, stimulating inflammation and destruction of the periodontium13.

**Bacteria in oral health and disease**

Current understanding of the role of bacteria in disease is changing and traditional principles such as Koch’s postulates are becoming increasingly irrelevant in modern microbiology in certain environments. Due to the difficulties in culturing some bacteria, it cannot be said that an organism is not involved in disease purely because it cannot be grown in culture as molecular bacteriology has shown. Likewise, to suggest that an organism is not involved in a disease because it may be found in healthy individuals or is unable to repli-
cate disease when inoculated into a healthy individual is to ignore variations in host-pathogen interactions. Analysis of the equine oral microbiome, has shown to be very different between healthy gingiva and cases of periodontitis15.

The anaerobic or partially aerobic environment of deep periodontal pockets encourages invasion and proliferation of micro-aerophilic organisms, anaerobes and spirochetes, while the environment of the general oral cavity supports a significantly different microbiota. Another hypothesis which can be applied to the diseased oral microbiome is the *keystone pathogen hypothesis* which maintains that certain pathogens existing at low abundance in the oral cavity may modulate their environment, disturbing the normally symbiotic relationship between the existing oral bacteria, creating a state of *dysbiosis* (dysregulation of commensal oral bacteria) thus contributing to the development of inflammatory disease. A recent molecular bacteriology study15 has revealed a population shift towards gram negative organisms as well as increasing numbers of spirochetes in horses with periodontal disease. In particular, bacteria belonging to the *Prevotella*, *Veillonella*, *Treponema* and *Tannerella* genera were found to significantly increase in equine periodontitis lesions15. Some species of these genera are well known human periodontal pathogens16.

*This an abstract of article by Kennedy, R. S, & Dixon P. M. (2016) The aetiopathogenesis of equine periodontal disease – a fresh perspective Equine Veterinary Education DOI: 10.1111/eve.12563*

**References**


The dilemma of equine cheek teeth diastema treatments – choosing the best treatments for different diastema presentations

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Despite many years of interest and research on the pathology and treatment of equine diastemas there is still no one treatment that is curative in all cases. This is particularly frustrating as periodontal disease associated with diastemas is regarded as one of the most painful conditions horses can suffer from. Diastema can present at different ages: from developmental issues causing diastemas in young horses to age related changes causing senile diastemas in older horses. Diastemas have been described as being ‘open or wide’ and ‘closed or valve’ based on their interdental appearance. Diastemas can be associated with mild gingivitis or severe periodontal disease with deep periodontal pockets. The pockets can be seen lingually/palatally and/or buccally. Diastemas, although more commonly seen in the mandibular cheek teeth, can be found in the maxillary cheek teeth. Diastemas may be localised to the rostral or caudal interdental spaces.

Treatment options include cleaning out the food and remedial rasping to remove any exaggerated transverse ridges or other abnormalities causing uneven wear and imbalances in the masticatory action. Further treatment may involve partial or complete widening of the interdental space with or without bridging material. The bridging material may be softer temporary bridges or harder semi-permanent bridges. There is also a plethora of human periodontics that may be used in the treatment of these equine periodontal pockets.

The aim of this study is to present the data from a dental referral clinic looking at which diastema treatment options were employed for specific type of diastemas, and determining which diastema treatment options are better suited to different diastema presentations.
posters
Case report: A rare case of oral benign neoplastic eosinophilic granulomas in a German Shepherd dog

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Eosinophilic granulomas is a rare disease in dogs. Eosinophils are the most infiltrative cells in the eosinophilic granuloma. Eosinophilic granulomas in dogs may have both hypersensitivity and genetic cause.

A rare case of oral benign neoplastic eosinophilic granuloma was referred to the dentistry section of Parsa Pet Clinic, Tehran.

History: A 4 year-old, female (Spayed), German Shepherd Dog (weight = 26kg) was referred for investigation of ulcers and plaques on the palatine arches and some pruritic lesions on the skin. The patient displayed coughing during and after meals, dysphagia and decreased appetite.

At the first preliminary examination of the mouth, ulcerated and raised plaques, orange in color were observed on the palatine arches. The plaques were larger in size and number compared with other cases of oral eosinophilic granulomas previously examined in dogs or cats. There were 6 plaques. The skin lesions were inflamed and resembled hypersensitivity lesions.

Biopsies of the intra-oral plaques and skin lesions were obtained sent for histopathologic examination which revealed Slight hyperplasia and hypertrophy of the epithelium, and neoplastic signs.

Oral Biopsy: The Basal layer was intact and few mitotic figures were seen, connective tissue was abundant and there was no sign of malignancy. The presence of Red blood cells, Neutrophils and Eosinophils were noticed too.

Left and right lateral radiographs of the thorax as well as of the lateral and ventro-dorsal sub-lumbar lymph nodes did not show any abnormalities or metastatic signs.

Skin biopsy: Skin biopsy showed hypersensitivity due to insect bite.

Forasmuch as some of the plaques were traumatized during eating food and given that some of these lesions are not responsive to medical treatment, such as Prednisolone, in dogs, surgical excision appeared to be the treatment of choice.

A routine blood sample for CBC, Urea, Creatinine, Total Protein, coagulation Factors and glucose was obtained and showed mild increase in WBC, mainly hand Neutrophils and Eosinophils. Other blood profiles and the physical examination were within normal limits.

After 12 hours NPO, Ketamine Hydrochloride and Acepromazin Maleate were administered intramuscularly as pre-anesthesia medication and the patient was then induced with Ketamine Hydrochloride and Diazepam intravenously. The dog was intubated with a cuffed endotracheal tube and Ringer’s solution was also administered at 10 ml/kg/hr. ECG, Body Temperature, SPO2, Heart rate, Respiratory rate and Blood pressure was monitored using specific monitoring equipment.

Surgery: An elliptical incision was made around each plaque using a Bard Parker # 11 blade and then each lesion was excised. The surgical sites were sutured with 3-0 absorbable synthetic suture material (Polygalactin 910, Vicryl) using a simple interrupted pattern.

Appropriate NSAIDs and antibiotic were administered for 7 days and after one week an anti-tick and flea skin drop (pipet) was administered.

24 hours post-operatively the patient and the surgical site were examined and found to be without any complications. After 2 weeks, the surgical sites had healed completely. There was no evidence of pain and
inflammation and the patient was asymptomatic during and after meals. After 6 months the patient was examined and found to be free of the oral lesions and radiography confirmed that there were no metastases.

Palatability in dogs of a new vegetable dental chew (VeggieDent® FR3SH™) which helps to reduce plaque and calculus formation and maintain a healthy and fresh breath

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Introduction: Halitosis is a common complaint from pet owners. Periodontal disease is the most notable cause of halitosis. The basis of periodontal disease management is dental plaque control. VeggieDent® chew is a vegetable dental chew that has proven effective in the mechanical prevention of dental plaque and calculus in dogs. The FR3SH™ Technology is a unique combination of three ingredients which help to maintain a healthy and fresh breath: pomegranate, erythritol and inulin. This technology has been added to the VeggieDent® chews to answer to the needs of owners to get a powerful freshening of the breath, while helping to reduce plaque and calculus formation. The objective of this study was to assess the palatability of the new VeggieDent® FR3SH™ chews in dogs.

Materials & Methods: This study was conducted in an independent research centre experienced in palatability trial performance. Thirty-seven healthy adult dogs of various breeds, both males and females, were included. Dogs received XSmall, Small, Medium or Large sizes of VeggieDent® FR3SH™ chews if they weighed less than 5kg (4 dogs, mean body weight (BW)=3.8kg), from 5 to 10kg (8 dogs, mean BW=7.3kg), from 10 to 30kg (20 dogs, mean BW=20.0kg) or more than 30kg (5 dogs, mean BW=34.3kg) respectively.

Two criteria were used to assess palatability: prehension and total consumption. Prehension was defined as the act of taking the chew spontaneously into the mouth, independently of whether it was then consumed. Total consumption was defined as the act of eating all the chew.

Results: Prehension was noted in all dogs, regardless of chew size. Total consumption was recorded for most animals, in all sizes (100%, 87.5%, 90% and 100% for XSmall, Small, Medium and Large sizes, respectively).

Conclusion: The excellent prehension rate and the high total consumption rate observed in this study indicate that VeggieDent® FR3SH™ chews are highly palatable for dogs.

Bibliography


### Profiling the salivary proteome of two canine breeds

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**Saliva is a complex biological fluid** that interacts with both soft and hard tissues in the oral cavity. Its multiple functions indicates its potential as a diagnostic fluid, such functions include forming a foundation for dental plaque, acting as a medium for bacteria transport through bacteria-protein coaggregation, and acting as a source of host proteins in oral cavity. It is therefore critical to establish the baseline profiles in order to understand the dynamic changes that arise during the progression of the target diseases both oral and systemic. There is currently little knowledge of the protein composition of dog saliva. Moreover it is unknown whether saliva composition differs from breed to breed, and thus it is important to understand normal cross-breed physiological variations in the saliva proteome in order to evaluate the impact of genetic polymorphism. This study aimed to examine the saliva proteome of two breeds of dog (Labrador retriever and Beagle).

A quantitative isobaric tagging approach was used to label saliva samples from 8 dogs (age 1-8 and balanced for sex) from each breed. Fifty nine proteins were identified from Labrador samples and 60 from Beagle samples. The overlap in identified proteins was 63% (i.e. those proteins common to both samples). Six of the top ten most abundant proteins are involved in modulation of the innate immune response to lipopolysaccharide. Immunoglobulins, carbonic anhydrase and cytochrome c were also highly abundant. Our results suggested there is a suite of proteins present in both human and canine saliva that perform the same function to protect the oral cavity against bacteria.

### Dental radiographs sans intubation

Ren R. Garcia

**Introduction**

Full mouth dental radiograph are at the core of any comprehensive dental examination. They are an essential part in order to be able to fully, and accurately diagnose dental disease. There is a growing trend of pet owners who want to be more active in their pets oral health plan. A limiting factor in being able to perform biannual dental examinations and diagnoses is the fear or reluctance of pet owners to put their pets through multiple anesthetic procedures each year.

To this point, the only option pet owners have to be able to obtain full mouth dental radiographs is to have their pet intubated, and placed fully under anesthesia.
Procedure

A complete blood count, and chem 28 blood panel are required prior to the procedure. Patients are catheterized, A combination of dexmedetomidine, butorphanol, and midazolam is administered intravenously.

Dose rates

*Start with a dose rate of:*
- Butorphanol 0.2mg/kg
- Midazolam 0.2mg/kg
- Dexmedetomidine 0.01mg/kg

*Every 20 minutes, increase as needed:*
- Butorphanol 0.1mg/kg
- Midazolam 0.1mg/kg
- Dexmedetomidine 0.01mg/kg

Benefits of performed dental radiographs without intubation

1. Decreased overall anaesthetic time over the lifetime of the patient;
2. Easing anaesthetic worries and concerns of modern day pet owners;
3. Decrease cost of dental diagnostics to the owner;
4. Ability to achieve a definitive diagnosis and being able to discuss surgical plan with the owner, prior to anesthesia;
5. Decreasing the total time the patient is anaesthesized;
6. Allows the veterinarian to see their patients twice yearly, providing better patient care, and promoting health and wellness through prophylactic and preventative healthcare;
7. Increasing the number of full dental radiograph procedures in your practice, which helps better guide short and long term treatment plans;
8. Increase the numbers of dental surgeries performed in your practice;
9. Increased overall revenue for your practice.

Influence of dental bites containing Ascophyllum nodosum on oral health in dogs. Double-blind, randomised, placebo-controlled unicentre study

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**Objective:** To determine the influence of 90 day administration of dental bites containing the brown algae *Ascophyllum nodosum* on plaque and dental calculus accumulation as well as on other parameters characterizing oral health status: Oral Health Index (OHI), Total Mouth Periodontal Score (TMPS) and Volatile Sulphur Compound (VSC) concentration in canine oral cavity.

**Materials and Methods:** 60 client owned dogs representing Japanese chins, miniature Schnauzers, Chihuahuas, Pomeranians and West Highland White Terrier (WHWT) breeds underwent prophylaxis procedure and were randomly subdivided into 2 groups receiving daily dental bites containing brown algae *Ascophyllum nodosum* or placebo according to their bodyweight. Clinical assessment of Plaque index, Calculus index, OHI and VSC was performed under sedation after 30, 60 and 90 days of treatment. The study was
conducted as a placebo controlled, double blind, randomized study.

**Results:** Oral administration of dental bites containing the brown algae Ascophyllum nodosum significantly improved the investigated indices and parameters, i.e. Plaque index, Calculus index and VSC; when compared to placebo-treated group.

**Conclusion:** Dental bites ProDen Plaque Off containing Ascophyllum nodosum efficiently decreased plaque and calculus accumulation in study dogs. Measured concentration of VSC and Oral Health Index in study group showed significantly lower concentration of VSC and better oral health status of the dogs respectively.

**Table 1.** Average combined plaque index (given as an arithmetic mean ± standard deviation and a range in parentheses) of dogs from two groups (P1 and P2) at four consecutive time points (T0, T30, T60, T90).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>T0</th>
<th>T30</th>
<th>T60</th>
<th>T90</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>30</td>
<td>0.96 ± 0.42 (0.4-2.0)</td>
<td>1.94 ± 1.14 (0.9-4.8)</td>
<td>2.71 ± 1.36 (1.1-6.4)</td>
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<tr>
<td>P2</td>
<td>30</td>
<td>0.62 ± 0.31 (0.2-1.7)</td>
<td>1.49 ± 1.17 (0.6-6.4)</td>
<td>1.67 ± 0.81 (0.9-4.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>0.79 ± 0.40 (0.2-2.0)</td>
<td>1.72 ± 1.17 (0.6-6.4)</td>
<td>2.19 ± 1.23 (0.9-6.4)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.** Average Calculus index (arithmetic mean ± standard deviation and a range in parentheses) in dogs receiving for 90 consecutive days dental bites containing placebo (P1 group - blue) or brown algae Ascophyllum nodosum (P2 group - red).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>T0</th>
<th>T30</th>
<th>T60</th>
<th>T90</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>30</td>
<td>0.60 ± 0.15 (0.3-1.0)</td>
<td>1.05 ± 0.24 (0.7-1.6)</td>
<td>1.34 ± 0.23 (1.0-1.9)</td>
<td></td>
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<tr>
<td>P2</td>
<td>30</td>
<td>0.39 ± 0.14 (0.2-0.9)</td>
<td>0.82 ± 0.29 (0.4-2.1)</td>
<td>1.07 ± 0.39 (0.7-2.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>0.50 ± 0.18 (0.2-1.0)</td>
<td>0.94 ± 0.29 (0.4-2.1)</td>
<td>1.20 ± 0.32 (0.7-2.6)</td>
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</tr>
</tbody>
</table>

**Fig. 1.** – Average combined plaque index (given as an arithmetic mean with 95% confidence interval) of dogs from two groups (P1 and P2) at four consecutive time points (T0, T30, T60, T90). Asterisk (*) signifies the time point when groups significantly differed from each other.

**Fig. 2.** – Average Calculus index (given as an arithmetic mean with 95% confidence interval) of dogs from two groups (P1 and P2) at four consecutive time points (T0, T30, T60, T90). Asterisk (*) signifies the time point when groups significantly differed from each other.
Comparison of physical and chemical properties of Hesperidin, MTA-Angelus, and Calcium hydroxide as pulp capping materials

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Introduction: Historically, various materials have been used during pulp capping. These include, but not limited to: ivory, quill, gold-beaters skin, oiled skin, paper, plaster of Paris, Canada Balsam, asbestos, gutta percha, lactophosphate of lime, oxychloride, oxyphosphate and oxyxulphate of zinc cement. During the past decade, considerable comparative studies had been conducted on different pulp capping materials in dogs.

Calcium hydroxide became the material of choice for pulp capping. The studies have been continued on several materials as pulp capping agents and new materials were introduced as Mineral Trioxide Aggregate (MTA), Portland cement, composite resin, Propolis and finally Bioaggregate.

In last decade, considerable studies had been conducted on Propolis, a resinous material collected by honey bees from various plants. Propolis had been used as an anti-inflammatory and antimicrobial agent for many centuries. Among its constituents, flavonoids regulate the immune response, reduce the release of free radicals and inhibit bacterial and fungal growth, suggesting that flavonoids have natural anti-inflammatory and immuno-regulatory features. Hesperidin is one of the most important flavonoids.

The aim of this study was to evaluate the physical and chemical properties of Hesperidin cement in comparison with MTA-Angelus and Calcium hydroxide cements as a pulp capping material.

Materials and methods: The setting time, radiopacity, solubility and pH changes of the materials were evaluated. Tests followed specification #57 from the American National Standard Institute/American Dental Association (2000) for endodontic sealing materials and pH was determined by a digital pH meter. Measuring pH was performed at 7, 14, 21 and 28 days from mixing. It was measured eight times for each material. All data were analysed statistically.

Results: Considering the setting time, the highest mean value was for the MTA-Angelus followed by Hesperidin and Calcium hydroxide with 72.83, 48.26 and 1.58 min respectively. Regarding the radiopacity evaluation, Hesperidin showed the least radiopacity value due to absence of radiopacifiers followed by Calcium hydroxide and the highest radiopacity value was recorded for the MTA-Angelus. Hesperidin showed the solubility in distilled water (∼45% mass loss) in relation to Calcium hydroxide (∼19% mass loss). On the contrary, MTA-Angelus showed 9% increase in weight. Hesperidin showed decrease in pH value throughout the evaluation periods while in MTA-Angelus and Calcium hydroxide, pH mean value increased by time. Comparing the pH value between the three materials revealed statistically higher values in MTA-Angelus and Calcium hydroxide in comparison with Hesperidin.

Conclusions: Despite its slight acidic nature, longer initial setting time and lower radiopacity, Hesperidin is a promising pulp capping material. Further studies on its biological properties and addition of radiopacifiers to the Hesperidin powder are recommended.

References

The effect of autologous blood-derived platelet-rich fibrin in the treatment of periodontitis in dogs

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Objective: To evaluate the efficacy of the platelet-rich fibrin (PRF) in the management of periodontitis in dogs.

Methods: Using a split-mouth design, 10 mixed breed dogs with 20 paired maxillary 4th premolar and mandibular 1st molar periodontitis sites were randomly treated either with open-flap debridement (OFD) (control group, n=20) or OFD plus PRF (experimental group, n=20). Clinical parameters including gingival index (GI), mobility index (MI), and periodontal pocket depth (PD), together with inflammatory cytokine expression analysis assessed by means of real-time polymerase chain reaction (qRT-PCR) were evaluated at baseline, day 7, and day 14. Data were subjected to analysis of variance by using a non-parametric Mann-Whitney test with $P$ value $\leq 0.05$ was considered significant.

Result: Regarding clinical parameters, experimental group showed a significant reduction in GI and PD on day 14 as compared to controls. However, there was no significant difference in MI between two groups at any trial periods. As regards to inflammatory cytokine expression analysis, experimental group showed a significant increase in fold expression of anti-inflammatory transforming growth factor-beta 1 (TGF-β1) on both trial periods. The highest of TGF-β1 expression level was observed on day 14.

Conclusion: Since PRF can improve clinical and inflammatory cytokine expression aspect regarding periodontitis, it can be concluded that PRF has the ability to augment the periodontitis treatment in dogs.

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