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New advances in oral and maxillofacial surgery in small animals

Fidel San Román Ascaso DVM, MD, DDS, PhD, DEVDC
Complutense University of Madrid, Spain.

The objectives of this lecture are:

- To review certain techniques that have been developed and applied in recent times.
- We will deal with anesthetic blocks, Surgical Laser, Piezosurgery, Microsurgery, Flaps, Apico-ectomies, mini plates and locked plates in maxillofacial fractures.
- We will finish with cancer surgery, regenerative medicine and investigation of maxillofacial surgery in dogs and cats.
small animal & exotic animal dentistry
COHAT – Comprehensive Oral Health Assessment and Treatment. It’s NOT JUST a Prophy or a Cleaning!

Teresa Jacobson

**Pellicle**
A thin scum of polysaccharides and glycoproteins.
Part of the saliva, sticky.
Forms immediately after brushing.

**Plaque**
Pellicle and bacteria. Plaque is the enemy, it has active bacteria and is the cause of dental disease.

**Calculus**
Forms in as little as 72 hours (3 days). It is calcified plaque. Calculus does not cause dental disease but leaves more surface area for plaque to occupy.

**The seven steps to a comprehensive oral health assessment and treatment (COHAT)**
2. Subgingival cleaning – Root planing and curettage.
3. Explorer – check your work.
4. Polishing – supra and subgingivally.
5. Probing and charting – four handed dentistry.
6. Irrigation and rinsing.

**Preparation for the COHAT**
Eye protection
Mask
Cap
Gloves
Rinse mouth with 0.12% chlorhexidine

**Step one**
Gross calculus removal and supra gingival scaling – what you see.
Preserve the gum when using tartar breaking forceps. The use of ultrasonic and hand scalers is done here.
Ultrasonic scaling – contact with the tooth should be no greater than 8-10 seconds to avoid thermal damage to pulp. Claw tips are best for cats. Tips wear out so you need to have and use a tip gauge.
Hand instruments are used for the removal of calculus above the gum line (supra-gingival). They are held with a modified pen grip and are used with a wrist rock motion. All three edges of this instrument are sharpened.

**Step two**
Subgingival cleaning
Curettage on the gingival surfaces (gum) is accomplished by entering, rotating and pulling. Root plane is on the root surface of the tooth. Both must be done together to remove pockets. Curettes – remove calculus below the gum line. Use a modified pen grip to hold the instrument. One edge is used and sharpened on the Gracey curette and both edges are used and sharpened on the universal curettes. There are regular working tips of 4 mm and there are mini working tips that are great for cat’s mouths. Universal curettes are at 90 degrees, they are used in an insert, rotate and pull fashion. They are to be sharpened daily and you can use both sides. Gracey curettes are at 70 degrees, they are used in an insert, rotate and pull fashion. They are to be sharpened daily and you use only the lower side. The rule of thumb: the lower the number of the instrument, the further rostral in the mouth that it is designed for; the higher the number, the further distal in the mouth that it is used. For example a Gracey 1-2 is used in dogs for incisors and canine teeth.

**Step three**
Explorer – checking your work
Use the explorer to check your work and feel the surfaces of the crown and the root. Place the tip at 30 degrees relative to the tooth’s surface. Use it to detect missed plaque and calculus. A clean tooth should feel like a glass jar.

**Step four**
Polishing
Polish supra and subgingivally. Use 3cc syringe caps to hold polish that is bought in bulk. Use fine or extraction fine prophy polish to prevent damage to the tooth enamel. Flare the prophy cup under the gumline. Go as slow as possible (if you speed up you heat up). Do not stay on a tooth for greater than 5 seconds to prevent thermal damage.

**Step five**
Probing and charting
This is a two person job (four handed dentistry). Probing is very important to be sure that the work is done correctly. Hold the probe with just the weight of the instrument.

*Normal pocket depths*
Canine: 1-3 mm
Feline: 0-1 mm

**Step six**
Irrigation and rinsing
Use the air water syringe on your machine. Direct the jet toward the gum line. Do not leave any blood on the patient, it will not impress the client. Do not leave any clots or prophy paste in the patient’s mouth; they can’t talk remember!

**Step seven**
Client education
This is the most important step. Discharge appointment is to be done by a well-educated veterinarian or technician. Establish a client home care program. Periodontal disease is a progressive process; it is not cured by one COHAT.

Periodontal disease is controllable, not curable.
Proactive approach to oral health

Katie Kangas, DVM, CVA, CVCP
Integrative Veterinary Care, San Diego, CA, USA.

It is now a well known fact that oral & dental health significantly affects overall systemic health in both animals and humans.\(^1\,^2\) It is also known that periodontal disease is the single most common problem diagnosed in small animal patients.\(^3\,^4\) Historically within veterinary medicine however, the mouth is often largely ignored in evaluation of our patients. Therefore it is typically under-appreciated in the treatment planning for patients with systemic disease issues and even in goals for supporting preventative health and wellness.

The lack of awareness and attention to oral health within the veterinary profession is mostly due to the lack of training within curriculums in most veterinary education institutions. In human medicine, dentistry is a completely separate medical science and requires its own intensive education. Veterinarians have a general lack of knowledge and training regarding this extremely important aspect of general health. For all veterinarians, and especially those practitioners who take an interest in the “wholistic” approach, recognizing the true impact of oral health on the complete health status of our patients is the initial step. Our next step is then to take a more proactive approach to improving and maintaining oral health for our animal patients, which in turn will make a tremendous impact on their quality of life, promote their resilience to disease and support their overall balance and wellness.

In the specialty field of biologic dentistry within the human sector, there are many practitioners who actually utilize and greatly respect the dental meridian chart, which displays that every tooth aligns with a specific organ or system within the body. This makes perfect sense to those of us who are trained in Eastern and Chinese Medicine philosophy. Furthermore, many biologic dental practitioners (and their gratified human patients) have seen very specific and significant problems and diseases resolve when dental problems are addressed and properly treated.

It has been well established that periodontal disease negatively affects the health of the heart, brain, liver and kidneys. It is also known that chronic periodontal disease creates insulin resistance, affecting the control of diabetes and increasing diabetic complications. Additionally, periodontal disease has been linked to other endocrine diseases and also to cancers. It is important to note that proper therapy of periodontal disease has been shown to have positive affects on specific organs and disease problems. In fact, some cases of feline diabetes resolve with proper treatment and resolution of periodontal disease, and human studies have reported improved cardiac function/parameters after treatment of periodontal disease. Despite this information, there is minimal awareness amongst most veterinary practitioners of the true scope of the systemic effects of periodontal disease.

The impact of periodontal disease certainly makes sense from a broad perspective, when you

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consider that it provides a constant source of chronic inflammation to the whole body. In other words, dental disease is not just a local problem in the mouth and gums, it affects nearby structures such as the eyes and nasal sinuses, as well as spreading through the bloodstream to the entire body. Just as poor diets (sugar, carbs, heavily processed foods) are pro-inflammatory and are thus fueling inflammation in the body, so is chronic periodontal disease.

The focus of many current medical papers is on the role of chronic inflammation in the body. In fact, numerous recent veterinary journals and CE events (including our previous AHVMA convention) have given much attention to the role of chronic inflammation in disease. Therefore, it is extremely applicable to include a discussion of periodontal disease in the veterinary holistic approach!

Now that we have established that chronic periodontal inflammation has significant negative effects, let’s discuss some ways to proactively improve dental and oral health.

Host modulation is a new treatment approach in the human dental field, and is gaining popularity as a form of “novel” periodontal therapy in animals as well. The term, host modulation, implies supporting the host (i.e. the whole patient) in controlling the body’s response to inflammation and infection. Why is this approach so potentially beneficial?

In explanation, plaque is considered to be the etiologic agent of periodontal disease, but it is actually the inflammatory cascade, and most specifically chronic inflammation, that ultimately leads to the periodontal disease cycle. This pathway is also thought to be the main cause of the systemic ramifications of periodontal disease. Plaque bacteria and their byproducts initiate the inflammatory changes in the tissues which can then lead to alveolar bone loss in susceptible individuals. However, it is known that the body actually controls its own osteoclasts which play the role in alveolar bone loss. If the acute inflammatory response can be resolved quickly, tissue injury is prevented. Alternatively, inadequate resolution and failure to return tissue to homeostasis results in neutrophil-mediated destruction and chronic inflammation.

There are many options available to affect host modulation and to assist the body’s ability to combat gingival and general inflammation.

**Diet and nutrition**

Diet and nutrition choices are paramount in overall health, and this includes dental health as well. Although most of us were taught in veterinary school to believe that dry pet foods were beneficial to dental health, this has been disproven in specific studies. The chewing action (if chewed at all!) of dry kibble food only provides cleaning of calculus (tartar) on the incisal edges (tips) of the teeth. It does not actually promote cleaner teeth at the gumline. In other words, chewing standard dry kibble food does not provide cleaning/protection where periodontal disease occurs, and is therefore not protective against gingivitis or periodontal disease. Only dental prescription diets with proven impact on gingivitis are truly helpful for dietary management of oral health in regards to dry foods. On an additional note, most dry kibble foods are heavily processed via extrusion methods (combination of high heat and pressure), creating AGE’s (Advanced Glycation End Product’s) which are known to be pro-inflammatory. This means that heavily processed diets can ultimately promote inflammation in the body.

Consequently, a fresh and un-processed (or low-processed), species-appropriate diet can be a critical piece of overall wellness in addition to oral health and general resistance to chronic inflammation. Furthermore, raw meaty bones can provide a true active chewing and gum cleaning advantage. However, hard and/or cooked bones can cause broken teeth when chewed. Cooked bones also carry the danger of the potential to splinter and cause GI perforation, etc. Veterinary dentists report that larger sized raw bones such as marrow bones are rarely seen to cause broken teeth, while the


smaller thin, long bones and similar shaped objects are common culprits. This has to do with canine oral anatomy and the physics of mastication as the dog’s teeth are positioned against the object being chewed. Larger, bulky objects do not create the same angle and force on the carnassial teeth as do smaller and longer objects. In fact, common items that are seen to break dog’s teeth are nylon bones, cooked bones, antlers, hooves, and bully sticks.

In addition to the impact that diet has on oral health, there are various nutraceuticals and nutritional supplements that can help to decrease the amount of both oral and systemic inflammation. This in turn decreases the amount of osteoclastic bone resorption, thereby slowing the progression of periodontal disease. It is interesting to note that several conventional drug therapy options are available to address gingival and periodontal inflammation, but most of these have significant side effects which makes their use much less desirable.

**Antioxidants**

Recent studies have linked chronic oxidative stress with periodontal disease. Oxidative stress can be defined as free-radical damage to the body’s cells/tissues. In fact, proper equilibrium between free radicals and antioxidants is now thought to be the main prerequisite for healthy periodontal tissues. As such, it appears that antioxidants play an important role in periodontal health and thus appropriate supplementation should offer protective benefits.

There are numerous nutritional products available for increasing antioxidant capacity. These can range from simple vitamin supplementation (such as Vit C and E), preferably from food-based sources vs synthetic vitamins, to specific products which provide a more effective increase in total antioxidant capacity. Topical application of antioxidants has also been shown to improve periodontal health, and a topical veterinary specific formulation has been shown to decrease halitosis in dogs.

In regards to systemically increasing antioxidant capacity, many recent studies have evaluated the Nrf2 pathway and its tremendous benefits to overall health. Nrf2 is a messenger protein which triggers a natural pathway in the body to stimulate the body’s own antioxidant production. These indirect internally produced antioxidants (vs direct, food-based, externally sourced antioxidants) are very powerful enzymes such as Glutathione, Superoxide Dismutase (SOD) and Catalase. These indirect antioxidants are known to be highly protective against free radicals and in reducing oxidative stress. Stimulating the NRF2 pathway to create increased production of powerful antioxidants such as Glutathione and SOD has benefits for periodontal disease (as well as more than 200 other diseases that have been linked to oxidative stress). Indirect antioxidants cannot be well absorbed by the gut and must be produced by the body. There is a natural, plant-based product with a canine specific formulation (the human product version is also used in dogs, cats and horses), which has

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13 Canine Health, LifeVantage.
shown the ability to very effectively increase the body’s production of indirect antioxidants.\textsuperscript{14,15}

**Other Neutraceuticals**

Recent studies on the use of fatty acid supplements have shown beneficial results in periodontal inflammation.\textsuperscript{16,17,18,19,20,21} The anti-inflammatory action of Omega-3 fatty acids are widely known for their benefits to joints, but they have also been shown to support periodontal, heart, kidney and brain health too. Furthermore, due to the high epithelial penetration of fatty acids, topical application of fatty acids also appears to be very useful for the treatment of local oral inflammatory diseases, including periodontitis.

A particular fatty acid called 1-Tetradecanol complex is an esterified monounsaturated fatty acid that has shown very positive effects when applied topically to the gingiva. In two in vivo studies on New Zealand Rabbits, it stopped the progression of periodontal disease and resulted in a significant reduction in macroscopic periodontal inflammation, attachment, and bone loss.\textsuperscript{22,23} In addition, histologic assessment demonstrated that it also inhibited inflammatory cell infiltration and osteoclastic activity. This product\textsuperscript{24} offers a proactive approach to support host resilience to inflammation and therefore minimize the progression in the periodontal disease cycle. (It is worthwhile to note that 1-Tetradaconal Complex also has a high affinity for joints and muscle/tendon/ligament tissues and is delivered to those tissues systemically after oral absorption or ingestion).

A deficiency of coenzyme Q10 has been shown in human patients with periodontal disease.\textsuperscript{25,26} Conversely, there are reports that supplementation (systemic or topical) may have a beneficial effect.

\begin{footnotesize}
\begin{enumerate}
\item Nauroth JM, Liu YC, Van Elswyk M: Docosahexaenoic acid (DHA) and docosapentaenoic acid (DPAn-6) algal oils reduce inflammatory mediators in human peripheral mononuclear cells in vitro and paw edema in vivo. Lipids. 45(5):373-84, 2010.
\item 21 TDC Elite Science.
\end{enumerate}
\end{footnotesize}
on periodontal health. Studies have demonstrated that folic acid is also effective in preserving gum tissue and reducing the risk of gingivitis and periodontitis.

**Probiotics**

The benefit of probiotics in supporting both gastrointestinal health and the overall immune system is the subject of growing focus. An important point in this discussion is that the mouth and oral cavity are indeed part of the gastrointestinal tract. Another important point is that we now understand that the body’s microbiome plays a critical role in systemic immune system function and therefore in the ability to positively affect chronic inflammation. As a matter of fact, recent information is supporting the use of probiotics both orally and topically within the regimen for proactive oral health. One human study in Japan showed significantly reduced probing depth of periodontal pockets in subjects consuming daily probiotics, namely Lactobacillus Planatarum (L-137), after just 12 weeks of consumption. These results were compared with the control group consuming daily placebo for the same 12 weeks duration. Another human study reported that the oral-topical application of probiotics containing L. brevis decreased inflammatory mediators involved in periodontitis. An evaluation in dogs showed that with the application of topical probiotics into periodontal pockets, subgingival recolonization of pathogenic bacteria was reduced, as was the degree of inflammation, at a clinically significant level. An additional study in dogs found that bone density within periodontal pockets treated with beneficial bacteria improved significantly after 12 weeks, (while the difference was non-significant for the control pockets). The benefit of oral probiotics is to deliver bacteria that work in the mouth to alter the oral biofilm content. In other words, these beneficial bacteria can form colonies that will create a healthier biofilm in the mouth and help crowd out the bacteria that cause harmful inflammation and lead to caries and periodontal disease.

**Active plaque removal**

It would be remiss to not cover one the most effective proactive methods of supporting oral health, which is back to the basics of plaque removal. Regular professional dental cleanings are extremely helpful if they are done properly and performed with the patient under general anesthesia. General anesthesia is required for effective cleaning and is also needed to perform a complete oral health evaluation.

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exam as well as the ability to obtain dental x-rays to find pathology and address it.\textsuperscript{35,36,37,38}

The most effective way to achieve plaque removal via home care is with the mechanical action of regular tooth brushing.\textsuperscript{39} In reality, we know that many pet owners are not likely to do this on a daily basis, but they are certainly less likely to make that effort if they are not educated as to the value it can provide to the health of their pet, especially with small breed dogs! In other words, if more pet parents truly understood how much this daily routine could impact the health, well-being and longevity of their pet, the compliance rate would be much higher.\textsuperscript{40}

With advancements in our knowledge regarding the impact of periodontal health on systemic health, along with expanding awareness of the role of chronic inflammation in the progression of illness and disease, it is our responsibility to educate pet parents about the various proactive options they have in safeguarding their pets to the best of their ability.

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\textsuperscript{35} Colmery B. The gold standard of veterinary oral health care, in Holmstrolm SE (ed) Veterinary clinics of North America. 35(4): pp 781-7, 2005

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**Dental extractions made easier**

Brook A. Niemiec, DVM, DAVDC, DEVDC, FAVD
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Extractions are surgery, and therefore need to be treated with appropriate respect. Patience and gentle technique is the best way to achieve a successful outcome. All extractions can be broken down into simple, single rooted extractions. Therefore proper elevation and extraction techniques learned and performed on incisor teeth will make all extractions easier.

Proper and well maintained equipment is critical for successful extractions. This author prefers luxating elevators to standard or winged elevators. Small extraction forceps and needle holders will also benefit the surgeon.

**Single root extractions**

*Incise the gingival attachment*

This is accomplished with a scalpel blade (number 11 or 15), elevator, or luxator. The selected instrument is placed into the gingival sulcus with the tip of the blade angled toward the tooth (this will help avoid going outside the bone and creating a defect or cutting through the gingiva). The blade is then advanced apically to the level of the alveolar bone, and the instrument is carefully worked around the entire tooth circumference.
This step is very helpful as the gingival attachment contributes approximately 15% of the re-
tentive strength of the periodontal apparatus. More importantly, however, this procedure will keep
the gingiva from tearing during the extraction procedure. This is most important with mobile teeth
where little elevation is needed, but one edge is still attached. Gingival tearing can cause defects that
require closure or can make a planned closure more difficult.

Elevate the tooth

Elevation is the most dangerous step in the extraction procedure. Remember that you are holding
a sharp surgical instrument and working in an area of numerous critical and delicate structures.
There have been many reports of eyes that have been gouged and lost by extraction instruments
as well as at least one confirmed fatality due to an elevator puncturing a patient’s brain. The index
finger is placed near the tip of the instrument to avoid causing iatrogenic trauma in the event of
instrument slippage or encountering diseased bone. In addition, the jaw should be gently held with
the opposite hand to provide stability.

First, select an instrument which matches the curvature and size of the root. There are numerous
instruments available including the classic elevator, the luxating elevator, and the winged elevators.
Classic elevators and winged elevators are used in an “insert and twist” motion to tear the periodon-
tal ligament, whereas luxators are used in a rocking motion during insertion to fatigue as well as cut
the periodontal ligament. Luxators can be GENTLY twisted for elevation, but they are not designed
for this and can be easily damaged.

Elevation is initiated by inserting the elevator or luxator firmly yet gently into the periodontal
space. The insertion should be performed while keeping the instrument at about a 10 to 20 degree
angle toward the tooth, to avoid slippage. Once in the space between the bone and the tooth, the
instrument is gently twisted with two-finger pressure. This is not to say that the instrument should be held with two fingers, rather the entire hand should be used to hold the instrument. Twist only with the force that you could generate when holding with two fingers. Hold the position for 10-30 seconds to fatigue and tear the periodontal ligament.

It is important to note that the periodontal ligament is very effective in resisting intense, short forces. It is only by the exertion of prolonged force (i.e. 10-30 seconds) that the ligament will become weakened. Heavy stresses only serve to put pressure on the alveolar bone and tooth which can result in the fracture of one of these structures.

After holding for 10 to 30 seconds, reposition the instrument about 1/8 of the way around the tooth and repeat the above step. Continue this procedure 360 degrees around the tooth, each time moving the elevator apically as much as possible. Depending on the level of disease and the size of the tooth, a few to several rotations of the tooth may be necessary. The key point to successful elevation is PATIENCE. Only by slow, consistent elevation will the root loosen without breaking. It is always easier to extract an intact root than to remove fractured root tips.

**Extract the tooth**

Removing the tooth should only be attempted after the tooth is very mobile and loose. This is accomplished by grasping the tooth with the extraction forceps and gently pulling the tooth from the socket. Do NOT apply undue pressure as this may result in root fracture. In many cases, especially with premolars, the roots are round in shape and will respond favorably to gentle twisting and holding of the tooth while applying traction. This should not be performed if there are root abnormalities (significant curves, weakening) seen on the pre-operative radiograph. It is helpful to think of the extraction forceps as an extension of your fingers. Undue pressure should not be applied. If the tooth does not come out easily, more elevation is necessary. Start elevation again until the tooth is loose enough to be easily removed.

**Closure of the extraction site**

This is a controversial subject among veterinary dentists, and thus some texts recommend suturing only in large extractions, other authors (including this one) recommend suturing almost all extraction sites. Closure of the extraction site promotes hemostasis and improve post-operative discomfort and aesthetics. It is always indicated in cases of larger teeth (e.g. canines, carnassials), or any time that a gingival flap is created to allow for easier extraction. This is best accomplished with size 3/0 to 5/0 absorbable sutures on a reverse cutting needle. Closure is performed with a simple interrupted pattern with sutures placed 2 to 3 mm apart. It is further recommended to utilize one additional throw over manufacturer’s recommendations.

**Extraction of multi rooted teeth**

Section all multi-rooted teeth into single rooted pieces. The roots of almost all multi-rooted teeth are divergent and this will cause the root tips to break off if extractions are attempted in one piece. Root fracture can occur even if a tooth is relatively mobile to start with. With mobile teeth, the sectioning step alone often allows for simple extraction.

The best tool for sectioning teeth is a bur on a high-speed air driven hand piece. Besides being the quickest and most efficient tool for the job, it also has air and water coolant that will avoid overheating the tooth. Many different styles of burs are available, however this author prefers a cross-cut taper fissure bur (699 for cats and small dogs, 701 for medium dogs and 702 for large breeds).

The best way to section the teeth is to start at the furcation and work towards the crown of the tooth. This method is used for two major reasons. First, it avoids the possibility of missing the furcation and cutting down into a root, which subsequently weakens the root and increases the risk of root fracture. In addition, this method avoids the possibility of cutting through the tooth and inadvertently damaging the gingiva or alveolar bone.
Extractions of maxillary molars

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Introduction

Because of their location, maxillary molars often suffer from severe periodontal disease. They are deep in the mouth and hard to clean. In brachycephalic breeds, they are caudal to the end of the palate and often have minimal bone support. In dolichocephalic breeds, they are simply hard to reach. The second molar is less than half the size of the first and is usually the one most affected. They are often both mobile but in some cases the second molar is still solid while the first suffers from bone loss. The various presentations affect the technique used and the design of the flap.

Method

Second molar alone. It is a small tooth which would make it easy but it is three rooted and hard to reach. Lateral or dorsal recumbence will help visualising the tooth. Start with an intra-sulcular incision to create an envelope flap. Elevate the buccal attached gingiva to expose the furcation. Section the crown to separate the three roots. The first cut is vertical between mesiobuccal and distobuccal roots. The second cut, to separate the palatal root, is made as close as possible to the buccal cusps with the bur slanted apico-buccally. Next luxate the roots, starting with the mesiobuccal one. Wedge the luxator into the periodontal ligament space and apply pressure for 30 seconds at a time. Luxate distal and mesial to the root. Once the root starts to move (one to two mm), hold the root with the forceps and rotate in line with the axis of the root. Hold the force for 30 seconds, reverse direction of rotation and repeat. Once the mesiobuccal root is out, proceed to the distobuccal root using the same technique. The approach to the palatal root is different. The root is short and sturdy. On a cut section, it ressembles a muffin with the cusp being the muffin top. Ledges are present below the cusp. A luxator is placed parallel to the palate with one edge under the cusp. A quick rotation of the luxator is usually enough to lift the cusp and loosen the fragment. Once it is removed, one is left with a trapezoid defect. Use your periosteal elevator and lift the tissue at the caudal edge of the defect. You will lift the tissues covering the cranial edge of the coronoid process. It is a safe area without large vessels or nerves. Once lifted these tissues easily cover the defect. One only should place a few sutures with 4-0 or 5-0 absorbable monofilament and it is done.

First and second molars

Start with intrasulcular incision to create an envelope flap. Elevate the attached buccal gingiva. Expose the roots, divide them, luxate, rotate, remove. Now the whole remaining is much bigger and the first impulse is to try to elevate the buccal mucosa to rotate it over the defect. Do not, this approach is fraught with problems: both parotid and zygomatic salivary ducts papillae are in the vicinity and could be damaged. Moreover, the mucosa in this area is tightly attached to the fibers of the masseter muscle making it very difficult to mobilize. Rather than going buccal lift the distal tissues with a periosteal elevator. It is quick and easy to lift enough tissue to cover the defect and to suture it closed.
First molar

The extraction technique remains the same. Once the 3 roots are out, one is left with a defect between the fourth premolar and the second molar. There exists a ledge at the caudal border of the first molar. This ledge is buccal to the second molar. Introduce the periosteal elevator or spatula under that ledge and lift. You mobilize the tissue caudal to the first molar and buccal to the second molar. To cover the defect, you need to incise the flap at the rostro-buccal corner of the second molar. This provides release and allows rotation of the tissues into the defect. Suture close and you are done.

Crown extensions: a useful technique for many indications

Helena Kuntsi

Crown extensions provide a non-invasive technique for many indications in veterinary dentistry and oral surgery. The technique is not described in literature and is not included in the list of routine procedures required in our board examination. However, it’s a technique utilized for different purposes by many veterinary dentists. The presentation will include description of variable indications for using crown extensions for orthodontic and surgical purposes. The technique and materials will be described in detail to allow colleagues who are not familiar with his technique to encourage using it and also open ideas for new indications and useful aspects for those already familiar with this technique.

The orthodontic indications for crown extensions include mandibular distoclusion in deciduous and permanent dentition to direct the mandibular canines into a non-traumatic occlusion. In deciduous dentition, crown extensions can be used as a non-invasive alternative to extraction of mandibular canines to achieve a non-traumatic occlusion and still avoid iatrogenic trauma to the unerupted permanent canines. This treatment is usually performed as soon as the trauma from linguoverted canines is noted, i.e. starting at the age of 7 weeks or at the time when the deciduous mandibular canines would be extracted. The entire crown is etched and bonded and the extension is built using a flowable composite, making sure the tip is round and the gingival margin smooth. The extension is built as long as necessary to ensure that it occludes buccal to the upper gingiva but keeping it as short as possible to avoid fracture. If necessary, an upper jaw gingivoplasty is performed to help the mandibular canine to occlude buccally. The orthodontically corrected position of deciduous mandibular canines may also help to direct the path of eruption of permanent mandibular canines.

In permanent dentition, crown extensions provide a tool to direct mandibular canines into a non-traumatic occlusion in variety of malocclusions, and possible combine it with gingivoplasty or selected extractions of maxillary teeth. Crown extensions are also useful in retaining of orthodontically moved mandibular canines in the acquired position. The extension is made from a hybrid composite using a contemporary technique: scaling, polishing, etching and bonding the crown surface starting from very close to the gingival margin to achieve adequate bond and aid in smoothing the restorative margin. The length of the crown extension is chosen as long as needed to ensure that the
extended tooth occludes buccal to the upper gingiva, but as short as possible to avoid fracture of the extension. The occlusion is checked with a closed mouth and the extension is carefully smoothed and polished. The need to remove the extension is evaluated in 2-3 months.

Crown extensions of incisors can aid in selected cases of rostral crossbite or displacement of a single incisor to maintain a non-traumatic scissor bite.

The ethics of orthodontic treatment must be considered, as the treatment involved change of the fenotype.

Surgical indications for crown extensions include maintaining a non-drifted mandible after segmental or caudal mandibulectomy and in mandibular fracture treatment. The extension is built at the time of mandibulectomy or fracture repair when the masticatory muscles are still “used to” keeping he occlusion straight. The technique is otherwise like orthodontic use of crown extensions except that in mandibulectomied, the extension is permanent.

More technical details are described in the presentation.

The presentation will also include a retrospective clinical study with follow-up of different types of cases in a referral practice.

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**Feline dental radiology**

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**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
Step 5: Exposing the radiograph

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

Oral inflammatory diseases in cats

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The most common oral inflammatory disease in cats is plaque induced and manifests as gingivitis. The gingiva is divided into free and attached gingiva. Attached gingiva is firmly integral with the subgingival tissue and the periosteum, via which it is attached to the alveolar bone. The attached gingiva is also firmly attached via the junctional epithelium to the tooth by hemidesmosomes. The gingiva is periodically perforated by the teeth and free gingiva develops around each tooth forming a collar which is separated from the enamel by a sulcus. Normal sulcular depth is less than 1mm. Where teeth do not develop, free gingiva is absent.

The sulcus contains Gingival Crevice Fluid (GCF) (an inflammatory exudate by classification) comprised of: cellular elements (bacteria, desquamated epithelial cells and leukocytes); electrolytes (Na, K and Ca); and organic compounds (carbohydrates, proteins and others including antibacterial factors and endotoxins). Clinically normal gingiva has been shown to be histologically inflamed. The amount of GCF is greater in the presence of inflammation and after periodontal surgery. Metronidazole and tetracyclines are present in GCF and can therefore be considered for use in periodontal treatment. Leucocytes migrate into the sulcus and play a protective role – PMN 91% vs mononuclear 8%. Leucocytes are found in sulcus of SPF animals, whose gingiva appear clinically normal. (Clinical Periodontology 12 ed page 215-217.)

Early signs of gingivitis are most easily and objectively determined by bleeding on gentle probing. This is more accurate than changes in gingival colour and other signs of gingival inflammation. The absence of bleeding on probing is a good negative predictor of future attachment loss. (Clinical Periodontology 12 ed pp.214-223.)

Plaque, comprised of: bacteria, salivary proteins, food debris and other by-products adhere to the tooth surface and when not removed elicits an immune response that initially will cause inflammation of the attached gingiva. If the plaque is removed, the gingiva will return to health. Where plaque remains, gingivitis can move through the grades of severity from Initial to Advanced and then
to periodontitis. Although periodontitis is commonly used to describe the visible condition of the periodontium, severity and extent can be determined on probing and confirmed radiographically. There is a form of periodontitis, viz. periapical or peri-radicular periodontitis that is associated with necrotic pulp and is commonly not visible clinically. The lesions are diagnosed on radiographic examination, which is one of the reasons why full-mouth radiographs should be obtained routinely when animals are undergoing dental and oral examinations and treatment.

Traumatic cheilitis post maxillary canine extraction. A partial alveolectomy is often performed to facilitate extraction of the maxillary canine tooth. The alveolar bulge (canine juga) is sacrificed causing the upper lip to move medially where it becomes trapped by the mandibular canine. The chronic trauma to the lip can result in an eosinophilic granuloma. Ideally, as much of the canine juga should be maintained as possible, to act as the “lip retainer”, keeping it out of contact with the mandibular canine tooth. Where alveolectomy is essential, odontoplasty of the ipsilateral mandibular canine crown, followed by sealing with a varnish, should be performed to minimize lip trauma. The thickness of enamel and dentine and proximity of the pulp to the incisal edge of the crown, must be determined prior to commencement of odontoplasty to prevent inadvertent pulp exposure.

**Eosinophilic granuloma complex**

Indolent (Rodent) ulcer. Some cats which suffer from flea infestation will groom excessively, as will cats that are unduly stressed. In both situations, rodent ulcers may develop on the upper lip due to the chronic trauma. Treatment is primarily aimed at eradication of the fleas and a course of corticosteroids after histological confirmation of the eosinophilic plaque lesion. A tapering dose should be prescribed and response to treatment should be evaluated to determine when the treatment can be decreased and finally terminated.

Excessive grooming can also result in chronic ulcerative trauma to the hard palate mucosa, manifested by bleeding episodes. Often bleeding has ceased by the time the cat is presented for examination, making it a bit of an enigma. It would appear that the palatine arteries may become lacerated by the lingual papillae, causing the episodic bleeding. Treatment includes removal / elimination of the cause of the licking, whether this be due to psychosomatic or allergic stimuli. In some situations, where severe bleeding has occurred, ligation of the palatine arteries proximal to the trauma site has been performed. Elimination of the aetiology would be favoured over palatine artery ligation!

Traumatic ulcero-proliferative alveolar mucositis has been diagnosed in many pure breeds of cats as well as in domestic cross-bred cats. In affected animals, the maxillary carnassial teeth and Premolar 3 (P3&P4) have palatal inclination of the main cusp. This is often associated with narrowing of the space between the mandibles caudally (causing the mandibles to be closer together than they should be), resulting in the maxillary teeth contacting the gingiva of the mandibular P4&M1 and in severe cases the gingiva and alveolar mucosa of these teeth. In mild cases, there will be erythema of the gingiva and or alveolar mucosa, but in severe cases there is ulceration and there may also be proliferation of these tissues. The lesions should not be confused with the pyo-granulomatous lesions described by Gracis. From time-to-time marked gingivo-alveolar mucosal recession and or alveolar bone recession may be seen. The treatment of mild to moderate lesions is debridement of the ulcero-proliferative soft tissues and odontoplasty of the crowns of the associated maxillary teeth. This requires crown height reduction as well as increasing the space between the maxillary teeth and the mandibles by removing some of the palatal aspect of the crowns. This is only performed after the thickness of dentine has been radiographically established and thereafter the teeth are sealed with an unfilled resin. Post-operative re-evaluation is required and follow-up treatment may be necessary.

**Juvenile periodontitis**

Juvenile periodontitis appears to be a lesion that follows on from shedding of the deciduous teeth and eruption of the secondary teeth. In some cases, there is marked gingival enlargement with
periodontitis, characterised by gingival and bony recession with mobility of the teeth and often evidence of teeth having been shed. The treatment in these cases is extraction of the compromised teeth, partial gingivectomy / gingivoplasty and prophylaxis. Further extractions may be required and antibiotic and analgesic therapy may be required as well.

**Stomatitis**

Stomatitis may be focal, multi-focal or diffuse. There are often distinct sites within the oral cavity which are inflamed and they are commonly where the soft tissues (e.g. cheeks and tongue) make contact with plaque on the teeth. These are called CUPS (Chronic Ulcerative Paradontal Stomatitis) lesions and may be referred to as “kissing lesions” and can cause pain disproportional to the size of the lesions.

Stomatitis, inflammation of the oral cavity soft tissues includes: gingivitis, caudal oral stomatitis, glossitis, inflammation of the sublingual tissues, buccal stomatitis, inflammation of the gloso-palatine folds and faucitis (inflammation of the region housing the tonsils). Lymphocytic plasmacytic gingivo-stomatitis complex (LPGC) is a commonly received histopathological description of biopsies submitted for elimination of squamous cell carcinoma (SCC) or chronic gingivo-stomatitis. In this disease, not only do the gingiva become inflamed, but inflammation extends to affect other areas of the mouth as well, particularly at the back of the mouth (caudal oral stomatitis) and in some cases involves the area called the ‘fauces’ (found medial to the ‘glossopalatine folds’). NB Faucitis is rare in cats.

The exact cause of this disease is still unknown. Most cases are associated with persistent FCV infection, and many cats positive for FIV infection may be predisposed to this as well. In these cases however, while dental plaque and some calculus may be present, the amount of inflammation is disproportionate. It is thought that some immune dysregulation may be involved in the disease where the cat’s immune system may be responding in an exaggerated manner to the presence of plaque, bacteria or other infectious agents in the mouth.

This is an extremely painful disease and cats will often have difficulty eating, hypersalivate (drool), paw at the mouth and show other signs of mouth pain. They may lose weight due to the reduced appetite. They do not groom themselves efficiently and some will have a soiled coat as a result of the oral discharge (ropy saliva and pus).

Although the majority of cats positive for FeLV and FIV will be positive chronic gingivostomatitis, the chronic disease cannot be reproduced routinely by infecting cats with these viruses.

Various treatments may be used including initial scaling and polishing of the teeth, adequate compliant dental home care, antibiotics and anti-inflammatories. The response to therapy is varia-
ble and many cats do not respond to scale and polish and antibiotic and anti-inflammatory medication. The treatment of choice in almost all cases of chronic gingivostomatitis is extraction of all teeth behind the canine teeth and in some cases, all the teeth. Longterm treatment with antibiotic and pain medication may be required. The use of cyclosporine has shown some benefit as has oral application of bovine lactoferrin. Electing to have teeth extracted early may result in earlier resolution and relief of pain and suffering.

Treatment with a chlorhexidine oral rinse is very effective and in some cases the inflammation can be radically reduced with twice daily oral rinse administration. Chlorhexidine oral rinse should also be used after the tooth extraction surgery has been performed and is often used life-long in affected cats.

Chlorhexidine oral rinse is an integral part of dental home care and is the mainstay of some cat oral disease treatment protocols. It is administered to the cat using a syringe either once or twice daily.

Inadequate dental home care will result in the cat requiring professional tooth cleaning on a more regular basis.

**References**


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**Soft tissue trauma/injury recognition and management in the oral cavity**

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**Introduction**

Oropharyngeal trauma of the soft tissues includes the oral mucosa, connective tissue, muscles, tongues, and tonsils. Trauma secondary to wooden sticks, plant material, sharp dental instruments, chemicals, electricity, crushing, and self-trauma not only damage the teeth and bones but the soft tissues protecting and covering these structures.

**Trauma (chemical, thermal, mechanical)**

Chemical and pharmaceutical burns result after ingestion or administration of products that
contact the oral mucosa. Both alkaline and acidic chemicals can burn the oral mucosa. Some medications (e.g. pancreatic enzymes, oral chemotherapeutics), when administered and not swallowed, cause focal erosions and ulcerations. Likewise, some insects and associated defensive chemicals can be caustic to oral mucosa.

Thermal injuries from hot substances such as microwaved food can burn the oral cavity. Thermal injury is common in electrocution injuries with associated resulting tissue necrosis, fibrosis and wound contracture that may take several weeks to fully delineate in addition to the obvious acute systemic injuries (e.g. pulmonary edema and multiple organ failure).

Mechanical injury from self-trauma such as sublingual/buccal granulomas, pyogenic granulomas, and traumatic malocclusions all damage the mucosa and may result in missed diagnosis of the underlying cause. Mechanical ballistic injuries have unique delayed sequelae due to the direct effect of the projectile and the related shock wave and cavitation.

The avulsion of soft tissue from the rostral mandible or maxilla can occur secondary to mechanical trauma. The neurovascular structures exiting from the mental foramina are often avulsed. The bone is exposed and may or may not have suffered fractures.

Oropharyngeal foreign bodies can cause lacerations, abrasions, and impalements that damage deeper tissues and result in conditions such as retrobulbar abscess/cellulitis, glossitis, and actinomycosis cervicofacialis by inoculating ubiquitous environmental pathogens resulting in pyogranulomatous inflammation. The secondary pain and difficulty opening the mouth must be differentiated from masticatory myositis to avoid disastrous and fatal treatment consequences. Sticks and bones may lodge across the dentition of the maxillary arcade resulting in palatal ulceration and periodontal disease.

**Oral mucosal inflammation**

Acute mucosal ulceration is often painful. The lesions are often pale to yellow with a reddened halo of surrounding inflammation. Healing often occurs in 7-10 days when the source of trauma is removed or is no longer present. Chronic oral mucosal ulceration may not have significant or evident pain associated. The lesions will often be thickened, elevated, yellow, and with scarred margins. Delayed and non-healing lesions may be easily confused with more sinister neoplastic processes. Trauma may also lead too amorphous, gritty, mineralized deposits such as calcinosis circumscripta in the tongue. Radiation induced mucositis is beyond the scope of this lecture. Likewise, mucositis secondary to odontogenic infection is not discussed here.

**Diagnostics**

A thorough clinical history and anesthetized oral examination are necessary for many conditions. Advanced imaging with CT and/or MRI may be necessary for differentiating severe cases of maxillofacial/retrobulbar cellulitis and masticatory myositis in addition to muscle biopsy and Type 2M antibody titters. Cytology and cultures are often unrewarding for oral ulcerations. Histopathology is helpful and necessary for chronic lesions.

**Treatment**

Treatment is best instituted after an accurate diagnosis is obtained. The majority of the conditions have an inflammatory component and non-steroidal anti-inflammatory medications are often utilized if there is no contraindication. Additional analgesia such as gabapentin, tramadol, and/or oral buprenorphine is prescribed. Oral 0.12% chlorhexidine products are useful to decrease the oral bacterial load during the healing process. If indicated, systemic antibiotics such as clindamycin or amoxicillin/clavulanic acid may be prescribed. In some cases of maxillofacial/retrobulbar cellulitis
additional antibiotics such as a fluoroquinolone may be added to the antibiotic regiment. Softened kibble or canned food is often necessary during the healing process in cases of oral soft tissue trauma and ulcers.

Soft tissue lacerations are sutured with 4-0 or 5-0 poliglecaprone-25 simple interrupted suture pattern. Meticulous suturing and various interdental and mucogingival junction suturing techniques are necessary for labial avulsion injuries. With severe concurrent injuries from electrocution, vehicular trauma, gunshot injuries, etc. the patient often requires stabilization prior to treatment of the non-life threatening soft tissue and hard tissue (e.g., teeth and bone) trauma.

**Hard tissues**

Treatment of concurrent maxillofacial fractures and dentoalveolar injury is beyond the scope of this lecture. Treatment of hard tissues as indicated is necessary. Likewise, full mouth intraoral radiographs and follow-up radiographs of the dentition is recommended in all cases of maxillofacial trauma including concussive forces with no evident hard tissue injury, ballistic, chemical, and electrocution injury.

*References available upon request*

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**What makes extractions difficult & how to make them easier**

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Extraction of teeth in small animal veterinary practice is a common procedure. Surgical extractions in dogs and cats in general veterinary practice can be a challenge for the surgeon. Despite this few veterinary students receive much, if any, hands-on training in this regard. The result is often a low level of both confidence and skill. This can be a toxic mix. In many cases the procedure can be made much easier and outcomes for both the patient and surgeon vastly improved by better understanding of the problems likely to be faced. This presentation focuses on five of the main reasons that make dental extractions difficult and focuses discussion on solutions designed to improve operator understanding.

The presentation explores specific areas that improve technique and offer solutions based on sound surgical technique.

Although dental radiographic technique will not form part of this presentation per se, it must be said at the outset that it is a fundamental component within the exodontia process. Diagnosis, prognosis, treatment planning and execution of exodontia all require the use of dental radiographs.

**Objectives**

Surgical removal of teeth; Techniques for reliable surgical removal in dogs and cats.
Key learning aims

- Understand oral anatomy and tooth root morphology.
- Discuss available instrumentation and how it can improve outcomes.
- Describe bone and soft tissue access via mucogingival flaps and how they differ in planning.
- Review fundamentals of extraction technique and post op considerations.

Root morphology

Canine and feline roots differ markedly in shape, numbers and location. A basic understanding of anatomy is important when undertaking extraction surgery. The anatomy of teeth, their root structure and surrounding support tissues can be reviewed from standard veterinary anatomy and dentistry texts.

Dogs

Incisor teeth are all single rooted structures. Although the roots are short, relative to other teeth, their length is still twice as long as the crown. They also have an oval cross-section with roots curving dorsally. This combination can make luxation difficult, especially without compromising the adjacent teeth. The maxillary third incisors have very long curved roots and are best treated like canine teeth.

Canine teeth have very long curved roots. The maxillary canine root jugas can be palpated for the whole of their length. Normally the root apex is dorsal to premolar 2. Although the roots are accessible, the proximity of the nasal cavity on the medial aspect must be taken into account. Mandibular canine tooth roots cross the floor of the mouth and are not accessible without surgical exposure.

Premolar teeth are mostly two rooted structures, with the exception of the first premolars in both jaws, which have single roots, and the maxillary fourth premolar (carnassial) which has three roots.

All maxillary molars have three roots and the first and second mandibular molars have two. The third mandibular molar has one root.

Cats

In cats there is only one molar in each quadrant. Maxillary molars have one root and mandibular molars have two. Cat teeth are much more fragile than those of dogs and are more likely to be weakened by tooth resorption.

Deciduous teeth

There are some circumstances when deciduous teeth need removed. Deciduous canine teeth have a ratio of 75% root to 25% crown. Most deciduous canine teeth are in the region of 2.5cm long regardless of the size of the breed. An open surgical extraction is indicated for these teeth in the author’s opinion if the permanent teeth have not erupted.

Pre-operative radiographs will pre-warn the operator of location and length of roots. Radiographs also provide information with regard to the permanent teeth.

Instrument selection for extraction

Instruments for surgical extraction should be of good quality and be well maintained. There are many examples of poor quality facsimile copies of instruments on the market. They may look like a good deal at the time but if the alloys are poor quality, the blades cannot be machined to provide thin sharp edges. This leads to broken tooth roots and a failure to keep sharp.

Following use, instruments should be cleaned, preferably in an ultrasonic bath, before being sharpened and autoclaved. If the instruments are kept colour coded in cassettes, they need never come
out of their space except for use. This ensures their longevity and protects them from damage.

Many oral surgical instruments need to work in confined areas. For that reason, ophthalmic instruments work well. The following table is a good kit for oral surgical procedures of this type.

| Nichrominox cassette or similar (e.g. IMS resin cassette for 18 instruments) |
| Periosteotome EX19 (2mm/3mm tip width) |
| Molt #2/#4 periosteal elevator |
| Lip Holders No. 47 |
| Scissors – Iris scissors straight or LaGrange curved. Goldman-Fox curved |
| Suture scissors |
| Scalpel handle (#3 or #5) and blades #15, 11 or #15c. |
| Delicate Adson 1x2 tissue forceps |
| Hemostats – 2 small curved |
| Gingival retractors – Seldin or Senn |
| Fine needle holders – Halsey 130mm, DeBakey 180mm, Castroviejo or Olsen-Hegar |

The burs needed for surgical extraction are few in number and can be kept in a small bur block, sterilised and ready for use. Suggested contents are all FG (high speed);

| Diamond round small/medium/large for buccal alveolar bone removal & alveoloplasty |
| Crosscut fissure 701L and 700L for sectioning teeth |
| Round carbide sizes 1,2 and 4 to widen PL space, remove cusps and identify root tips |

**Extraction technique – Luxators, Elevators and Mechanical Principles**

This is an area that confuses many practitioners. What is the difference between a luxator and an elevator? In essence an elevator is a robust blade, designed mainly to extract human teeth, using the “wheel and axle” technique. A luxator is a thinner, sharper blade designed to be inserted in the periodontal ligament space using the “wedge principle”. The wedge principle uses the thinner luxator type blade as a wedge to expand the alveolar bone whilst simultaneously severing the periodontal ligament fibres.

The wedge principle is generally safe, with the direction of blade in the long axis of the root, as long as:

1. The blade size is properly selected
2. The blade is prevented from slippage with a finger stop on the shaft
3. There is a small allowance for circumferential movement around the root. Torquing the blade by rotating the wrist is the movement most likely to fracture a root that is still well attached by periodontal ligament and supported by alveolar bone.

For the Wedge Technique, insert the blade down one side of the root until resistance is felt, rotate slightly and hold the tension for ten seconds, then let go. Remove the blade and insert into the other side of the root and keep repeating until the root is finger loose. The main error in technique that fractures roots is lack of patience leading to excess rotation and torquing. A root still well attached cannot move and will fracture if the instrument is torqued excessively.

In the Wheel and Axle technique a blade is inserted perpendicular to the long axis of the root – either between the roots or using a sound adjacent tooth. The handle is rotated in the direction (like an axle) that will lift the root out of the alveolus using the blade as a wheel.

Extraction forceps are employed as the last instrument. Normally only one set is required – Small Breed. The beaks are used to grip the root as far apical as possible and remove it with a combination
of gentle rotation and simultaneous traction in the direction of the root’s long axis to remove the root from the alveolus. At this point NEVER rock the root from side to side as this will also fracture it.

**Access for extraction**

Most teeth benefit from a planned surgical extraction technique. To do so means the operator is control during all aspects of the procedure from start to finish and can deal with any complications easily. To convert from a failed closed extraction to an open surgical extraction in mid-procedure is an admission of poor decision making and will likely result in needless trauma to supporting tissues. Prior permission, preferably written, to extract teeth is essential before proceeding.

**Soft tissue access**

The purpose of soft tissue access is to expose and visualise the bone surrounding the roots. The soft tissues usually comprise the gingiva and the (buccal) mucosa. Gingiva is very tough, collage-rich tissue which is tightly adherent to the bone. Mucosa is thin, flexible and relatively fragile tissue.

Three types of flap are commonly used in surgical extractions. In order to plan these is wise to know which teeth have to be removed before starting as, in some cases with releasing incisions, it can be hard to extend the flap to include adjacent teeth without prejudicing closure.

**Envelope flap** – This type of flap is the simplest. A scalpel is used into the gingival sulcus round the circumference of the tooth/teeth and a periosteal elevator used to elevate some of the gingiva away from the tooth and the alveolar crestal bone on both sides. The elevation generally does not extend beyond the mucogingival junction and often involves at least one tooth either side of the target tooth or teeth. For this reason, there is little flexibility to the soft tissue and, as a consequence, relatively poor access to the bone.

**Triangular mucogingival flap** – This can be an extension of an envelope flap or, more commonly, a flap designed initially to provide better access than an envelope. In addition to the sulcal incision, a vertical release is made in the gingiva over the line angle (mesiobuccal or distobuccal) of the tooth to be extracted. This incision is extended past the mucogingival line and several millimeters into the alveolar mucosa. If the incision is not made boldly into the mucosa, the flap will not be mobile enough to provide good access. For most extractions this is the best flap.

**Pedicle mucogingival flap** – This is a four-cornered flap which can be an extension of a triangular flap or designed to provide better access than a triangular flap. It is essentially the same as a triangular flap with a second vertical release at the (usually) distobuccal line angle of the tooth or teeth to be removed.

**Important principles of flaps**

1. The vertical releasing incisions should not be made over a void that will be created once a tooth has been removed. The eventual suture line is best supported by bone or it may well dehisce.
2. Vertical releasing incisions can be made on the line angle of the target tooth or the line angle of an adjacent tooth root but not at the interdental papilla
3. The length of the vertical release into the mucosa should be at least the anticipated length of the root
4. Initially the flap can be hard to lift as the gingiva is tightly adherent to bone. A sharp periosteal elevator is used for this (Molt 2/4 or periosteotome) working from the edges to the centre. Take care not to shred the flap as this will be the “bandage” that covers the extraction site.
Bone access

Once the flap has been raised successfully, the buccal bone can be removed to facilitate the surgical removal of the roots.

Buccal alveolar bone

For multi-root teeth with no exposure of the furcation angle, a round diamond FG (high speed) bur with copious water irrigation is used in a sweeping motion (like a windscreen wiper) to provide semi-circular exposure of both roots and the furcation. Once the furcation is visible the direction of the bur can be altered to expose the roots. How much bone is removed will depend on whether there is advanced periodontal disease or a degree of ankylosis. For the latter, up to 75% of the buccal bone should be removed.

Defining/widening the periodontal ligament space

Once the majority of the buccal bone is removed, some teeth (canines included) benefit from widening the periodontal ligament space so a luxator blade can be inserted. A small round bur is used for this purpose. The space needs to be deep enough to take the width of the desired luxator blade but not too wide as any leverage from the surrounding bone will be lost.

Alveoloplasty

A diamond bur should be used after the root(s) has been extracted to remove sharp edges of the bone and create a beveled edge. If sharp spicules of bone are left, the mucogingival flap can be perforated and will be uncomfortable. A bone file or rongeurs can also be used for this purpose. Flush well with sterile saline throughout the process to avoid tissues becoming desiccated.

Flap closure

Once the alveolus has been cleared of debris, and the area flushed with sterile saline, the mucogingival flap is used to close the site.

This will be a coronally repositioned flap. This means that it needs to extend beyond its origins to the soft tissues on the palatal or lingual side of the site. To do so without any tension, the flap should be under-run slightly to mobilise it. A more reliable method of mobilising the flap is to sever the periosteum at the base. The flap is full thickness. Once lifted the deepest layer is the smooth and shiny periosteum. This layer is tough and inflexible. Use the points of sharp iris scissors to separate and sever the periosteum at the base of the flap in a line from mesial to distal. This will substantially release the flap and allow it to be laid in the position desired to suture it without any elastic recoil.

Suture in place using an appropriate sized, monofilament absorbable material (e.g. Monocryl). Normally 5/0 (1 metric) is advised for cats and small dogs, 4/0 (1.5 metric) for most dogs and 3/0 (2 metric) for large, boisterous dogs over 35kg. Suture the mesial and distal corners first to place the flap in the correct position then work up the vertical releases from the gingiva to the mucosa. The buccal to palatal/lingual sutures are placed last. Ensure sutures are placed at intervals of 1-2mm. For most oral sutures an interrupted pattern is best.

Planning

Procedure planning underpins a successful procedure. Having the time available to conclude the procedure and deal with any complication (such as other damaged teeth) and have instrument kits ready, perform necessary imaging and select appropriate analgesia is integral to a successful outcome.

Post op considerations

Post op considerations include analgesia, dietary change and denial of toys and chews during the
healing process. Owners appreciate being provided with written instructions they can refer to during this time. Warning of possible blood stained discharge and loss of sutures is important at this stage. A recheck by a practice member 2-5 days post-operative is advised to ensure all is well with drug administration, sutures and general recovery.

References and further reading


CT technology for the veterinary dentist

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Introduction

Computed Tomography (CT) is a well established technology for the examination of the head in many species treated by veterinary dentists. Multi-slice CT offers excellent detail of dental and oral structures of the entire dental apparatus and mouth. Cone Beam computed tomography (CBCT) is a relatively new technology on the veterinary market. It is based on flat panel detector design and some manufacturers prefer the name Flat panel detector computed tomography (FPCT). This presentation discusses the history, basic principles, human and veterinary applications of Multi-slice CT, CBCT and FPCT and the potentials and limitations of this technology for veterinary patients.

Multi-slice Computed Tomography

CT has become a powerful and popular diagnostic imaging modality in veterinary praxis since the 1990ies. In particular the development helical and multi-slice technology has enabled rapid scanning of large animal body parts with thin slice width. Therefore current CT technology provides good diagnostic information imaging modality for all body parts and excellent results for most of them. However CT has still some drawbacks, which include the size of the unit, room and cooling needs, three-phase-power requirement and the need for general anaesthesia for many patients. A small, mobile CT unit that would meet the same standards but without its drawbacks would be highly desirable in veterinary praxis. Cone beam CT (CBCT) and related flat panel detector CT (FPCT) are interesting technologies that have some potential in this regard.

Cone Beam CT and Flat Panel Detector CT history

CBCT was first developed in the 1990ies as an application for fluoroscopy units, also termed as “3D Fluoroscopy” for cardiovascular imaging and stenting purposes. These units are now technologically out-dated and have not found entrance into the veterinary market. More recently CBCT
has been developed as a modification of Direct Digital Radiography (DDR) units, mounting the flat panel detector panels from DDR units onto a rotating gantry device with an X-ray tube. Aptly these units are also sometimes called “3D-Röntgen”. This has become possible due to the increased affordability of flat panel detectors. The newest technology applies hybrid technology but using DDR based flat panel detectors. To encompass the entire range of these technologies, the term FDCT has been proposed for all CT technology using DDR-based detectors.

**Cone Beam CT technology**

The word “cone beam” refers to the way the data are reconstructed into images, which is different from ordinary CT units. In ordinary CT (even in helical mode), image data are reconstructed slice by slice in the transverse plane, using a filtered back projection for each slice. In CBCT image data are reconstructed within a three-dimensional conical space using a convolution back projection method called FDK (after their inventors Feldkamp, Davis and Kress). CBCT solves in principle a long on-going problem in CT technology: To view images in another plane than the originally acquired transverse slice, a multiplanar reconstruction (MPR) is performed on either the raw data or, more commonly, the DICOM transverse images. The resolution of the MPR images is rarely isometric in ordinary CT, meaning that the MPR images are of lower resolution than the original transverse images. A CT image is made of a matrix of picture elements, or pixels, with equal height and width in the sub-millimetre range. Since these images represent a slice of tissue, the elements are also referred to as volume elements, or voxels. The depth of the voxel represents the selected slice width. The height and width of the voxel are much smaller than the voxel depth. In CBCT all three dimensions of each voxel are equal because it is directly reconstructed from 3 dimensional data. Therefore CBCT delivers isometric image resolution, meaning one can view images in any selected plane in the same resolution.

CBCT reconstruction methods are mathematically much more complex than filtered back projection and the datasets are several orders of magnitude larger, requiring considerably more time and more corrections, particularly for the periphery of the cone. A typical CBCT unit may have a 1024 x 1024 detector plate and achieve an isotropic spatial resolution of 0.1 to 0.3mm, covering a 10 to 15cm area during one rotation. To process these data, high-end graphic cards from the computer gaming technology are used and the reconstruction time for the covered area is currently between 15-30 seconds.

In FDCT the X-ray tube needs normally 10 to 20 seconds to perform one gantry rotation compared to 0.3 to 1 second in ordinary CT. The main reason for this is the much slower read-out speed of DDR-based flat panel detectors compared rare-earth detectors used in ordinary CT. Therefore FDCT is more prone to motion artefacts and this is one of the limitations of FDCT which causes constraints on using it for vascular and respiratory studies. However due to the slower rotation time the power consumption is also considerably lower (1-2kW) than with ordinary CT (50kW), meaning that a standard power supply is sufficient for CBCT allowing mobile use. Ordinary CT requires 3-phase power and is stationary.

Ordinary CT has excellent scatter minimisation because of efficient pre- and post patient collimation of the X-ray beam, exposing only a thin slice of patient anatomy at any time. Therefore image noise is brought to acceptable levels and contrast resolution is relatively good. In CBCT units a wide cone of tissue is exposed creating significant scatter. Post patient collimation cannot be applied. Instead mechanical grids and scatter correction algorithms can be applied in CBCT. However, the image noise is higher and contrast resolution is poorer in CBCT compared to ordinary CT. Image noise visibility is suppressed with wide window settings, which are appropriate for structures like the nose, lungs, bone and teeth. CBCT therefore delivers good image quality for these structures. However narrow window settings are required for viewing soft tissues and for any post i.v. contrast study. The resulting image quality of soft tissue structures is therefore often poor or even
non-diagnostic in CBCT units. Many efforts are currently being made by manufacturers to remedy this problem, which include use of specific algorithms and noise reduction techniques and the combined use of cone-beam and fan-beam scanning (which makes these units FDCT rather than CBCT) and some progress has been made already.

**Human Cone Beam CT applications**

CBCT is currently used in humans mainly in dentistry and for radiation treatment guidance and less frequently for angiography, intraoperative imaging and mammography.

Particularly in dentistry CBCT has much to offer: The units are small and mobile and can be installed in an environment where an ordinary CT would not be a cost effective option. Because dental imaging mainly relates to teeth and bone, CBCT offers adequate image quality. The extremely high spatial resolution and the lack of image distortion (as present on radiographs) are additional benefits, particularly for endodontic and implant planning. Also, the curved anatomy of the dental arcade makes curvilinear reconstructions with isometric resolution a very useful application.

In radiation treatment guidance CBCT units are small enough to fit into the linear accelerator device and are sufficient for the daily patient setup. Because most tumours are soft tissue structures, CBCT is usually not sufficient for the initial treatment planning imaging, for which ordinary CT is used.

An emerging application is intraoperative FDCT. There is particular potential to use FDCT for operative guidance of metal implants into bone structures, allowing precise placement of often very narrow implantation corridors, such as in the vertebral column.

**Veterinary Flat Panel Detector CT applications**

Within the last 10 years, CBCT and FDCT have found entrance into the veterinary market. First and foremost, CBCT units are being used in small animal dentis-

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Dental and masticatory CT in dogs, cats and rabbits

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Introduction
Dogs and cats can suffer from problems associated with closing or opening their mouth, pain on mastication and other problems such as halitosis. Rabbits and rodents have many dental related pathologies. Diagnostic imaging is an important part of the diagnostic work up of masticatory conditions. Radiography and with increasing frequency computed tomography are the imaging modalities of choice.

Computed Tomography
Computed tomography is an ideally suited imaging modality for dogs and cats with masticatory problems. Modern computed tomography technology allows submillimeter slice thickness images, providing excellent anatomical detail of teeth, bones and joints. It also allows assessment of masticatory muscles and nervous system. The entire dental apparatus can be scanned within less than one minute. Images can be reviewed in transverse or orthogonal planes. Curvilinear reconstructions allow a panoramic view of all teeth. Given the fact that general anaesthesia is required for all imaging modalities and that computed tomography is the fastest imaging modality assessing the entire head, it makes sense to use computed tomography as the first line diagnostic imaging tool for all masticatory conditions, except for specific localised dental diseases.

Imaging features of dental and masticatory disease processes

Head Trauma: Radiography allows a relatively quick assessment of the skull, but not the soft tissue structure of the head. Proper positioning and interpretation can be time consuming. Computed tomography is the modality of choice for assessment of head trauma. It is quick and very detailed for all osseous, dental and soft tissue structures. Temporomandibular joint luxation can be monitored pre- and post-reduction. Intravenous contrast medium application is usually not necessary.
Paraoral foreign bodies and abscessation: Computed tomography is the modality of choice for suspected foreign bodies, abscessation and wounds of the oral cavity wall, masticatory muscles and retropharyngeal space. Intravenous contrast medium application is essential to outline abscess walls and foreign body reaction. Small foreign bodies from plant material may not be visible directly, however the reactive tissue surrounding it usually is.

Craniomandibular osteopathy: This is an inflammatory condition in young West Highland White terriers and less commonly other dogs leading to pain and reduced ability to open their mouth, associated with mandibular and temporal periosteal reaction. The condition is self-limiting and the role of imaging is to rule out other diseases and monitor its progression. Radiography is usually sufficient.

Masticatory myositis: This is an autoimmune disease in young to middle aged large breed dogs against the 2M fibres of the masticatory muscles leading to pain on mastication and later inability to open their mouth and muscle atrophy. Computed tomography is the imaging modality of choice, allowing to rule out other dental and masticatory problems, identify abnormal masticatory muscles based on size, shape, density and contrast enhancement, and to select appropriate sites for a muscle biopsy, which is required for ultimate confirmation of this condition.

Oral and masticatory neoplasia: Oral neoplasia is relatively common in dogs and cats. Radiography allows only a crude assessment of bony involvement. Computed tomography is best suited to assess the tumour margination, bony involvement, local (lymph nodes) and distal (lung) metastases. It is also required for all radiotherapy cases.

Temporomandibular joint diseases: Computed tomography is best suited for assessment of the temporomandibular joints. A closed and a maximally opened jaw view should be obtained. Subluxation and luxation are easily visible. In cats a chronic irregular ankylosis can sometimes be seen. Irregular joint surfaces are often visible in dogs. These can be caused by osteoarthritis and osteochondrosis. Neoplastic conditions show often marked osteolysis and swelling.

Open jaw lock: Dogs and cats with a locked open jaw have a displacement of one coronoid process lateral to the zygomatic arch. This can be demonstrated radiographically quickly and easily. However, to establish the exact cause of open jaw lock, computed tomography is highly efficient. This can demonstrate mandibular symphyseal laxity, temporomandibular joint laxity or abnormal shape of the mandible or zygomatic arch and muscular changes.

Jaw drop: Dogs that cannot actively close their mouth, but the jaw can be closed by the examiner usually suffer from idiopathic trigeminal neuritis. Other differentials to consider are neoplasia or infection of the central nervous system. Magnetic resonance imaging is best suited to rule out central nervous system conditions.

Dental diseases: Intraoral radiography has traditionally been the modality of choice for diagnostic imaging of dental diseases in dogs and cats. It allows detailed assessment of individual teeth and allowing specific treatment decisions. Computed tomography has become a useful adjunct to intraoral radiography, as it provides an almost as detailed depiction of the entire dental apparatus.

Rabbit and rodent dental diseases: CT offers detailed assessment of the entire dental arcade. A post contrast series should be performed routinely to outline periodontal abscessation.

Conclusions

Computed tomography provides excellent image detail for dental evaluation and in addition enables assessment of the entire masticatory apparatus.
Anatomy of the head and oral cavity

Barron P. Hall, DVM, DAVDC, FAVD

The skull is divided into two major regions: facial with palate and braincase, separated by the cribriform plate. The major paired bones of the braincase are the occipital, parietal, frontal, and temporal. The major paired bones of the face and palate are the incisive, nasal, maxilla, zygomatic, palatine, lacrimal, pterygoid, and mandible. The incisive bone contains three incisor teeth and the palatine fissure. The maxilla, the largest bone of the face, contains the remaining upper cheek teeth: canine, premolars, and molars; and the infraorbital foramen. The infraorbital neurovascular group exits to supply the rostral maxilla.

The mandible is made up of mirrored left and right halves that are firmly united rostrally at the intermandibular 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 condyloid process. The condylar 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.

There are five muscles of mastication. The four used to close 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 ventrolateral 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 masseteric fossa where 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 paracondylar 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.

Knowledge of the anatomy of the head is vital when doing any type of oral surgery, maxillofacial surgery, or fracture repair. In order to repair a fractured mandible 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.
New from iM3, introducing the Vet-Tome

The Vet-Tome improves the tooth removal process for both vets and their patients by providing greater control during extractions. The Vet-Tome is an automated periotome that offers extremely precise tooth extraction with minimal or no alveolar bone loss.

The surgery is often flapless so the animal experiences reduced pain and swelling. This translates to less time spent extracting teeth and faster recovery time for the animal.
Imaging and Visualisation are key to successful veterinary dentistry. This presentation will provide a brief overview of the main topics and consider various solutions – bearing in mind the needs of different budgets.

**Magnification**

Without magnification a veterinary dentist cannot perform their role to the best of their ability. There are a wide range of solutions available, these vary dramatically in price – but also in their value. Consideration will be given to simple lenses, basic loupes, customised loupes and operating microscopes.

**Illumination**

The benefits of local illumination will be discussed, together with some drawbacks.

**X-ray generators**

Dental radiographs can be produced with our standard veterinary x-ray set-ups. Indeed this is where most of us started. Some ideas as to how to get around the challenges this presents will be provided.

Dedicated dental x-ray generators are the obvious way forwards. Features to consider when making a purchase are discussed.

**Radiographic processing**

A brief discussion on the pros and the many cons of conventional film processing, followed by consideration of digital radiography. A comparison of the application of both DR and CR systems – things to consider when making your choice.

**CT scanners**

A brief discussion on the merits of Cone Beam and Conventional CT for the veterinary dentist. An introduction to Vimago which might be regarded as a novel compromise.
Simplified techniques for canine and feline dental radiography

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Introduction

Dental radiography is essential for the diagnosis, treatment and planning of canine and feline oral pathology and conditions. However, achieving the desired positioning of the patient, sensor and tube head can be extremely frustrating – particularly in cats and for practitioners new to dental radiography. A simplified approach has been developed that can consistently produce diagnostic images with less confusion if a few principles are mastered and followed.

Only the coronal third is visible in the mouth for canine and feline teeth with the apical and middle thirds (the root structure) embedded in the mandibles or maxilla. Much dental pathology (periodontal and endodontic disease specifically) is hidden beneath the gingival margin and cannot be visualised without dental radiography. Diagnosis, prognosis and treatment planning or review is therefore impossible without dental radiographs.

What to radiograph

A number of references recommend full mouth radiographs (2,3). The author recommends a minimum protocol to radiograph all missing teeth, all periodontal pockets over 4mm depth in dogs and 2mm depth in cats, all damaged or visibly abnormal teeth and full mouth radiographs in feline patients with tooth resorptive lesions. In addition, pre- and post-op radiographs of any treated or extracted teeth.

Radiographic criteria

The criteria the author uses for each diagnostic radiograph are:

- The target tooth should be central and the main focus of the radiograph.
- The root apex/apices should be clearly seen on the radiographs with at least 2 – 3mm of surrounding bone.
- The image should show good contrast of the 4 main hard tissues; cortical bone, cancellous bone, tooth dentine and enamel.
- There should be no superimposition of instruments or teeth on the target tooth.
- No artefacts such as blood or film sensor scratches should be visible on the image.
- Optimal exposures should be used.

Consistency

If the position of the patient is kept consistent and the sensor used is the same, the only variable will be the position of the tube head and its angle. In this modified simplified technique, the angle required for the same tooth in different patients can be considered the same.

Radiographic exposure is controlled by three components: kilovolt peak (kVp), milliamperage (mA) and exposure time (fractions of seconds). Generally, on dental radiography units the kVp and mA are set values. The author uses settings of 8Ma and 70KVp with a film-focal distance
of 15cms for all dogs and cats. The only variation is the exposure time set by the operator and de-
pendant mostly on patient size.

Patient positioning

Each patient should be positioned and approached in the same way when taking dental radi-
ographs to eliminate the variables that may alter the angles required. Lateral recumbancy, with the
palate at a right angle to the table, is preferred by this author. This position decreases the number of
times a patient must be turned when performing surgical or endodontic procedures.

The angle setting on the tube head of all dental radiography units is measured in degrees from
the horizontal plane. Therefore, in lateral recumbency 0° is when the tube head is aligned with the
philtrum of the patient’s nose. For obtaining images of both sides of the mouth the patient will need
to be turned once to gain access to the opposite side of the mouth.

Bisecting angle technique

This technique uses the theory of equilateral triangles to create an image that accurately repre-
sents the tooth. The film is placed as parallel to the tooth as possible. The angle between the tooth
root and film is measured. This angle is bisected and the beam placed perpendicular to this (1). This
can be a frustrating technique to master and teach.

Simplified technique

The simplified technique developed by Woodward and others does not use direct measurement
of any angle but relies on set predetermined angles that are the same for each patient in dorsal and
sternal recumbancy. There are three angles to remember; 20°, 45° and 90°. The author uses a va-
riation of this and this technique will be described in detail for canine and feline teeth.

The starting angle is 0° when the tube head is aligned with the nasal philtrum and the patient is
in lateral recumbancy. If you can read the angle from your x-ray machine it should read 0°. From
this angle, you add the set number of degrees depending on which tooth you are imaging.

Angles and positions

Dogs

1. Canine maxillary and mandibular incisors – The film should be placed perpendicular to the
nasal philtrum and flat against the incisors. Aim the beam at 0°, roughly parallel to the table
top and along the philtrum of the patient’s nose. Then turn your cone beam 20° in a rostro-
caudal direction over the maxillary or mandibular canines.

2. Canine maxillary canines – The film should be placed perpendicular to the nasal philtrum
and table and flat against and covering the canine. Aim beam at 0° horizontal to the table top
and along the philtrum of the patient’s nose. Then tip the beam so it is angled between 20°-
45° towards the midline and over the canine. The canine imaging angle is between 20°-45°
depending on the width of the maxilla. A smaller angle for narrower maxillas.

3. Canine mandibular canines – Place the film and angle the beam as for the maxillary canines.
When in its final position turn the tube head in a rostrocaudal direction. Due to the mandibles
being close together this angulation will stop superimposition of the image onto the opposite
side of the mandible.

4. Canine maxillary and mandibular premolars – The film should be placed perpendicular to
the nasal philtrum and flat against and covering the maxillary or mandibular premolars. Tip
the beam to 45° and aim over the premolars at the plate.

5. Canine maxillary fourth premolar and molars – The film should be placed perpendicular to


the nasal philtrum and flat against and covering the maxillary fourth premolar and molars. The film must be as far back in the mouth as possible to cover all three teeth. Tip the cone head so the beam is angled at 45° from the nasal philtrum. Due to PM 4 having 2 mesial roots and one distal root a lateral projection will superimpose the 2 mesial roots. Another image is needed to separate the two mesial roots and visualise them individually. The beam can be either aimed rostrocaudally or caudorostrally for this image to separate the two mesial roots. The author prefers to tip the beam caudorostrally as there is more film in the mouth in this direction and this will give the best chance of capturing the image. At least two images will be required of this tooth to fully assess it and to be able to apply the SLOB rule to the mesial roots.

6. Canine mandibular molars – The film should be placed between the tongue and teeth, parallel to the nasal philtrum and table. The beam is angled perpendicular to film at 90°. This technique can often be used for premolars as far rostral as PM3 but this depends on how far caudal the mandibular symphysis extends.

Cats

For feline patients, size 0 or 2 films should be used.
1. Feline maxillary and mandibular incisors – Use the same technique as the canine incisors.
2. Feline maxillary and mandibular canines – Use the same technique as the canine maxillary and mandibular canines.
3. Feline mandibular premolars and molar – Use same technique as for canine molars.
4. Feline maxillary premolars and molar – The feline maxillary premolars and molar are considered one of the most difficult images to take by the author as the zygomatic arch superimposes over the teeth when the standard angles for the canine maxillary premolars and molars are used.

Three different techniques used; the conventional approach, extra-oral technique and intra-oral near parallel technique.

A. Conventional approach – The film should be placed perpendicular to the nasal philtrum, flat against the hard palate to allow imaging of the maxillary premolars and molar. The film must be placed as far back in the mouth as possible to visualise all four teeth. The beam should be angled at 60° from the nasal philtrum and turned in a rostrocaudal direction.

B. Extra-oral technique – With the patient in lateral recumbency the target teeth are nearest the table. The film should be placed extra-orally on the table, parallel to the nasal philtrum and the long axis of the teeth. The mouth should be held open with a radiolucent gag. The beam should be aimed through the open mouth onto the target teeth and film. There is no specific angle for the beam and is positioned by line of sight. This technique pushes the zygomatic arch upwards on the film. Turning the cat skull 20° dorsally will give good access to the target teeth with the beam.

C. Intra-oral near parallel – The film should be placed diagonally across the mouth resting between the target (and uppermost) mandibular PM3 and PM4 and across the hard palate to rest on the palatal aspect of the contralateral maxillary cheek teeth not being imaged. The beam is angled 70° from the nasal philtrum, which is nearly parallel to the film.

Film placement

Most films have an embossed dot on one of the corners. When placing the film in the mouth, place the dot away from the tooth that you are imaging to ensure it does not interfere with your image.
The dot helps to differentiate between the left and right sides of your image. On images where this needs determined the author will also place a small paper clip on the film on the side closest to the operator for the exposure.

Place the film in the mouth so that the entire tooth and its root is covered by the film. Often the roots of the teeth are longer than you think. Place the tip of the crown at a corner of the film to give the best chance of the entire root being covered by the rest of the film.

The film should be placed as close to the tooth as possible without distortion to reduce the film/target distance.

Use props such as cotton swabs or paper towels to help keep the film or sensor in the correct position.

**Conclusion**

Using these simple angles and tips can make dental radiography easier and quicker to perform with excellent consistently diagnostic results. Mastering dental radiography technique will improve your ability to quickly and effectively diagnose dental conditions and reduce patient anaesthetic time.

**References**


**How & why I remove lingually displaced mandibular canines in pups**

Norman W. Johnston BVM&S FRCVS DAVDC DEVDC

**Introduction**

The condition of lingual displacement of pups is becoming more common as a presenting condition to both first opinion and referral practice. It is important the attending clinician fully examines the mouth and assesses the bite at the first opportunity any pup presents to the clinic.

The condition is considered to be an inherited condition and can occur as a class 1 malocclusion or as a combined class1 and class 2 malocclusion if there is also mandibular distoclusion. The inheritance pattern is complex and a study is ongoing to determine the exact nature of this with genetic material from cases being submitted to the Animal Health Trust in the UK for gene sequencing. Results are not yet available but early indications are that this is a complex autosomal recessive mutation that requires sire and dam to both be recessive carriers for the litter to have pups appearing with the condition. Pups that show lingual displacement of the deciduous mandibular canines phenotypically also have a positive genotype for the recessive nature of this condition. Repeating
a mating that has produced affected puppies runs a high risk of producing more affected pups and therefore is not advised. Current research opinion by the geneticists at the Animal Health Trust continues to improve and expand our knowledge of the exact mode of inheritance. Currently they think that it is difficult to advise excluding other individuals, such as unaffected litter mates and the sire and dam, from other potential matings. Clearly such matings carry a strong potential for passing this genetic material into the breed’s gene pool and both the pup’s owners and breeders need counselled to that effect.

The condition can vary widely in severity. The mildest presentation is a class 1 malocclusion when the relationship between the maxilla and mandibles is normal and the abnormal contact between the crown tips of the deciduous mandibular canines is within the gingiva of the diastema between the deciduous maxillary canine and the third incisor with the resulting pit or wound mainly buccal. The most severe presentation is when there is also a significant class 2 malocclusion (or mandibular distoclusion) leading to the deciduous mandibular canines (and often incisors) occluding into the soft tissues of the hard palate. Many times these pits are medial to the deciduous maxillary canines with a mandibular distoclusion of 1 cm or more. Occlusion of teeth onto the incisive papilla is intensely uncomfortable.

The majority of mandibular growth occurs along the caudal aspect and this may mean that there is no change in mandible length between the incisors to first molars between 3 and 6 months of age. From day 50 in dogs, mandibular growth is almost all from the caudal mandible (Hennet 1992 Snyder 2013). Growth in the mandible is rapid during early skeletal development and appears mostly complete by 6-7 months of age although there is clearly much breed variation with large and giant breeds maturing much more slowly than smaller breeds.
Treatment aim

The purposes of surgical treatment to remove the deciduous mandibular canines in affected pups are three-fold:

1. Immediate relief of pain from contact of the sharp crown tips of mandibular canines (and possibly incisors) with the soft tissues of the gingiva or hard palate. Many owners do not recognise that pain is present and this can be a real welfare issue until the problem is relieved. Once treated the patient's demeanour often changes markedly for the better, once pain free. Some pups try to limit discomfort by not fully closing their mouth to avoid contact.

2. To remove the current dental interlock when the mouth is closed. As the mouth closes the deciduous lower canine teeth become locked into soft tissue pits. This prevents normal independent growth of the mandibles relative to maxilla and, in some cases, leads to deviation of the skull to left or right. Asymmetry of the palatal rugae may be present and visible in such cases.

3. To provide a clear eruption path for the permanent mandibular canines in a buccal direction. Given the permanent mandibular canine buds are located lingual to the deciduous canines, surgical removal of any obstruction to a normal eruption path is important.

Surgery is best performed as soon as possible after the problem is recognised to ensure enough time for the treatment to have benefit – optimally 8-12 weeks or so. The deciduous mandibular canines should be fully erupted by 6 weeks of age and the permanent mandibular canines usually start erupting at 22 weeks of age or so (Wiggs 1997). After 16 weeks of age surgical removal is slightly more difficult once the buccal bone mineralises and the time frame before adult tooth eruption is much reduced.

Surgical approach

The deciduous mandibular canine teeth have long, curved roots approximately 2.5cm in length. The roots often comprise 70% of the total length of the tooth. The use of a closed extraction technique is technically difficult as there is a strong risk of fracture of the root and/or damaging the developing enamel of the successor tooth. The closed technique is not advised in the author’s opinion.

Surgery is best performed via a full thickness mucogingival pedicle flap. This approach allows clear access to the buccal bone over the whole of the deciduous lower canine. The location of significant structures on the lingual aspect means that no instrumentation can take place on this 180-degree arc. This will be described in detail.

Up to 16 weeks of age the bone is soft enough to be shaved off the buccal aspect of the root with a periosteal elevator with a chisel type blade at one end (EX19; Cislak Manufacturing). Hand instrumentation is more delicate and no drilling is required.

Once the bone is off the buccal aspect, the tooth can be gently lifted bodily from the alveolus. Preventing rotation or tipping of the root is wise otherwise the developing enamel on the tooth bud of the successor permanent canine can be damaged.

Closure of the flap is with single interrupted Monocryl 5-0 sutures.

Post op

Owners are advised to monitor the eruption of the permanent mandibular canines and email photographs once the erupting crowns are visible. In some mild circumstances, when the mandibular canine teeth can be simply tipped buccally, the use of “ball therapy” (Verhaert 1999) can improve matters. In more severe cases, especially if there is significant mandibular distoclusion, ball therapy will not work and a more proactive approach is required.

References

Linguoversion of the permanent canines – How I perform crown amputation and partial coronal pulpectomy

Norman W. Johnston BVM&S FRCVS DAVDC DEVDC

Introduction

The condition is considered to be an inherited condition and can occur as a class 1 malocclusion or as a combined class 1 and class 2 malocclusion if there is mandibular distoclusion. The inheritance pattern is complex. A study is ongoing to determine the exact nature of this inheritance with genetic material from cases being submitted to the Animal Health Trust in the UK for gene sequencing. Results are not yet available but early indications are that this is most likely a complex autosomal recessive mutation that requires the sire and dam to both be recessive carriers for the litter to have pups appearing with the condition. Pups that show lingual displacement of the deciduous mandibular canines phenotypically also have a positive genotype for the recessive nature of this condition. Repeating a mating that has produced affected puppies runs a high risk of producing more affected pups and therefore is not advised.

Current research opinion by the geneticists at the Animal Health Trust in the UK continues to improve and expand our knowledge of the exact mode of inheritance. At this time, they think that it is difficult (scientifically) to advise excluding visibly unaffected litter mates and the sire and dam from other potential matings. This advice may change in due course as the knowledge base expands.

The condition can vary in severity. The mildest presentation is a class 1 malocclusion when the relationship between the maxilla and mandibles is normal but there is abnormal contact between the crown tips of the mandibular canines and the gingiva of the diastema between the maxillary canine and the third incisor. The most severe presentation is when there is a significant class 2 malocclusion (or mandibular distoclusion) leading to the mandibular canine crowns occluding into the soft tissues of the hard palate and/or making contact with the maxillary canines. Many times these pits are medial to the maxillary canines

Treatment options

Lingually displaced permanent teeth can, theoretically, be treated by four options. Not all options are available to all cases. These options are:

1. Surgical removal of the lower canines teeth (and possibly incisors also)

Johnston NW. Veterinary Orthodontics – a five-year retrospective study. Proceedings 8th Veterinary Dental Forum 1994 p 64-67
Wiggs RB and Lobprise HB. Veterinary Dentistry Principles and Practice: Lippincott- Raven
2. Crown amputation and partial coronal pulpectomy
3. Orthodontic movement
4. Crown extensions

Surgical removal of the permanent mandibular canines at any age is probably the most demanding extraction performed in veterinary dentistry. The procedure is highly invasive with regard to the amount of bone that needs to be removed. The void left behind after successful extraction is relatively large and the risk of jaw fracture can be high. To perform this procedure bilaterally is a very poor option for a young dog with regard to excessive weakening of the rostral mandibles and symphysis.

Orthodontic treatment has a number of options available. Many of these have poor or uncertain outcomes for reasons out with the veterinary dentist’s control. The use of inclined bite planes, crown extensions or other regimens are invariably invasive, need regular professional cleaning and adjusting under sedation or anaesthetic. There is a risk the patient may destroy or displace the device.

Treatment can take many weeks or months and may ultimately fail to achieve the desired aim for reasons out with the control of the veterinary dentist. Orthodontic treatment is also carries questionable ethics. To change the conformation of a dog with a known inherited defect and perhaps provide it with an opportunity to re-enter the gene pool with a normal bite is dangerous for the long term health of the breed.

**Crown amputation and partial coronal pulpectomy**

This is the author’s favoured option and involves reducing the height of the lower canines to that of the adjacent incisors. This procedure has a number of advantages over surgical removal or orthodontics.

- The whole of the root and most of the crown is retained
- The aim of eliminating pain and resolving the soft tissue palatal wound(s) is achieved in one procedure
- The pulp remains alive and the dentine wall strengthens naturally over time
- The success rate using MTA is very high (92%)

One study (Luotonen 2014) reviewed 190 dog cases treated over a ten-year period with vital pulp therapy. The long term success rate for teeth treated by MTA was quoted as 92% against 58% of those treated by calcium hydroxide.

Elective crown amputation of the mandibular canines is a sterile procedure designed to reduce the height of the lower canine crown to the height of the adjacent incisors. Many dogs that present for this procedure are between 6 and 8 months with the mandibular canine teeth still having erupt-
ve potential. The amount of crown removed should not only relieve current contact but anticipate future eruption.

The procedure will be described in a step by step manner. It is a delicate procedure best performed using suitable barriers. It requires a removal of some pulp (partial coronal pulpectomy) and placement of a direct pulp capping. This must be performed as gently and atraumatically as possible.

In order to monitor this process of maturation we need to radiograph these teeth at four months post-op. This is a mandatory check and we will not perform this surgery unless the owner agrees to this. The study previously quoted (Luotonen 2014) noted around half of the cases that failed (8%) were found at an examination more than one year after the original procedure. A further review with radiographs is now advised to all owners.

The left radiograph shows the left lower canine immediately after crown amputation and partial pulpectomy. The right radiograph is the same tooth 18 weeks post-op. Note the thickened dentine walls, development of an internal dentine bridge between pulp stump and direct pulp cap and the closed and matured root apex. These three criteria, in addition to the lack of any lesions of endodontic origin, indicate a successful procedure at this stage.

The advantage of this procedure is that the whole of the root and the majority of the crown remain. The strength and integrity of the lower jaw is not weakened by the procedure and long term results are very good due to the use of Mineral Trioxide Aggregate as a direct pulp dressing.

References
Endodontics and prosthodontics in working dogs

Barron P. Hall DAVDC FAVD

Cases on preparing canine teeth in working dogs for full jacket metal crowns, some using posts.

Review of small animal dentistry and oral surgery literature

Alexander Reiter
School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA, USA.

This presentation is most suited for residents enrolled in training programs of the European Veterinary Dental College (EVDC), the American Veterinary Dental College (AVDC), and those with a desire to stay on top of the game with regards to up-to-date knowledge about evidence-based veterinary dentistry and oral surgery. The most pertinent conclusions made in peer-reviewed journal publications of the last 1-2 years are discussed. References are available at request (reiter@vet.upenn.edu).

Exotic endodontics and prosthodontics

Barron P. Hall DAVDC FAVD

Cases on endodontically treating a variety of exotic species. One case of two metal crowns being placed on endodontically treated teeth in a clouded leopard.
VETERINARY GUIDE

A whole range to support you
Use of CBCT in a private veterinary dental clinic

Kuntsi-Vaattovaara, Helena DVM, Specialist in Small Animal Diseases, DEVDC, DAVDC

Introduction and literature review

CBCT (Cone Beam Computed Tomography) technology provides high resolution isotropic volumetric (3D) images of hard tissue of a small area with minimal irradiation and much lower cost compared to conventional CT. The most common uses for CBCT in human health care are in dentistry and oral maxillofacial surgery with a vertical positioning of the patient. However, some newer CBCT devices also allow horizontal or oblique positioning of the object, thus extending the use of this technology to human orthopedic diagnostics and veterinary medicine.

This presentation includes the first year’s clinical experience of a compact, stand-alone and mobile CBCT unit at a private veterinary dental clinic in Finland. This type of unit was originally designed for imaging of extremities and head of human patients. Due to the possibility for horizontal patient positioning, this device suits well for small animal patients, too.

Technical data and clinical set-up

The dimensions (width x length) of the device are 1740 x 910 cm (685 x 358 inches). Additional space is required for the examining table. The unit is mobile, weighs 350 kg and connects to an ordinary electrical grid. The unit comprises a touch screen with factory settings for different targets and a joy stick controlled gantry that can be tilted from horizontal to vertical position. This allows obtaining images of a small animal patient in a horizontal positioning but also weight-bearing images of a leg with a standing position. Radiation shielding regulations may vary locally, but usually a 1 mm Pb equivalent shielding is recommended, as CBCT technology provides up to 10 times lower radiation dose compared to conventional CT scanners and scattered radiation is low. There is a remote control to allow the personnel to step out of the room to acquire images.

In our practice, the device is situated in close proximity to the dental suite, in the radiology room, right next to our digital full-body x-ray machine. The size of the room is 3000 x 4500cm (1200 x 1800 inches).

The maximum field of image (FOV) is 16 x 12,8cm. The device takes 300 projection images during 18 seconds and in less than 1,5 minutes, produces a 3D- reconstruction with an isometric resolution of 0.1, 0,2 or 0.4mm. The study includes 800 Dicom-images which can be read with the unit’s own software or any other software made for Dicom-images. The unit’s own software allows multiplanar viewing and editing the 3D-reconstruction views in different windows (bone, teeth and soft tissue), panoramic view, accurate measurements for implants and also possibility to stich volumes to combine two or more 12,8 cm wide volumes to build a larger image. Images can be sent to a radiologist through a cloud service and 3D-printing for e.g. surgical guides and custom-made bone plates is possible.

During the CBCT study, the patients are anesthetized with IV-fluids; intubated to receive oxygen and kept warm with a soft fleece pad and blanket. The usual time to move the patient from the dental suite to CBCT, obtain the images and move the patient is about 5-15 minutes. The acquired images are exported to the reviewing room through our internal network.
Number of cases and economy

These numbers will be updated closer to the conference but the data is as follows: After two years and 2 months, we have performed 353 studies, i.e. 14 cases per month.

The cost of the study to the client is 196€ (including VAT 24%) if the scanning is done during other dental/maxillofacial treatment and about 450€ if the scanning is done as its own entity. As a comparison, in our country, a conventional veterinary CT study costs about 700€ to the client and the price for a human CBCT study varies between 200 and 500€.

Indications and examples of cases

The indications for obtaining images have included the following: defining anatomical/developmental, periodontal and endodontal diagnosis, tumors of the oral and nasal cavity, foreign bodies of the nasal cavity, periorbital and retropharyngeal abscesses, maxillofacial trauma, otitis media and a small number of orthopedic problems.

Anatomical and developmental findings

Unerupted teeth with or without the formation a dentigerous cyst have been the most common indication in this group. A 3D-reconstruction of the area of interest has proved useful in planning the surgical technique and shortening the surgical time.

Periodontal findings

As stated in the human literature, the advantages of CBCT for periodontal findings include detection of buccal and lingual bone loss but it is also helpful in clinical decision making and monitoring in guided tissue regeneration cases.

Endodontal findings

According to human literature, advances of CBCT compared to intraoral radiography include more accurate detection of periapical lucencies, localization and characterization of root canals, detection of root fractures and treatment planning for periapical surgery. According to the study by Lofthag-Hansen et al., CBCT showed 62% more periapical lesions than intraoral radiology. In our patients, CBCT has been useful in differentiating a chevron artefact from a true periapical lesion, detecting communication between a periapical lesion and nasal cavity and aiding in localization of a lucency in cases where the obliqueness of an intraoral x-ray beam causes confusion as to which root the periapical lesion is associated with. We have also used CBCT in apicoectomy cases for clinical decision making and monitoring success.

As per human literature, CBCT is not helpful in evaluating the quality of root canal obturation, and this has proved to be the true also in our clinical cases.

Human literature mentions resorptions under “endodontal findings”, including not only internal but also external resorptions. We have only had 16 cats for CBCT studies and none of them have been scanned to detect resorptive lesions. This is definitely an area that would be worth more investigation. Apical inflammatory resorption, however, has been clearly detected in our canine endodontic patients.

Oral-maxillofacial trauma

As expected, CBCT has proven to be crucial in diagnosis and treatment of oral-maxillofacial trauma. It is a well-known fact that TMJ diagnosis requires the use of CT, and CBCT has proven useful, too. In addition, CBCT has been very helpful in diagnosing and treatment planning of more simple trauma cases, such as rostral mandibular fractures.
Tumors

CBCT is useful for diagnosing for tumors affecting the bone. However, tumors originating from the soft tissue are difficult or impossible to diagnose accurately. This has to do with the fact that in theory, CBCT is made for hard tissue diagnosis and producing different gray scales of soft tissue is difficult. Also, the use of contrast is challenging and requires more work to be successful.

Other pathology of the head

Clinical cases in this group have included cranio-mandibular osteopathy, abscesses of the retropharyngeal and retrobulbar area, otitis media, foreign bodies of nasal cavity and chronic rhinitis. Human radiology literature lists numerous typical CBCT findings in nasal disease but for a veterinary dentist, these cases are very challenging. Even though we might be familiar in interpreting dental and oral-maxillofacial pathology, the nasal cases definitely require consulting a veterinary radiologist.

Novel uses of CBCT in veterinary medicine

In human medicine, the horizontal-plane CBCT devices are very useful in orthopedic surgery. The mobile CBCT unit is easy to transport within the hospital and can also be easily used in first-aid diagnosis in sport events. Furthermore, CBCT with intra-articular contrast media has proven to show cartilage tears of a human knee more reliably than MRI.

We have scanned areas including and distal to the knee and elbow but have not really had a chance to work with a veterinary orthopedic surgeon. Another interesting application would be equine dentistry and orthopedic surgery.

Summary

Utilizing CBCT, an ultramodern imaging technique, is another hallmark of veterinary dentistry being one of the fastest developing branches in veterinary medicine. We, as veterinary dentists, are used to being the “aliens” in veterinary medicine: having worked with our tiny intraoral films that no-one else will read, it may be time to step in the wagon of CBCT.

References are available upon e-mail request: h.kuntsi@kolumbus.fi

Bone augmentation strategies: case studies

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With the advent of implants, the need to preserve or augment bone is becoming more pressing. Luckily, many products are now available to achieve that end. They are divided in two categories: osteoconductive products and osteoinductive products. Synthetic products (alloplast) and xenografts are osteoconductive and less onerous. Fresh cancellous bone (autogenous), demineralised freeze dried bone and freeze dried bone (allograft) are the only osteoinductive products. New on the block
are bone morphogenic proteins (BMP2 and BMP7) that also stimulate bone formation. They are now available commercially.

This paper will review the uses of various implant materials and demonstrate their uses in different situations.

**Periodontal surgery**

Autogenous graft, allograft, alloplast and xenografts have all been used to fill periodontal pockets. Three wall pockets carry the best prognosis. The pocket is curetted clean, the edges of the crestal bone are smoothed out, the graft is packed into the pocket and the gingival flap is sutured closed over the defect. This technique helps but does not prevent the epithelial cells from migrating into the pocket before the bone has had time to mature. To eliminate this problem, a membrane barrier needs to be placed between the graft and the gingival flap. Here too there are many products to choose from. Absorbable membranes are preferred as a second surgery is not required to remove the membrane. Further details on techniques and products can be found in books such as: Oral and Maxillofacial Surgery in Dogs and Cats, Verstraete FJM, Lommer MJ eds, 2012 Elsevier Ltd.

**Bone preservation**

Following extraction of a large or strategic tooth, the alveolus is curetted clean, the edges of the crestal bone are smoothed out, the alveolus is filled with a bone implant and the gingival flap is sutured closed over. A membrane barrier can be added between filler and flap. Implant in the form of blocks or granules are commonly used in this instance. Osteoconductive, osteoinductive or a mixture of both products may be utilized. They allow preservation of the bone ridge in order to keep the normal anatomy or to prepare the area for a titanium implant at a later date.

**Bone augmentation**

When presented with a severe bone loss secondary to periodontal disease or secondary to a mal-union. Usually, there is a V shaped bone defect in the mandible. Once the area has been cleaned and debrided a block of bone may be shaved to fit the defect. The soft tissues are closed and the area is splinted for 6 to 8 weeks. At time of recheck, obtain an x-ray to make sure that a callus is forming, then remove the splint. Further x-rays weeks later should show good bone integration.

**Oronasal fistula repair**

This technique is reserved for recidivist fistulae. On a first time fistula, the best procedure remains the single flap technique. A large gingival flap is created, the bone edges are exposed, the area is cleaned carefully, making sure that no bone sequestrum is present. Select a lamellar bone membrane or a piece of auricular cartilage large enough to cover the bony defect. Place it over the defect. Suture the implant to the underside of the gingival flap with the help of vertical mattress sutures placed at the corners. Suture the gingival flap back over the implant and close the fistula. A series of oronasal fistula repairs will be presented.

**Cleft palate repair**

There are several techniques available to repair secondary cleft palate. In those techniques the most troublesome spots are around the nasopalatine fossae and the connection of the hard palate to the soft palate. Those are the areas where the sutures dehisce the most often. Once again, a lamellar bone implant may be placed under the soft tissue flaps to stabilize the area and prevent dehiscence. The implants are secured in the same way than in the oronasal fistula repairs.
Dentigerous cyst in a dog

Niina Luotonen DVM, DAVDC, DEVDC

Dentigerous cyst (follicular cyst) is an odontogenic cyst associated with the crown of an unerupted or developing tooth. The cyst attaches to the cementoenamel junction and encloses the crown of an unerupted tooth. According to the literature, a dentigerous cyst develops from proliferation of the enamel organ or reduced enamel epithelium, but the exact histogenesis remains unknown. The supporting fibrous connective tissue wall is lined with a stratified, non-keratinized squamous epithelium. The epithelial lining has a thickness of 4 to 6 cell layers.

An odontogenic cyst is derived from the odontogenic epithelium. It can be developmental or the result of an inflammatory process. In addition to dentigerous cysts, the reported odontogenic cystic processes in dogs include periapical (radicular) cysts, lateral periodontal cysts, odontogenic kerato-cysts/keratocystic odontogenic tumor (OKC) and gingival inclusion cysts.

In people, several cysts, such as gingival cysts of a newborn, eruption cysts, glandular odontogenic cysts and calcifying odontogenic cysts have been reported. A periapical (radicular) cyst is inflammatory in origin and by far the most common cysts of the jaws. Periapical cysts develop from odontogenic epithelial residues (cell rests of Malassez) of the periodontal ligament adjacent to the root of a nonvital, necrotic tooth.

A lateral periodontal cyst is defined as a developmental cyst with a thin, nonkeratinized epithelial lining, located lateral or adjacent to the roots of vital teeth and arising from odontogenic epithelial rests of the dental lamina. An OCK derives from remnants of the dental lamina. It is typically not associated with the teeth. The cyst wall of an OCK has a thickness of 6-10 cell layers with hypercromasia and palisading of the basal cells. An OCK has a high recurrence rate. As with other cysts, expansion of the dentigerous cyst is related to epithelial proliferation, release of bone-resorbing factors, and an increase in cyst fluid osmolality as a result of passage of inflammatory cells and desquamated epithelial cells into the cyst lumen.

Resorption of roots of adjacent erupted teeth is occasionally present. In dogs, a dentigerous cyst is most commonly associated with an unerupted mandibular first premolar in brachycephalic breeds.

The exact reason for overrepresentation in brachycephalic breeds is unknown, but crowding of teeth as a result of cephalic conformation may be an underlying factor. Although dentigerous cysts have been discussed in veterinary literature, they are still regarded as a rare occurrence.

According to a recent study by Verstraete et al., a dentigerous cyst was the most common type of odontogenic cysts in dogs, identified in 29 of 41 (71%) cases. In this study, dentigerous cysts were diagnosed in dogs of a wide age range (6 months to 10 years), but dogs between 2 and 3 years old were overrepresented and sex did not seem to affect the incidence. Verstraete proposed a term “canine odontogenic parakeratinized cyst” (COPC) for cysts in dogs resembling OCKs in people. The COPC differs from OCK histologically only by lacking the hypercromatic, palisading cell layer. Interestingly, in contrast to people with OCK, no recurrence of COPC was reported in the study.

In humans, a dentigerous cyst is the second most common type of cysts in the jaws after a periapical cyst. It is most often associated with unerupted third molars and maxillary canines. The highest incidence of dentigerous cysts occurs during the second and third decades. There is a greater frequency in males, with a ratio of 1.6 to 1.2 About 4% of individuals 216 with at least one unerupted tooth
have a dentigerous cyst, and cysts around supernumerary teeth account for 5% of all dentigerous cysts. The clinical examination reveals an absent-appearing tooth or teeth and possible fluctuant soft tissue swelling, occasionally resulting to facial asymmetry. The patient typically shows no pain or discomfort. The dentigerous cyst is capable of achieving a significant size, occasionally with associated cortical bone expansion and sometimes even to an extent predisposing to pathologic fracture.

Radiographically, a dentigerous cyst typically presents as a well-defined, uni- or multilobular radiolucency in association with the crown of an unerupted tooth. The cysts range in size from several millimeters to several centimeters. Although a histologic examination is important to differentiate the exact nature of the cyst, the histopathologic appearance of the lining epithelium is not always definitive, and the diagnosis of a dentigerous cyst relies on the surgical and radiographic observation of the attachment of the cyst to the cementoenamel junction.

The treatment of a dentigerous cyst involves the removal of the associated tooth and enucleation of the soft tissue component. Because an incomplete removal of the cyst epithelium may result in recurrence, the cyst wall is thoroughly curetted to ensure complete removal. Any teeth that are resorbing secondary to the cyst, should be surgically extracted. Malignant transformation of the epithelial lining cells to an ameloblastoma, primary osseous carcinoma and adenomatoid odontogenic tumor has been reported in humans. Hence, histopathologic examination of the lesion is mandatory, and the surgical site should be carefully evaluated postoperatively.

According to many studies, enucleation is a definitive treatment, with rare recurrence. In large cysts in which enucleation may lead to a pathologic fracture or damage to neurovascular structures, marsupialization may be chosen. Marsupialization allows decompression and reduction in the size of the cyst and osseous defect. The cyst can then be enucleated during a subsequent surgery. The use of a cancellous or corticocancellous bone graft is recommended in selected cases for filling bone defects as a consequence of cyst removal. Osteogenesis after enucleation begins with the formation of a blood clot, which is eventually replaced by immature bone. According to the study of Chiapasco et al., the increase in bone density was 48% at 12 months and 91% at 24 months after enucleation of mandibular cysts without filling in the cavity as compared with the immediate postoperative values. However, many studies show that use of a defect-filling graft promotes new bone growth.

Graft materials are classified as autografts (from the same individual), allografts (from the same species), xenografts (from another species), and non-bone graft materials, and evaluated based on their osteogenetic, osteoinductive, or osteoconductive potential. Osteogenesis refers to the formation of new bone by the cells contained in the graft, whereas osteoinduction is a chemical process by which the molecules contained in the graft (e.g. bone morphogenetic protein) convert the neighboring cells into osteoblasts, which in turn form new bone.

In conclusion, dentigerous cysts arising from unerupted teeth is the most common odontogenic cyst in a dog. To prevent the development of these cysts and avoid unwanted effects on adjacent teeth, early detection comprising a thorough clinical and radiographic examination is necessary.

References available upon request.
A rare case of infected hyperplastic dentigerous cyst in a Terrier

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There have been reports of many Dentigerous cysts over the years, a condition when an unnatural eruption of a tooth might form an epithelial cyst in a part of bony or soft tissue of either mandible or maxilla. It arises from odontogenic epithelium which can cover a part or whole of an un-erupted adult tooth and often is filled with liquid, although there were reports of infection in rare cases. Usually, this cyst is benign, however, it may cause dental displacement, root lysis of the neighbour teeth and bone destruction. There are cases reported on turnover of this cyst into malignancy and ameloblastoma, though the incidence in veterinary medicine is unknown. Depend on the cyst’s size, there might be no sign in affected animal or it can be followed by a gingivitis or stomatitis. In some cases, the cyst is big and malformed. The typical side effects of dentigerous cysts are facial asymmetry due to the expansion of the bone, other dental disorders, osteolysis and loosening of the neighbour tooth. Infected cysts usually are with inflammation and pain in the area, which can be the leading cause in mistaking dental abscess with dentigerous cyst. The diagnosis is based on history and oral examinations which, generally, reveal an absent tooth. However, radiology is the best option to confirm the existence of the cyst. Although, the radiographs still need to be approached cautiously due to the similar features of other dental ailments. Normally, after a preliminary diagnosis, a surgical procedure is the best option for treatment.

A quite rare case of dentigerous cyst was referred to the dentistry ward at Parsa pet clinic, Tehran. A 5-years-old female (spayed) terrier, (weight = 9 kg) was referred with a swelling and pain in the left side of mandible. On the contrary to the obvious swelling of the site, no facial alteration could be seen. On the preliminary examination, the first premolar of the left mandible (305) was noticed to be missed. Also a gingivitis (score = G3) and moderate calculus, without any mobility and fraction was revealed. Further inspection showed a 3mm x 2mm nodule at the region of tooth 305.

In the next stage, radiography was performed. An oval radiolucency at the region of first Premolar of the left mandible could be seen. There was an osteomyelitis about 1mm just around the cyst. The tooth 305 was to be found near the alveolar crest inside the cyst.

After the confirmation with x-ray, we were decided to surgically remove the cyst. Thus, a routine blood sample to test CBC, Creatinine, Urea, Glucose and Total protein was obtained, and showed normal values after analysis. Other physical examination was satisfactorily normal.

After 12 hours NPO, Ketamine hydrochloride and acepromazine maleate was administered intramuscularly for preanesthesia and induced with Ketamine hydrochloride and Diazepam, Intravenously. The dog was intubated with 5mm cuffed-ended tracheal tube. A Ringer infusion 10ml/kg/hour was also administered. Temperature, Heart rate, ECG, Blood pressure, SPO2 and respiration-rate, was kept under control with a monitoring machine. Supragingival and subgingival scaling was performed.

An elliptical incision was made with a Bard Parker blade #11 to remove the dentigerous cyst. Tooth 305 was extracted and the liquid which filled the cyst was drained. A sample of the filling liquid that looks turbid grossly, was collected. On the cyst wall curettage was done and the area around the cyst which in the radiograph was shown to involved osteomyelitis was removed by dental
high speed handpiece. The powdered bone grafting material was used to aid and accelerate the healing process. Gingiva was sutured with simple interrupted pattern and 3-0 vicryl used. Appropriate NSAIDs and antibiotics were administered, post-operation.

Cyst cytology showed presence of RBC, inflammation and infection. The result of this test, led to another blood sample to make sure that the infection did not pass over the immune barrier. And to stay on the safe side, the case was to consume antibiotics for a duration of five days.

On the histopathology showed a slight hyperplastic and hypertrophic epithelium above the basal line. However, there was no sign of neoplastic cells.

The case and surgical site were rechecked after 24 hours post-operative, to ensure of no complications. After fifteen days, the surgical site was examined and the gingiva was healed accordingly. There was no evidence of inflammation or pain and the animal was eating normally. After eight months, another radiograph was obtained to confirm the completion of healing and absence of any hyperplastic tissue.

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Staged treatment of periapical cysts in dogs by marsupialisation and curettage

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Treatment of periapical cysts includes removal by curettage or enucleation of all of the epithelial lining and extraction or endodontic treatment of the involved teeth. It is imperative to confirm a diagnosis by histopathology. Periapical cysts are often asymptomatic in humans as well as in dogs, and many may be large before they are found by clinical or radiographic examination. Thus, periapical cysts may present with extensive bone resorption around one or several teeth.

Extensive cysts are often multilocular and difficult to debride without risk of iatrogenic damage. Complete resection will be comprehensive, removing healthy tissue, and possibly compromising function. Enucleation may not easily succeed because of the cyst’s multilocular shape.

In humans with extensive cysts, staged treatment with initial marsupialization or decompression with stents is recommended prior to curettage or enucleation. Leaving the cyst open to drain will induce a reduction of its lumen by gradual bone regrowth from within the cyst’s periphery. This may reduce the risk of complications such as nerve or dental damage and jaw fractures during definitive cyst curettage or enucleation.

References available upon request: hak@sund.ku.dk
Unerupted teeth in dogs and cats: a clinical, radiographic and histological study in 59 cases (2001-2016)

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Background

An unerupted tooth is a tooth that does not emerge into the mouth within the expected time frame because of lack of space, malposition and other physical impediments such as the presence of a tumor along the path of eruption (impacted tooth), or because of a lack of eruptive forces (embedded tooth) (Juodzbalys and Daugela, 2013). The development of dentigerous cysts and tumors may be associated to teeth that fail to erupt (Adeyemo, 2006).

Clinical, radiographic and pathological features associated with unerupted teeth are well described in human dentistry (Santosh, 2015), while only a few reports are present in the veterinary literature.

In human patients, the prevalence varies considerably in different countries (from 8% to 38%). The most frequently affected teeth are the mandibular and maxillary third molar (up to 68.6% of the cases), followed by the maxillary canine, mandibular and maxillary premolar teeth, and maxillary central incisor teeth (Kaczor-Urbanowicz et al., 2016). 1.4% of unerupted teeth develop dentigerous cysts in humans (Mortazavi and Baharvand, 2016) and less than 1% may be associated to tumor development (Adeyemo, 2006). Unerupted teeth are normally asymptomatic, but pain may be reported because of inflammation of the soft tissues surrounding the crown (pericoronitis), or pressure resorption of adjacent roots (Juodzbalys and Daugela, 2013). Diagnostic imaging (i.e. radiography or CT) is required to confirm the presence of an unerupted tooth in edentulous areas (Montazavi and Beharvand, 2016). Extraction is the treatment of choice in case of loss of bone around the impacted teeth, presence of cysts or tumors, displacement of the adjacent teeth, or chronic pain (Juodzbalys and Daugela, 2013). However, because of the closeness of many unerupted teeth to the inferior alveolar nerve, coronectomy and intentional root retention of healthy, unerupted teeth has also been recommended (Leung and Cheung, 2009). Furthermore, orthodontic treatment with surgical exposure may be attempted in selected cases (Kaczor-Urbanowicz et al., 2016).

Prevalence of unerupted teeth in animals is currently unknown. Only few cases have been described in cats (Surgeon, 2000; Gioso, 2003; Hoffman, 2008). In dogs, most of the studies and case reports have focused on the description of dentigerous cysts associated to tooth uneruption (Verstraete et al, 2011). Brachycephalic breeds (e.g. Boxer, Boston Terrier, Pugs, Shi-Tzu) have been described as more frequently affected, but a variety of breeds (e.g. Belgian Malinois, German Shepherd, Labrador Retriever, Dalmatian Dog, Greyhound and others) have also been reported. Based on the available information, the permanent first premolar tooth seems to be the most affected tooth in dogs, followed by the canine teeth. Extraction of embedded and impacted teeth is often recommended even in the absence of clinical or radiographic pathologic findings, as a preventive method against the development of cystic lesions that can lead to severe loss of surrounding bone and resorption of adjacent teeth. However, there is lack of information in the veterinary literature about the total prevalence of unerupted teeth and the likelihood of development of dentigerous cysts or other pathology.
Objective

The main purpose of this retrospective study was therefore to describe canine and feline dental patients with unerupted teeth (with or without cystic lesions). Furthermore, the prevalence of associated dentigerous cysts and tumors, and the evaluation of possible factors implicated in cystic development were also assessed.

Materials and methods

Medical and dental records, intraoral photographs and intraoral radiographs of client-owned dogs and cats examined between February 2001 and September 2016 at different veterinary clinics in Northern Italy were reviewed. All patients were presented because of an oral or maxillofacial problem, but not necessarily because of the lesion object of this study. Head and oral examinations were performed under general anaesthesia.

Patients were included in the study if they had at least one unerupted tooth as shown following radiographic examination (full mouth intraoral radiographic examination or at least radiographic examination of all edentulous areas).

Data collected for each patient included: signalment (species, breed, sex, age and body weight at the time of diagnosis), main reason for presentation (i.e. missing tooth/teeth or others), number and type of unerupted teeth, direction of the unerupted teeth in the jaw, depth of inclusion (i.e. covered by soft tissues only vs. covered by bone and soft tissues), presence or absence of a clinically and/or radiographically visible cystic lesion surrounding the unerupted tooth/teeth, radiographic abnormalities of the impacted tooth/teeth and adjacent teeth, performed treatment, histopathological findings (for biopsied lesions), and follow-up findings.

Results

59 animals [55 dogs and 4 cats] with 94 unerupted teeth were included in the study. Further results and conclusions will be presented.
References


Durability of adhesion of composite filling material depending on the length of etching on enamel

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Introduction

Durability of the contact of the filling material on tooth tissue is important for the quality of filling and all prosthetic and orthodontic work. It concerns mostly filling, for which it is not possible to ensure mechanical retention. Therefore reconstruction of surface enamel and crown replacement, but also fixation of lingual buttons. In the list of important factors, significant effect has the durability of the adhesion material on tooth tissue (enamel), the length of etching, therefore the amount of disturbance of the particular surface. For humans the optimal length for necessary erosion of tissue is calculated at 20 seconds, where as in dogs this remains a topic of discussion, with estimates being up to two minutes. The goal of our work was finding the connection between durability of composite material on enamel (microretension) in connection to etching of tooth enamel.

Materials and methods

For our research we used teeth extracted from dogs due to outstanding health issues, examined in Small animal Clinic at the University of Veterinary and Pharmaceutical Sciences in Brno. The
age of the patients ranged between 10-15 years old, the patients were in the weight category of 8-14kg. Used, were the teeth from patients in which all four canines were extracted. Prior to extraction, any tooth tartar-plaque was removed, for the ensurance of purity of tooth enamel. Following extraction the teeth were preserved in 10% formaldehyde. Seven days later, the samples were rinsed with distilled water and the storage was continued with the samples kept in a dry environment. For the individual measurements, the teeth were separated in such a way that, teeth obtained from one patient underwent a closed examination, meaning that one group of teeth originated from the same dog and on each individual tooth different times for erosion were allowed.

Duration of etching was set for particular teeth on 10, 30, 60 and 120 seconds. The choice of application was between 1/3 and 2/3 of the height of the crown from the labial side.

The etching material used was the product Etching Ge (Spofa Dental a.s) composed of phosphoric acid in the concentration of 20-30% (made according to personal request). After the predetermined time of application of etching gel, the tooth was flushed with distilled water for 20 seconds and then dried. As an adhesive, we used the product Prime&Bond NT, which has been recommended by the producer. It was applied on the prepared enamel surface, lightly distributed on the entire labial surface for approximately 5 seconds and finally, adhered with use of the polymerisation light for 10 seconds.

Similarly, the adhesive is applied also to the orthodontic lingual button (Densply, no. 30-000-01). On each orthodontic lingual button was then applied, in a slight excess composite material Opticor Flow (Spofa Dental Inc.). The button was pressed against the enamel surface, the excess composite material was removed and the remaining was polymerised with the application of curing light on all 4 sides, in alternating intervals of 20 seconds. The prepared teeth were clamped into the universal tribometer MFT (Rtec Instruments, USA) in the required configuration for the tension of the test, the lingual buttons were pulled in the direction of the long axis of the tooth, excess removed, and the end position was measured and recorded. Statistical evaluation of the results was made using Student’s t-test and Friedman ANOVA test.

**Results**

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Time allowed for etching [s]</th>
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<tbody>
<tr>
<td></td>
<td>Power of force [N]</td>
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<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>26</td>
<td>65</td>
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<td>38</td>
<td>58</td>
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<td>24</td>
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<td>38</td>
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<td>100</td>
<td>60</td>
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<td>82</td>
<td>56</td>
</tr>
<tr>
<td>45</td>
<td>64</td>
</tr>
<tr>
<td><strong>mean</strong></td>
<td>57.70</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>12.45</td>
</tr>
<tr>
<td><strong>median</strong></td>
<td>59</td>
</tr>
<tr>
<td><strong>min</strong></td>
<td>38</td>
</tr>
<tr>
<td><strong>max</strong></td>
<td>76</td>
</tr>
</tbody>
</table>

Tab. 1: The resulting force in Newtons required for recession of orthodontic locks at different times of allowed etching.
The results were statistically evaluated, revealing in the following findings:

Assessment of significance of difference between two groups: parametric Student t-test. Subsequently, we have the same assessment of the values between the experimental groups, using a more accurate test, the Friedman ANOVA.

<table>
<thead>
<tr>
<th>Student's t-test*</th>
<th>ANOVA**</th>
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<tbody>
<tr>
<td></td>
<td>10s</td>
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<tr>
<td>10s</td>
<td>-</td>
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<tr>
<td>30s</td>
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<tr>
<td>60s</td>
<td>-</td>
</tr>
<tr>
<td>120s</td>
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</table>

* Results of Student’s t-test – statistically significant value compared to 60s and 120s. The other time intervals are not significant. ** Results of ANOVA – statistically significant difference between 60s and 120s. The other time intervals are not significant.

Discussion

In order for the test results to be statistically significant, the final value of the test must be less than 0.05. A highly significant result would be such, if the resulting value in the table was less than 0.01. Required value was achieved for the interval 120-60 sec and the differences in adhesion strength between these two values are, therefore statistically significant. In shorter time intervals there were no statistically significant values noted. Contrary to expectations, values when comparing duration of adhesion to etching intervals, are surprisingly balanced. Besides the extend of agitation of the enamel, for the duration of adhesions, an important role plays the type of adhesion material used (bond). For our study we used the same in all cases, the same two-step bonding system, following the standard manufacturer recommendations. In this way it was ensured that regardless of the products primary quality, findings would not be interfered with. Another negative impact to the duration of the adhesion would possible have the lack of polymerisation of the material on the underside of the lingual buttons. Given that the shape and dimensions of the buttons are standard, there should not be differences in the strength of adhesion affected by this issue. The use of the polymerisation light,
way and duration was also the same in all cases to eliminate other variables in the overall study. The light does not penetrate the buttons and this gives cause to believe that, this area in discussion has not received adequate polymerisation which would, logically, lead to lower bond strength. While the size of the buttons used and the way of lighting should have given rise to an error, the fact that in all cases the standards were kept the same, should eliminate any cause of statistical error arising from these parameters. Other factors which would alter the quality of adhesion, are biological properties of individual teeth and tooth enamel. These are not factors which can be completely excluded but, the effects can be minimised. All used teeth were from elderly individuals with macroscopically intact enamel. All teeth originated from the same size category. Thus, we tried to ensure constant quality of the enamel and approximately the same size and curvature of the tooth surface. Furthermore, the differences in curvature of the surface of the tooth could negatively affect the bonding strength of material.

**Conclusion**

The best time length to etch enamel relative to the strength of adhesion of the lingual buttons appears to be 60 seconds.

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**Feline oral diseases diagnosed by histopathology: a retrospective study of 6 years**

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Oral lesions are common in cats and may be divided into two major categories: inflammatory and neoplastic. Their exact characterization relies on a histopathological exam.

Aiming at determining the frequency of oral diseases in cats, a retrospective study was performed using histopathological reports from DNAtech Laboratory (Lisbon) from 2010 to 2015.

The 297 studied lesions were more common in males (173, 58.4%) and in 7 to 10 years old cats (88, 33.0%). Regarding breed, European Shorthair was predominant (206, 73.6%), followed by Persian (32, 11.4%) and Siamese cats (21, 7.5%), from a total of 9 purebreds. Gingiva was the most affected site (127, 43.1%), followed by oral mucosa (15.9%) and lips (8.1%). Incisional biopsy technique was selected to obtain the majority of samples (256, 86.2%), excisional biopsy in 36 (12.1%) and punch-biopsy in 5 (1.7%) cases. 186 lesions were inflammatory (62.6%) and 111 were neoplastic (37.4%), of these 81.1% were malignant. Older cats showed an increase in neoplastic diseases and a decreased in inflammatory. Benign tumors were mostly seen in younger cats, while malignant in older cats. Feline chronic gingivitis-stomatitis was the most prevalent diagnosis (115, 39.0%), followed by squamous cell carcinoma (49, 16.5%) and the eosinophilic complex (34, 11.4%).

This work, using sample cases from different location practices examined in one Veterinary Pathology Laboratory added a helpful understanding of the epidemiology of feline oral disease.

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Composite restorations

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Indications for restorations

Uncomplicated Crown Fractures: These are very common in large breed dogs. They occur when a piece of the crown is broken off, which exposes the dentin but not the pulp. Occasionally, these teeth can become infected through the dentinal tubules. Again, this infection will go undiagnosed without dental radiology. However, teeth with no to small pulpal exposures tend to be the ones with clinical abscession.

Caries: True bacterial caries are rare in dogs and almost unheard of in cats. They are most common on the occlusal surface of the upper first molars, but can be seen on any tooth. In addition, the most common breed is a German Shepherd dog. Early lesions can mimic wear, and are best diagnosed by tactile feel of the defect with a sharp explorer. If it is sticky, like wax, it is likely a caries lesion. These lesions can progress into the endodontic system resulting in pain and infection.

Enamel Hypocalcification (EH): Hypocalcification results from disruption of the normal enamel development. Ameloblasts are very sensitive and minor injuries can result in enamel malformation. Areas of enamel hypocalcification will generally appear stained a tan to dark brown (rarely black) color, and may appear pitted and rough. The tooth surface is hard however, as opposed to the soft/sticky surface of a caries lesion. The areas of weakened enamel are easily exfoliated which will expose the underlying dentin, resulting in staining. Dentin exposure will result in significant discomfort for the patient (see uncomplicated crown fractures above). The roughness of the teeth will also result in increased plaque and calculus retention, which in turn leads to early onset of periodontal disease.

Therapy

Diagnosis: First, perform a thorough visual exam to determine the presence of pulp exposure or other extensive damage. Finally, expose a dental radiograph to rule out endodontic disease. If there is radiographic evidence of endodontic disease root canal therapy or extraction is indicated.

Tooth Preparation: Scale and polish the surface of the tooth to be treated. Make sure to use fluoride free pumice for polishing to avoid interfering with future acid etching.

If treating a small uncomplicated crown fracture, no actual restoration will be placed. Therefore smooth the rough edges with a white stone or fine diamond bur. This can be followed with sanding discs if necessary.

In cases where a restoration will be placed, it is recommended to use a coarse diamond or carbide bur for the preparation. This will leave a rough surface and increase bond strength. Furthermore, all non-occlusal edges should be beveled. This will make a more gradual transition of color as well as increase the amount of enamel for bonding.

For EH cases, remove all weakened diseased enamel with a coarse diamond bur and bevel the edges.

For caries cases remove all carious dentin as well as extend the prep into area where there is a high probability of extension. Then make sure that all of the unsupported enamel edges are removed. The bottom of the prep should be flat and the sides of the dentin parallel or very slightly undercut.
Bonding

*Acid etching:* This step is performed with a 37% phosphoric acid. The purpose is to remove all impurities from the tooth surface and slightly demineralize the tooth surface of the tooth. This will lead to increased surface area for bonding. Place the supplied acid on the tooth surface and let stand for 10-30 seconds. After the prescribed time, rinse thoroughly (20 seconds) as insufficient rinsing will result in residual acid remaining in the dentinal tubules and result in sensitivity. Finally, dry the area lightly (do not desiccate) as over drying will weaken bond strength.

*Place bonding agent:* There are many options for bonding agents that fall into two main types: “One Step” which combines the primer and bonding agent in 1 bottle and “Two Step” which have separate primer and bonding agents. In addition, the self-etching systems have shown promise and are less technique sensitive.

The bonding agent should be applied in a very thin layer. After it is applied, it is light cured with an intense blue light in the visible range for 10 seconds.

Restoration

For uncomplicated crown fractures, place a layer of unfilled resin over the bonding agent and light cure. This completes the therapy.

For defects to be filled, the composite is placed and then manipulated to fill the defect. This can be done with a plastic filling instrument or a beaver tail coated with unfilled resin. Once the defect is filled (to slightly overfilled) and the restoration roughly contoured, the restoration is light cured. After light curing, the restoration can be smoothed and shaped with white stones, fine diamonds, or sanding discs. Once finished. A layer of unfilled resin should be pace to fill in areas of polymerization shrinkage and smooth the final restoration.

Follow up

The patient can eat and drink normally following the restoration. Recheck dental radiographs are strongly recommended in 6-9 months.

**Comprehensive transcriptional profiling of feline tooth resorption using next generation sequencing**

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Feline tooth resorption (TR) is characterised by destruction of mineralised tissues of the tooth by dysregulated odontoclasts. Although TR is a common dental problem in cats, the aetiology of TR remains unclear. Moreover the molecular and genetic characteristics of TR are still poorly understood. We performed a RNA sequencing (RNA-seq) analysis of TR affected (TR+) and unaffected teeth (TR-) to investigate the comparative transcriptomes of tooth resorption. The RNA-seq data were divided into three groups; ‘TR tooth’ (TR+ n=5, TR- n=7), ‘paired TR’ (paired teeth within the same cat, TR+ n=3, TR- n=3) and ‘TR cat’ (teeth from TR+ or TR- cats, TR+ n=7, TR- n=3). Significantly differentially expressed genes (DEGs) (P<0.05) between TR+ and TR- were identified; number of DEGs per group were: ‘TR tooth’ n=45, ‘paired TR’ n=1,733, and ‘TR cat’
n= 315. The number of up-regulated genes in TR+ relative to TR- were 41, 1,287 and 279, in TR tooth, paired TR and TR cat respectively. Further pathway analysis revealed that subsets of DEGs were associated with cellular pathways involved in tooth resorption and development including osteoclastogenesis and odontogenesis, extracellular space, actin cytoskeleton and calcium signalling. Here we report, as a first to date, comprehensive transcriptome profiling of tooth resorption in cats. Our result shows potentially novel transcriptional differences between TR+ and TR-teeth, which provides new insights into the molecular basis of TR.

Tooth resorption in cats affected by osteomyelitis of the jaws

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The objective of this study was to evaluate presence and type of tooth resorption in cats affected by osteomyelitis. Twenty cats treated in one Veterinary Clinic from 2007-2017 were included in the study. Inclusion was based on histopathologic diagnosis biopsy the alveolar bone. Clinical diagnosis of bone pathology was first based on presence of the significant thickening of the bone, pain, swelling of the area and purulent discharge. Radiographic features of osteomyelitis were: osteolysis, osteosclerosis and proliferation of periosteal new bone. One cat suffered from acute osteomyelitis associated with inadequate mandibular fracture fixation, the other cats had a more chronic character of the disease.

Among 20 cats there were 14 male 6 female, 14 domestic shorthaired, 2 maincoons, 1 british, 1 persian, 1 siamese and 1 siberian. Mean bodyweight was 4,76 kg (ranged 2,9- 8,9) and the mean age was 10,5years (ranged 3-16).

All had teeth with resorptive lesions at different stages (1-5). Resorptive teeth represented type 1 (only in 13 cats), type 1 and type 2 (in 5 cats), type 1, 2 and 3 (in 1 cat) and only type 2 (in 1 cat).

All cats underwent surgical treatment with teeth extractions, removal of the most affected bone followed by adequate pain management and antibiotic treatment for 6-12 weeks. (either clindamycin 11mg/kg BID, or amoxicillin with clavulanic acid 12,5mg/kg BID or cefovecin 10mg/kg every 12 days). None of the cats presented reoccurrence of the disease after treatment minimum 3 months after treatment.

References
Pain assessment in cats with dental pathology: the accuracy of a behavioral observation-based scale

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Oral cavity pain is frequently overlooked in cats. This study aimed to evaluate the adequacy of the feline acute pain scale of the Colorado State University Veterinary Teaching Hospital (CPS) to identify dental condition-induced pain and its severity1,2,3,4.

Fifty-three cats were included. All cats had an accurate oral cavity examination done, and pain presence assessed according to the CPS. Six primary dental parameters - periodontal disease, gingival index, calculus index, tooth resorption, tooth fracture and missing teeth, and 5 secondary dental parameters – mouth discomfort, halitosis, hypersalivation, difficulty in holding food and several attempts in arresting food, were compared to CPS pain scores.

All secondary parameters evaluated, were significantly associated to higher pain scores assessed using the CPS (ρ < 0.05). Concerning primary parameters, only the number of missing teeth was significantly associated to higher CPS pain score (ρ < 0.0001). Although not statistically significant, a trend was observed regarding higher CPS pain score and tooth resorption (ρ = 0.08).

The behavioral observation-based CPS seems to be very accurate in evaluating oral pain in the context of a general worsening of oral health in cats, as demonstrated by its close association to secondary dental parameters. The latter are thus good indicators of the presence of pain themselves. CPS seems to be less adequate to detect pain due to specific, thorough clinical examination-derived primary dental parameters.

Concluding, this work allowed to definitely clarifying that cats with dental disease often feel pain, and that it increases in a disease severity-dependent manner, being CPS a promising, readily-available tool in this setting.

References

Oral malignant melanoma in 6 cats (2007-2016)

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Objective: To evaluate the prevalence, diagnosis, treatment, and clinical outcome of malignant melanoma of the oral cavity in client-owned cats between 2007 and 2016 and the associated challenges of histopathologic confirmation.

Design: Retrospective case series.

Materials and Methods: Medical and dental records from the Matthew J. Ryan Veterinary Hospital of the University of Pennsylvania (MJR-VHUP) were evaluated and patients selected if they met the inclusion criteria of a confirmatory histopathologic or cytopathologic sample of oral malignant melanoma. Assessment of history, signalment, tumor location and extent, clinical signs, diagnostic imaging findings, laboratory tests, treatment modalities, and clinical outcome was performed. Cases were selected based on availability of treatment data, diagnostics, and follow-up information which was obtained from medical and dental records or via interviews with referring veterinarians. Cases were excluded if a diagnosis could not be made based on histopathology and immunohistochemistry regardless of gross appearance or behavior of the tumor.

Results: Six client owned cats were included. The cats included in this case series were mostly older (greater than 10 years of age) and presented with such large tumors that complete surgical excision was either not attempted or not achieved. One cat treated with palliative radiation therapy alone died 99 days after the last fraction. Another treated with four doses of the melanoma vaccine and definitive radiation therapy was euthanized 193 days after the last fraction due to complications of the primary tumor. 42.8% of the cases included in this series had documented metastatic disease. 83.3% of the included cases had tumors present in the upper jaw and adjacent soft tissues.

Conclusions and Clinical Relevance: Oral malignant melanoma in the cat, while rare, may be underestimated based on difficulties gaining a definitive diagnosis histopathologically. Based on the cases in this series, oral malignant melanoma in the cat may have a predilection for the upper jaw and adjacent soft tissues. Overall outcome is poor, with a quickly progressive clinical course and high incidence of metastatic disease. Local control is often difficult to impossible resulting in euthanasia due to the primary tumor.
Preliminary results of a Feline Chronic Gingivostomatitis (FCGS) study using Recombinant Omega interferon of feline origin in refractory cases

S. Thorne

The objective of the study is to evaluate the efficacy of check teeth extraction on cats with FCGS and the efficacy of interferon administration for refractory cases.

54 cats are initially included in this preliminary ongoing study from October 2007 to January 2016. Cats used in this study were referred from first opinion practise for treatment of Feline Chronic Gingivitis Stomatitis syndrome (FCGS). Inclusion criteria were the presence of caudal stomatitis, an initial Stomatitis Disease Activity Index (SDAI) score of at least 8/30 and commitment to regular review until six months post initial oral assessment. Seventeen cats were eliminated from the initial 54 due to euthanasia (for reasons other than FCGS) or failure to return for rechecks, leaving a study group of 37 cats.

Case scoring and outcomes

To quantify results, a case is considered ‘successfully treated’ if an SDAI score of 5/30 or less is recorded at a revisit. A case is considered ‘cured’ with an SDAI score of 2/30 or less is recorded at revisit. Initial scores were recorded but not considered for the treatment outcome.

Materials and methods

The cats were seen for an initial oral evaluation. A full mouth assessment (including radiographs) was performed and a Stomatitis Disease Activity Index (SDAI) score was given. All teeth were cleaned and homecare using a chlorhexidine gel initiated. Cats were reviewed after 3 weeks and a further SDAI score noted. Cats whose scores had not reduced to a ‘successfully treated’ or ‘cured’ level on improved oral hygiene proceeded to elective cheek teeth extractions, generally over two staged procedures three weeks apart. Cats were reviewed four weeks post cheek teeth extractions. Refractory cases were dispensed interferon (Virbagen Omega: Virbac) for use per os at home. The cats were further reviewed following the full course of approximately three months.

All cats in the study were tested for feline calicivirus. From October 2014 PCR tests were performed and the viral load was quantified and recorded.

The administration regime of interferon was altered in August 2010 from 5MU submucosal/intralesional injection combined with a total of 5MU given in divided doses orally for 100 days to 10MU given orally in divided doses for 100 days. This change was due to a change in accepted “best practice” following a consensus study by a group of EVDC diplomates.

Due to this change in regime, the preliminary results of this study have been divided into two groups and the results may be eventually recorded in separate studies.

Fifteen cats were given 5MU intralesional injections of interferon and then 5MU oral interferon for 100 days (regime 1). Twenty-one cats were given 10MU oral interferon for 100 days (Regime 2).

The results of three cats are still pending that have not yet been administered interferon.

Results

Results are currently under evaluation. Once evaluated they shall:
1. Evaluate the correlation between feline Calicivirus and FCGS
2. Evaluate the efficacy of cheek teeth extractions and resolution of FCGS for those FCV positive and negative
3. Evaluate the efficacy of interferon administration in refractory cases
4. Evaluate the efficacy of different administration techniques of interferon and resolution of FCGS.

**Preliminary Results**

Gender: 19 Female Neutered and 19 Male Neutered.
Mean Age (at initial visit): 5 years 7 months.

26/37 Cases FCV positive (regime 1: 10 FCV +ve cats, regime 2: 16 FCV +ve cats)
11/37 Cases FCV negative (regime 1: 5 FCV –ve cats, regime 2: 6 FCV –ve cats)

3 case results still pending reviews (2 FCV –ve, 1 x FCV +ve)
FCV +ve = 10/24 (41.7%) unsuccessful, 8/24 (33.3%) successfully treated, 6/24 (25%) cured
FCV –ve: 0/10 (0%) unsuccessful, 4/10 (40%) successfully treated, 6/10 (60%) cured

**Regime 1**
FCV +ve = 5/10 (50%) unsuccessful, 3/10 (30%) successfully treated, 2/10 (20%) cured
FCV –ve: 0/5 (0%) unsuccessful, 3/5 (60%) successfully treated, 2/5 (40%) cured

**Regime 2**
3 case results still pending reviews (2FCV –ve, 1 x FCV +ve)
FCV +ve = 4/14 (28.6%) unsuccessful, 5/14 (35.7%) successfully treated, 5/14 (35.7%) cured
FCV –ve: 0/5 (0%) unsuccessful, 1/5 (20%) successfully treated, 4/5 (80%) cured
1 case was initially FCV +ve but tested FCV –ve at revisit and result was ‘cured’. Repeat testing for calicivirus was not completed on other cases, mostly due to financial constraints of the owners.

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**The new paradigm of periodontal disease and therapy**

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**Introduction**

Periodontal disease is the number one medical condition in small animal veterinary medicine. We will begin this presentation with an overview of the pathogenesis as well as local and systemic effects of periodontal disease. This will give attendees the ability to improve client compliance with dental recommendations. In addition, a firm grasp of the disease process will improve practitioner understanding of proper treatment modalities.

Due to the plethora of new and concerning information about this condition, treatment and prevention is the subject of significant research. This focus has resulted in numerous new products and procedures to prevent and treat periodontal disease and this presentation is designed as an in-
Small animal & exotic animal dentistry

**Introduction to these new and future therapies.**

**Periodontal disease overview**

Periodontal disease is the number one health problem in small animal patients. By two years of age, 70% of cats and 80% of dogs have some form of periodontal disease. However, there are generally little to no outward clinical signs, and therefore therapy typically comes very late in the disease. Consequently, periodontal disease may also be the most undertreated disease in our patients. Additionally, unchecked periodontal disease has numerous local as well as systemic consequences.

**Pathogenesis**

Periodontal disease is initiated by oral bacteria which adhere to the teeth in a substance called plaque. Plaque is a biofilm, which is made up almost entirely of oral bacteria, contained in a matrix composed of salivary glycoproteins and extracellular polysaccharides. Calculus (or tartar) is basically plaque which has secondarily become calcified by the minerals in saliva.

It is important to note that rough tooth surfaces will greatly increase the speed of plaque and calculus formation. Therefore any rough tooth surface will increase periodontal disease. The most common cause of rough tooth surfaces are uncomplicated crown fractures, however enamel hypocalcification can cause this as well. Any rough tooth surface (especially at the gingival margin) should be restored. This can take the form of a bonded sealant or composite restoration.

Plaque and calculus may contain up to 100,000,000,000 bacteria per gram. Bacteria within a biofilm do not act like free living or “planktonic” bacteria; and in fact are 1,000 to 1,500 times more resistant to antibiotics than are planktonic bacteria. Plaque on the tooth surface is known as supragingival plaque. Once it extends under the free gingival margin and into the area known as the gingival sulcus (between the gingiva and the teeth or alveolar bone), it is called subgingival plaque. Supragingival plaque likely affects the pathogenicity of the subgingival plaque in the early stages of periodontal disease. However, once the periodontal pocket forms, the effect of the supragingival plaque and calculus is minimal. Therefore, control of supragingival plaque alone is ineffective in controlling the progression of periodontal disease.

Initial plaque bacteria consists of predominately non-motile, gram-positive, aerobic facultative rods and coccis. Gingivitis is initiated by an increase in the overall number of bacteria, which is primarily motile gram negative rods and anaerobes.

The inflammation produced by the combination of the subgingival bacteria and the host response damages the soft tissue attachment of the tooth, and decreases the bony support via osteoclastic activity. This causes the periodontal attachment of the tooth to move apically. The end stage of periodontal disease is tooth loss; however the disease has created significant problems prior to tooth exfoliation.

**Clinical features**

The first obvious clinical sign of gingivitis is erythema of the gingiva. However, it is now known that the FIRST evidence of gingivitis is bleeding during brushing, probing, or after chewing hard/rough toys. Therefore it is important to realize that normal appearing teeth/gums can actually be infected. If the first stages of gingivitis are not treated, it will progress into edema, spontaneous bleeding, and halitosis.

The hallmark clinical feature of established periodontitis is attachment loss. In other words, the periodontal attachment to the tooth migrates apically. As periodontitis progresses, alveolar bone is also lost. On oral exam, there are two different presentations of attachment loss. In some cases, the apical migration results in gingival recession while the sulcal depth remains the same. Consequently, tooth roots become exposed and the disease process is easily identified on conscious exam. In other
cases, the gingiva remains at the same height while the area of attachment moves apically, thus creating a periodontal pocket. This form is typically diagnosed only under general anesthesia with a periodontal probe. It is important to note that both presentations of attachment loss can occur in the same patient, as well as the same tooth. As attachment loss progresses, alveolar bone loss continues, until tooth exfoliation in most cases. After tooth exfoliation occurs, the area generally returns to an uninfected state, but the bone loss is permanent.

**Severe local consequences:**
- oral-nasal fistula (ONF)
- class II perio-endo abscess.
- pathologic fracture
- blindness
- oral cancer

**Severe systemic manifestations:** Systemic ramifications of periodontal disease are also well documented. The inflammation of the gingiva and periodontal tissues that allows the body’s defenses to attack the invaders also allows these bacteria to gain access to the body. Recent animal studies suggest the possibility that these bacteria negatively affect the kidneys and liver, leading to decrease in function of these vital organs over time. Furthermore, it has also been suggested that these bacteria can become attached to previously damaged heart valves (IE valvular dysplasias) and cause endocarditis, which in turn can result in intermittent infections, and potentially thromboembolic disease. Other studies have linked oral bacteremias to cerebral and myocardial infarctions and other histological changes. Additional human studies have linked periodontal disease to an increased incidence of chronic respiratory disease (COPD) as well as pneumonia. There are many studies that strongly link periodontal disease to an increase in insulin resistance, resulting in poor control of diabetes mellitus as well as increased severity of diabetic complications (wound healing, microvascular disease). Additionally, it has been shown that diabetes is also a risk factor for periodontal disease. Periodontal disease and diabetes are currently viewed as having a bidirectional interrelationship where one worsens the other.

**Periodontal therapy**

“New” methods and products for periodontal disease treatment and prevention can be grouped into three different treatment areas:

1. Control the infection (pathogen control).
2. Decrease the amount inflammation and/or bone destruction by the host (host modulation).
3. Re-grow lost bone (guided tissue regeneration).
4. Extraction (the ultimate pathogen control).
Tip the scales – Understanding the secret of power-driven scalers

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Brno, Czech Republic

The lecture presents power-driven scalers – their history, principle of function, working properties, rules of proper use, risks of iatrogenic damage, operational hazards, and optional devices. In general, power-driven scalers are very popular in veterinary periodontology. Their effectiveness in calculus removal and relative affordability ensured that they can be found in almost every veterinary practice. However, operator must be aware of the basic rules of use and not underestimate possible risks and operational hazards.

Power-driven scaler is one of the most common and popular devices in veterinary dentistry nowadays – up to the extent that the rather complex procedure of professional dental examination and treatment got the nickname „scale & polish“. First scalers were developed in the 1950s when their intended purpose was cavity preparation. However, since the 1960s, many clinicians found them useful in tartar removal and that is the prevailing use of this devices in today’s practice – both human and veterinary dentistry (Lea and Walmsley 2009).

The crucial part of scaler is its working tip. Tips are manufactured in various sizes and shapes for different purposes – dental tissue cutting, better calculus removal, suitability for subgingival use etc. Therefore, power-driven scalers are multi-purpose devices. The principle of calculus removal (scaling) is quite simple; integrity of the calculus layer on the dental surface is disrupted by high frequency oscillation of the tip. The oscillation is generated by semiconductor crystal (piezoelectric scaler), coil with a ferromagnetic core (magnetostrictive scalers), or pressurized air (pneumatic scalers). Tip’s frequency can reach 25-42 kHz (ultrasonic devices – piezoelectric and magnetostrictive) or 2-6 kHz (sonic devices – pneumatic). Such high frequency movement requires cooling of the tip – either internal or external system of water cooling. The tip trajectory can be linear (piezoelectric devices) or elliptical (magnetostrictive devices). Tip movement amplitude depends on the device type: Ultrasonic devices have lower amplitude of ca. 10-100 µm whereas in sonic devices the amplitude is around 500 µm. Additionally, the tip vibration in the cooling liquid causes cavitation – microscopic unstable bubbles form and almost immediately collapse. This creates free radicals and pulse waves, both harmful for the common oral cavity bacteria. Cavitation depends on tip frequency, amplitude, and the device power. However, there are also studies which question the effect of power-driven scalers on bacteria vitality. Their data showed just a marginal effect of cavitation; even the power settings influenced the effect in a non-linear manner (it rose rapidly only when the highest power settings were used). Moreover, currently there is no study which would show a significant difference between hand and power-driven instruments regarding the effect on oral microflora.

Proper use for calculus removal has several basic rules. Highest power settings should be avoided. The working tip’s lateral surface should be applied parallel to the calculus surface. Short overlapping strokes with only slight (“featherlike”) pressure applied ensure gradual calculus detachment; the movement should be constant and a single tooth shouldn’t be treated for too long time (many authors recommend up to 15 seconds at once, some even 5-7 seconds). Therefore, it is advisable to perform the scaling systematically, treat all the teeth and return occasionally to the ones with more problematic calculus layer. Every time the scaler is being used, its tip must be cooled with water. Unless a special tip is used, power-driven scalers shouldn’t be used subgingivally.

These rules help to avoid unnecessary iatrogenic damage to dental tissues. Rapid movement of
the tip is not only effective in damaging the calculus surface but can also damage the enamel or cement layer. There are two main types of possible damage: Mechanical and thermal. Treatment of one place for prolonged time can damage the dental surface mechanically; even more when the point of the working tip is used. Typical situation is cleaning of the grooves on crown surface, e.g. the deep groove on the buccal side of upper fourth premolar. Surgeons and technicians are often tempted to treat such areas with the tip’s point and for a long time. Dealing with certain types of tartar which adhere to enamel firmly and can be removed only in tiny flakes is challenging, too. Another typical risk factor is any structural defect of enamel – rougher-than-usual surface is harder to scale. Mechanical damage can be so severe that the enamel layer could be penetrated. Although the sonic devices are believed to be safer, recent study showed comparable mechanical damage caused by piezoelectric and sonic device. Unfortunately, it was shown that even different tips of the same type show differences in movement characteristics. Therefore, the prediction of damage potential is difficult.

Some studies of subgingival periodontal treatment show that the more experienced device operators removed higher amount of calculus and caused less damage to the dental surface. Thermal damage is a possible consequence of scaler tip’s movement restrain or insufficient cooling – whenever the tip gets stuck in a tight place between tissues, is pressed against the calculus surface too much or is inserted into deep pockets, the excessive energy converts to waste heat. Although there are several studies to prove or disprove the heat alteration of dental tissues with mixed results, most authors are cautious and advise not to underestimate it. Most commonly mentioned consequence is aseptic pulpitis.

Separate category of complications of power-driven scaler use are operational hazards. Both the patient and the personnel can be affected by aerosol containing not only water but saliva, calculus fragments, bacteria etc. Safety precautions to protect the patient include rinsing of the oral cavity with chlorhexidine solution, endotracheal intubation with inhalation anaesthesia and monitoring, and gauze packs placed in the pharynx; suction devices are helpful, too. The personnel should always use masks, eye protection, gloves, and protective clothing; this is hopefully mandatory at every dental workplace without exception as well as meticulous cleaning of equipment and environment after each treatment. Moreover, vibrations generated by the power-driven scalers can affect small nerves and vessels in operator’s hands and ultimately cause Raynaud’s syndrome (or “white finger disease”). In severe cases, strength and sensitivity of operator’s fingers can be significantly affected. Time of use of these devices should be limited to a necessary minimum and operators should follow advice of the proper specialist in the field of neurology and rehabilitation regarding the exercise of affected nerves and muscles.

Considering the calculus removal, there are few viable options to power-driven scalers. Laser devices, demineralization and chemical scaling techniques are beyond the scope of this article. The most common alternative are hand instruments – scalers, sickles, curettes etc. These are cheap but demand certain level of skill, experience and care to achieve proper results and avoid unwanted iatrogenic damage to patient’s tissues. Many veterinary clinicians prefer power-driven instruments as they seem to remove the calculus faster and with less effort. It is disputable as massive calculus layers are much easier to remove with hand instruments. Another example – buying a Gracey curette to be able to perform safe subgingival scaling is obviously cheaper than getting a specialised tip for power-driven scaler. Most studies don’t favour one type of instruments over another, instead recommending the combined use. It seems reasonable to perform the initial removal of gross amounts of calculus with hand instruments and then commence with the finer work with power-driven scaler.

**Recommended reading**


microbiome of five advanced occlusal caries lesions in two domestic dogs

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Objective: Determine whether the supragingival plaque microbiome present at advanced occlusal caries lesions in dogs differs when compared to healthy sites, and whether it resembles that reported in people with advanced caries lesions.

Animals: Two client-owned dogs with advanced occlusal caries lesions; 17 control dogs.

Procedures: Supragingival plaque samples of 5 clinically-diagnosed caries lesions were obtained from 2 dogs. Affected teeth were extracted; 2 were analyzed histopathologically. Two samples were cultured using standard techniques. Molecular analysis of the 5 samples and of 29 clinically healthy control sites was performed via amplification and sequencing of the 16s rRNA gene.

Results: Histopathological findings confirmed advanced caries lesions at analyzed teeth; cultures revealed Lactobacillus spp., and Streptococcus spp. Molecular analysis revealed that the microbiome at healthy sites was more diverse compared to caries sites, and that the families Lactobacillaceae, Co-
riobacteriaceae, Veillonellaceae, Prevotellaceae, Bifidobacteriaceae and Streptococcaceae were more abundant at caries versus healthy sites.

**Conclusions:** The microbiome detected at advanced caries lesions in dogs differed significantly in its taxonomic composition and diversity compared to healthy sites, and closely resembled that reported in people in regards to the most abundant taxa.

## The canine oral microbiota: insights into the uniqueness of dental plaque

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Periodontal disease is the most widespread oral disease in dogs; it is accepted that the bacteria present in dental plaque are the aetiological agent. In recent years a number of studies have been completed which highlighted the microbial diversity of canine plaque. This new research has challenged the long held opinion that the canine oral microbiota reflect the communities identified in humans. In a large scale survey of plaque from client owned dogs over 80% of the taxa identified were novel and only 16.4% were shared with the human oral microbiota. Key bacterial species implicated in human periodontitis, including Treponema denticola, Tannerella forsythia and a close relative of Porphyromonas gingivalis, were present in dog but not strongly associated with the disease. Furthermore, from a microbial perspective, periodontal disease can be characterised by a reduction in previously relatively abundant health-associated species. Additional work to understand how the plaque biofilm forms on the tooth surface has revealed that the early coloniser species in dogs are not the same as those which initiate the parallel process in humans. This presentation will focus on the recent advances in our understanding of the canine oral microbiota, drawing attention to the large differences between canine and human plaque bacteria. The findings are important because they highlight that products targeted at human oral bacteria may not be efficacious for the prevention of gum disease in dogs.

## Endodontic complications, avoidance and repair

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Endodontic therapy is becoming increasingly common in veterinary medicine. It is a very technically demanding procedure, wrought with potential pitfalls. Most improper/failed endodontic therapies will not result in outward clinical signs, however the patient still suffers. Therefore, perfect
performance and routine recheck radiographs are critical to maintain patient health. Root canal therapy has three ordered components: access, cleaning and shaping, and obturation. They are separate steps, but each one builds upon the prior. This chapter will discuss common complications which occur during the procedure, keys to their avoidance, and correction when they occur.

**Step 1: Access**

It has been stated that failure to achieve proper access is one of the most common complicating factors for veterinarians. Therefore, careful access is crucial to proper endodontic therapy.

**Improper access placement:** The goal is straight line access to the apex therefore, the fracture site is not a good access site except for some incisor teeth and occasionally the maxillary canines in cats. When used as access, ledging and transportation commonly occur. To avoid this error, make sure to follow the correct placement.

If you determine that your access is incorrect during the procedure, there are several options for repair. If the access is only slightly off, consider enlarging the access in the direction of the ideal. If it is significantly incorrect, make a new access site.

**Improper access size:** The law of tooth conservation dictates a small hole to retain as much tooth strength as possible. However, insufficient access will bind the file in the coronal area, preventing it from following the canal curves or irregularities. This can result in errors of instrumentation such as ledging, gouging, or zipping (see below). In addition, the master file or cone will bind in the access, giving the erroneous feeling that the canal is completely cleaned, leading to short fills.

Prudent practitioners avoid this by approximating the master file based on pre-operative radiographs. Utilizing the anticipated master file and working length create the access slightly larger than the diameter of the calculated master file at the access point.

The repair for an undersized access is to enlarge the site to the proper size as soon as the error is realized. An overlarge access cannot be fixed. However, if a significant amount of crown has been removed, thus weakening the tooth, a crown is strongly recommended.

**Furcational perforation:** Overzealous use of a bur during access preparation can result in the perforation of the floor of the pulp chamber in the furcation of the tooth. This often offers a poor prognosis. In fact, more coronal perforations have lower prognoses.

Perforations can be avoided by approximating the distance to the floor of the tooth and advancing very slowly in the apical direction. Stop regularly during the access preparation and use a pathfinder or explorer to feel for the pulp chamber. Once the pulp chamber is exposed, there is no need to proceed apically.

If perforation occurs, the first step is to repair the defect. Prior to repair, the endodontic system should be protected against contamination with medicants and restoratives with paper or gutta percha points. Next, the defect is prepared to accept the barrier/restorative if necessary. This process is ideally performed with ultrasonic instruments However, as access perforations are generally caused with a bur, further preparation is generally unnecessary.

After preparation, hemostasis is achieved with cotton pellets or paper points. If this is ineffective, calcium hydroxide can be placed in the defect and allowed to sit for 4-5 minutes. Following this, it should be rinsed with dilute sodium hypochlorite. Two to three applications is generally sufficient for hemostasis. If hemostasis is still not achieved, consider placing the calcium hydroxide and temporarily filling for 2 weeks prior to continuing endodontic therapy. Another valid option at this point is extraction or hemisection. Other options for this step are collagen, calcium sulfate, freeze-dried bone, and MTA. Other hemostatic agents (such as ferric sulfate) are not recommended.

Following hemostasis, a barrier must be placed to protect the tissues adjacent to the perforation. There are many options for this step including the resorbable barriers of collagen and calcium ci-
These products require the subsequent placement of a non-resorbable restorative. MTA is non-resorbable and has excellent biocompatibility. Therefore is the current restorative and barrier material of choice.

After the defect is repaired, the canal(s) can be instrumented and obturated normally.

**Step 2: Cleaning and shaping**

Improper working length: Working length is approximated by measuring the distance on the pre-operative radiographs and gently introducing a small file to the apex and then exposing a dental radiograph. After the depth is determined, the endodontic stop is moved to the access point, the file removed and the distance measured. Once determined, all files are armed with endostops at the correct point and then files used to the working length.

If the practitioner does not determine working length correctly, the entire process of instrumentation will be performed erroneously. In general, a working length error will be short of the true apical contracture, leading to underextension/underfill. In cases of a significantly diseased apex, the file may be extended through the apex. This will result in overextension/filling if not corrected.

This error can be avoided by:
1. Approximating the working length by studying the pre-operative radiograph.
2. Gently advancing the working length file to the approximated apex.
3. Properly exposing and interpreting the working length radiograph.
4. Properly placing the endostop, measuring, and marking all subsequent files.
5. Exposing regular radiographs during the shaping procedure to ensure that work continues to the entire canal length.

If the working length was underestimated, reestablish the working length as soon as possible, remark all the files appropriately, and utilize the new working length.

If it was overestimated, hemorrhage will generally result as the file will traumatize the periapical tissues. This will often be evidenced by fresh hemorrhage from the apex. If this occurs, the first step is to control hemorrhage with paper points.

There are 2 options for sealing the apex.

**Backup technique:** Re-establish the working length radiographically, 1-mm short of the apex. Then carefully “overfile” the apex creating a “stop” at that point and obturate normally. In these cases, an open apex has been created, so caution must be taken with irrigation to avoid a hypochlorite accident. In addition, consider utilizing a sealer which is less inflammatory as overfill is a possibility. This technique has been clinically successful, but remains controversial.

**MTA seal technique:** This is the most proper technique for obtaining a quality apical seal. It consists of finishing the standard endodontic therapy and then placing a “plug” of MTA at the apex. The product is mixed according to package directions and placed to the apex. This can be via a customized needle or an endodontic trowel. Ideally, this is allowed to set prior to filling. This is accomplished by placement of a temporary filling material and performing obturation approximately two weeks later. However, the additional anesthesia is a concern, and so many veterinary dentists carefully obturate during the same anesthetic event.

Once obturation has been perfected, there are two options:
1. Give the case the “benefit of the doubt” and recheck in 6 months.
2. Perform surgical endodontics.

If properly obturated, these cases still have good prognosis and thus surgical endodontics should be reserved for future visits if failure occurs. Other authors may argue for immediate surgical endo-

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2 Capset: Lifecore Biomedical. Chaska MN.
dentists or even extraction of these teeth. These approaches, while more invasive, are more definitive. Therefore, the client should be informed of the complication. For strategic teeth however, the risk: benefit ratio is still on the side of standard root canal therapy.

**Ledging, zipping, and gouging:** Apical filing must be performed in a rotary manner with a feather light touch. Therefore, H-files are not recommended at the apex. Ledging or gouging the canal is common when too much apical force is applied.

This can be avoided by utilizing the correct instruments with a careful touch at the apex. Furthermore, identifying and respecting the three dimensional character of the endodontic system will help minimize the risks. Finally, exposing regular, intraoperative radiographs will help avoid this issue.

If ledging occurs, return to a small file size which is significantly pre-bent (almost 90 degrees at the tip), and carefully introduce it to the apex. This may require gentle turning at the ledge to find the canal. Enlarging the access to allow more freedom of movement for the files may also be beneficial. Once the apex is achieved and confirmed radiographically, the file is carefully moved up and down in very small strokes (1-2 mm). Always make sure to stay apical to the ledge. Once the small file is moving freely in the canal, longer strokes are utilized to smooth the ledge. Utilizing “anti-curvature” filing will help to remove the ledge. Finally, slowly and very carefully increase file sizes until instrumentation is complete. Exposing regular intraoperative radiographs will help ensure that the defect is not being recreated.

**Incomplete instrumentation:** The operator should have a rough idea of the master cone size based on the pre-operative radiograph. Two additional indications of complete filing are clean white filings and file binding at the apex. Most texts recommend filing to the third file size to bind at the apex. The master point should reach the apex and fit snugly, ideally creating “apical tug back”.

Incomplete instrumentation can be avoided by exposing a radiograph to assure that the point properly fills the apex. More than one view is ideal to help ensure a complete three dimensional fill.

If the master point does not fill the apex, return to instrumenting and continue until the fill is proper.

**File separation:** There are two main causes of file separation. The first is using old, damaged/weak files. The other is binding the file in the canal. If the file is turned excessively, binding and file separation can occur. File binding generally occurs when significant rotary motion (reaming) is performed with excessive apical pressure. Additionally, using H files in a reaming motion will rapidly result in canal binding. Once separation has occurred, endodontic therapy is made exceedingly challenging.

Always ensure the type of file, and utilize it in the correct manner (see chapters 2 and 6 for a complete discussion of files and instrumentation). Always use instruments with a feather touch and avoid overzealous rotation and apical pressure. When working on a constricted canal, use a “watch winding technique” and generous amounts of lubricant.

It is exceedingly rare for files to suffer from manufacturer’s defects, which means new files are very reliable. Oftentimes however, after just a few uses (even on the same patient), strain will start affect the file. This is especially true if the files are “prebent”. Files should be replaced for each patient, or at least routinely. If a practitioner is reusing files (which is somewhat understandable especially with the more expensive “veterinary length” files) they should be carefully cleaned and inspected (and ideally sterilized) between patients. An area of smoothness in the fluted area is indicative of a weak area and the file should be discarded.

If file separation occurs, there are several options for resolution.

1. If possible, remove the fractured file. If the file was fractured near or at the access (which is where “lightspeed” files are designed to break), removal should be fairly straightforward. If the fracture occurred deep in the canal, removal will be difficult to impossible. Filing around the file can as well as enlarging the access can be beneficial in some cases. Other helpful
instruments include an ultrasonic endodontic tip to loosen the segment and magnetized instruments for retrieval.

2. If the instrument cannot be removed, attempt to file around the obstruction and obtain a good seal. If this is possible, the prognosis should not be significantly decreased. The canal should be especially well lavaged with bleach to disinfect the file and canal. The canal is then cleaned and obturated normally. If obturation is adequate, a fair to good prognosis is still likely.

3. If the obstruction cannot be removed or negotiated, a surgical root canal or extraction should be performed.

**Hypochlorite accidents:** Sodium hypochlorite is highly corrosive and should never be forced periapically. Irrigation should be performed with a side exit endodontic needle without excessive pressure. Extreme care must be taken in the presence of diseased or barely complete apicies as they are more porous than mature/healthy ones.

The apex is ideally opened to at least an ISO size 25 file prior to irrigation to avoid forcing the irrigant peri-apically. It is critical that the irrigation needle not bind in the canal.

If an accident occurs, it is usually evidenced by a sudden change in the anesthetic plane of the patient during or right after irrigation. This typically occurs in spite of good surgical anesthesia including regional nerve blocks. This is evidence of the significant pain and inflammation created by the extrusion of the irrigant. Furthermore, immediate apical hemorrhage is a common consequence.

Treatment includes encouraging drainage from the root canal with suction and lavageing the canal with sterile saline to remove and dilute the bleach solution. In human dentistry, continued drainage is often allowed by leaving the tooth open for a short time if drainage is persistent. This is controversial in veterinary dentistry due to the anesthetic requirements. However, in cases with significant extrusion of solution, this should be considered.

The owner should be warned to expect some post-operative swelling and that follow-up care/monitoring is critical. In addition, pain medication and anti-inflammatories (NSAIDs or corticosteroids) are indicated and antibiotics should be considered. Finally, cold compresses should be performed to decrease pain and swelling.

**Step 3: Obturation**

A complete, homogeneous fill of the entire canal without voids is critical for endodontic success. The most critical area of the fill is the apex, but any defect can lead to failure.

**Underfill:** With cold gutta percha techniques, underfill generally occurs due to an inappropriate mastercone size. This error can therefore typically be avoided by careful radiographic study of the master cone prior to obturation. If utilizing softened gutta percha, underfill can occur secondary to an insufficient canal width to accept the cannula, or to inadequate vertical condensation.

Correction of cold gutta percha errors depends on the position of the defect(s).

If the post-operative radiograph reveals a less than ideal apical fill, the cone should be removed and replaced with the appropriate file. If the point stopped short, it should be replaced with one smaller size. If it does not fill the apex, one size larger should be selected. If obturation of the apex is not optimal after a few attempts, instrumentation should be repeated. If the apical seal is radiographically adequate with coronal voids, lateral condensation should be performed to complete the obturation. If this step is ineffective, the obturation should be removed and the canal reobturated. If obturation is not optimal after a few attempts, consider reshaping the canal to allow a proper fill.

For softened systems, attempt further condensation. If this is ineffective, remove the material and repeat obturation.

**Removal of gutta percha:** This removal is facilitated by softening the core filling material. This
can be performed via heat (e.g. touch and heat system), ultrasonic instrumentation, rotary files, or chemicals. Chemical softening with chloroform is the most common and effective method for this, but it is highly inflammatory. Other options include xylol, turpentine, eucalyptol, and orange oil. Chemical removal is generally accomplished by placing the agent on the gutta percha and carefully “pecking” away the softened material. Once this is accomplished, the residual GP, sealer cement, solvent, and smear layer is removed with paper points (wicking). This (Note that these same methods can be utilized for retreatment, see below)

**Overfill/overextension**: This is a fairly common complication in cases of a diseased, damaged, or barely mature apicies. It can also occur with overzealous vertical condensation. If the apex is immature or diseased, consider utilizing a less irritating sealer cement (such as CaOH or glass iomomer).

These complications can be avoided by a few meticulous steps which include: careful apical preparation, selecting a proper master cone, and not placing too much apical pressure when condensing.

If overextension occurs with solid gutta percha, attempt to carefully remove the point.

In cases where the point cannot be removed and/or there is significant cement extrusion there are several options.

1. Obturate and restore normally and monitor. This author has seen minimal complications in these cases, provided the extrusion was not severe.
2. Perform surgical endodontics. Make sure to thoroughly debride and lavage the extruded cement and gutta percha from the periapical area.
3. Extract the tooth. Again, make sure to thoroughly debride and lavage the extruded cement and gutta percha from the periapical area.

**Treatment of failed standard endodontic therapy**: There are numerous causes of failure of standard root canal therapy, but when properly performed it has an excellent prognosis. Avoid failures by meticulous cleaning and shaping, adequate disinfection, and perfect obturation and restoration.

If obturation of the standard root canal therapy is radiographically inadequate, reinstrumentation and obturation is performed (retreatment). If the obturation appears radiographically sufficient, this can be attempted, but success is much less likely. The options for well performed initial therapy that fails are surgical endodontic therapy or extraction.

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**Constructing a client survey**

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The construction and validation of questionnaires is an important topic. Survey methodology is a field of research in itself, and basic knowledge of this is essential when using questionnaires in research, but it is also a valuable tool e.g. when measuring customer and staff satisfaction. The most important thing to keep in mind is the goal of the survey. The next step is to decide if the survey will be
quantitative or qualitative, decide the target group and do a random selection of this group. When constructing the questions great care should be taken so that the questions and answering alternatives are easy to understand and not misinterpreted. It’s therefore important to avoid difficult words, negations, metaphors, leading questions and assumptions. A cognitive interviewing of persons that match the respondents give further information and is a step in the validation process. A pilot-study is carried out and the questionnaires adjusted accordingly. Statistical analysis from the pilot-study gives information about validity and reliability of separate questions as well as batteries of questions and this is used to fine-tune the questionnaires before sending it out to the final respondents. When analyzing the final results a fall-out analysis of the non-responders should be made, and it’s of absolute importance to use the proper statistical tools so that the right conclusions are drawn.

**Persistent oral canine viral papilloma type one (CPV-1) lesion undergoing malignant transformation into an oral squamous cell carcinoma (OSCC) in a dog**

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The primary goal of this case report is to inform the reader of a rare case of a persistent oral Canine Viral Papilloma type one (CPV-1)-induced lesion that underwent malignant transformation into an Oral Squamous Cell Carcinoma (OSCC) in a three and a half-year-old Labrador retriever cross dog. Initially, the patient had multiple and multifocal cauliflower-like lesions populating the oral cavity exclusively. The papillomas had persisted despite multiple surgical ablations, azithromycin, interferon alpha 2b, alternative medicines and off-label use an immunostimulant. After one year and six months, the most aggressive lesion had developed at the level of the left mandibular first molar (309) and had progressed to well differentiated invasive OSCC. The presence of CVP-1 DNA in the OSCC, and the known oncogenetic abilities of CVP-1, suggests that this virus might have played a significant role in the emergence of the OSCC that ultimately led to the patient’s euthanasia due to poor quality life. This is the first well-documented case where OSCC has developed from an oral papilloma (CVP-1) infection in which the presence of co-infection by another papilloma virus was excluded by multiple polymerase chain reaction (PCR) tests using various primers.
Ankylosis and pseudoankylosis of the temporomandibular joint in dogs: 10 cases (1993-2015)

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Objective: To describe the clinical features and results of treatment of true ankylosis and pseudoankylosis of the temporomandibular joint (TMJ) in dogs.

Design: Retrospective case series.

Methods: Ten client-owned dogs that were presented for inability to open the mouth or a severely decreased range of motion of the TMJ were included. Information on the surgical procedures performed and the perioperative complications were documented. Three-dimensional printing of the skull was performed in four dogs.

Results: Two dogs were diagnosed with TMJ ankylosis and seven dogs with pseudoankylosis. One dog had evidence of combined TMJ ankylosis and pseudoankylosis. Of the seven dogs with pseudoankylosis, six had an osseous fusion involving the zygomatic arch and mandible. Surgical treatment was performed in nine dogs and a revision surgery was needed in one dog. Follow-up ranged from five months to eight years (mean: 48.6 months). Eight out of nine dogs that were treated surgically regained the ability to open their mouth, but six dogs never regained a fully normal TMJ range of motion.

Clinical significance: Temporomandibular joint ankylosis and pseudoankylosis are uncommon in the dog. Surgical treatment for TMJ ankylosis or pseudoankylosis in dogs is a successful option and carries a prognosis dependent on patient-specific abnormalities. Computed tomography complemented with three-dimensional printing is valuable for understanding the extent of abnormalities and for preoperative planning.

Morphological study of naturally-occurring clefts of the lip and/or palate in domestic dogs

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Objective: Systematically document the morphology of cleft lip (CL), cleft palate (CP), and cleft lip and palate (CLP) in dogs, determine whether defect morphology varies among affected individuals, and whether the morphological variations observed in dogs resemble those described in people.

Animals: 32 client-owned dogs with naturally-occurring clefts of the lip and/or palate that had
received a computed tomographic or cone-beam computer tomographic scan of the head prior to any surgical procedures involving the oral cavity or face.

**Procedures:** Patient demographic information and skull type were tabulated; the anatomical forms of each defect were recorded using the LAHSHAL classification based on computed tomographic findings and clinical images; other defect morphological features were documented including shape, relative size, facial symmetry, and vomer involvement.

**Results:** Nine anatomical forms were observed based on the LAHSHAL classification in 32 dogs. Two anatomical forms were observed in 23 dogs with CP with differences in defect shape and size present, as well as vomer abnormalities. Seven different anatomical forms were observed in 9 dogs with CL or CLP, most showing incisive bone abnormalities and facial asymmetry.

**Conclusions:** The morphological features of CL, CP and CLP in dogs are complex and vary among affected individuals. The morphology of clefts may impact surgical planning and is relevant for scientific documentation.

**Outcome of cleft palate repair in dogs:**
**26 cases (2007-2016)**

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**Objective:** Report the clinical outcome of cleft palate repair in dogs; and determine whether age and body weight at the time of repair, history of previous surgery, skull type, surgical technique used, and defect severity are associated with outcome.

**Animals:** 26 client-owned dogs that underwent cleft palate repair.

**Procedures:** Medical records were reviewed. Relevant demographic, surgical, and clinical data was collected; advanced diagnostic images were reviewed. Pertinent data was categorized and tabulated. Statistical analysis using chi-squared and Fisher’s exact tests were applied to determine possible associations between outcome and age and body weight at the time of initial repair, history of previous surgery, skull type, the surgical technique used, and defect severity.

**Results:** Clinical success was achieved in 84.6% of patients. The incidence of oronasal fistula formation after initial repair was 42% and 15% for the hard and soft palate respectively. No association between outcome and age at the time of repair, history of previous surgery, skull type, surgical technique, or defect severity was observed; patients weighing less that 1 kg at the time of surgery had a significantly poorer outcome.

**Conclusions:** The success rate of cleft palate repair surgery is high in dogs regardless of the age at the time of repair, defect severity, history of previous surgeries, skull type, and the surgical technique used; dogs weighing less than 1 kg at the time of repair have a poorer outcome; oronasal fistula formation and revision surgery are common after cleft palate repair in dogs.
Oral and dental diseases in a family of zoo suricates (Suricata suricatta)

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Suricates are common ZOO species. However, data on their oral and dental diseases are rare. The objective of this report was therefore to describe oral and dental diseases in a family of ZOO suricates. In this cross-sectional clinical study, detailed oral and dental examination and full-mouth dental radiographs were performed in 6 suricates undergoing general anaesthesia for their regular annual wellness check. Attrition/abrasion was commonly observed, less so were dental fractures, but both conditions were found to be associated with endodontic disease. Periodontal disease of different stages was also commonly observed. Dental radiography was essential to determine dental anatomy, to accurately diagnose oral and dental diseases and to plan treatment. This report indicates that several painful oral and dental diseases can affect suricates in captivity, likely influencing their well-being. Thorouglh oral and dental examination supported by dental radiography under general anaesthesia is quick and simple, and should be performed as part of annual wellness checks in these animals.

References


Oral and dental pathology in beech marten (Martes foina)

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In our study 114 beech marten skulls from Slovenian Museum of Natural History were examined by means of visual inspection and full-mouth intraoral radiographs. All visual findings were recorded in the beech marten dental chart and selected findings were also photographed. All data and radiographs were subsequently evaluated on a tooth-by-tooth basis.

Majority of the skulls were determined to be mesaticephalic, but some dolichocephalic skull types were also identified. Most common type of incisor occlusion was described as a „level bite“; incisor scissor bite (with all maxillary incisor teeth positioned rostral to the corresponding mandibular incisor teeth) was less common. Presence of the mandibular and maxillary first premolar teeth varied among the specimens. Another commonly observed anatomical variation was the number of roots of the maxillary first molar tooth, with buccal mesial and distal roots commonly fused. Several other anatomical variations in presence of the teeth and tooth and root form were occasionally observed.

The most frequent dental pathology finding was attrition/abrasion, most commonly affecting incisor teeth. Dental fractures associated with lesions of endodontic origin were also commonly diagnosed. Contrary to our expectations and to findings previously observed in European polecats, several types (classes) of skeletal malocclusions were noted. Occasionally, impacted teeth were noted, most commonly canine teeth. Several skulls were diagnosed with bony changes, but it was not always possible to classify the lesions further. Surprisingly low was the occurrence of periodontitis.

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Diagnosis and treatment of dental disorders in a research colony of *Macaca fascicularis*: A case series

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**Introduction**
During the daily general health controls and routines in a Non-Human Primates (NHPs, *Macaca fascicularis*) research colony, a variety of bucco-dental pathologies as broken tooth, caries or gingivitis were identified. Dental pathology may lead to local or distant infection, pain, and distress, hindering the well-being of the animals.

Therefore a dental care program was deemed necessary to reliably diagnose the dental pathologies below the pic of the iceberg and provide state of the art treatment.

**Material and Methods**
The animals of this case series are part of a research colony of *Macaca fascicularis*. They were 9 to 22 years old and weighing between 5.6 and 12.2kg.

The animals were examined under general anesthesia by a veterinary dentist and treated immediately if needed.

**Results**
During the first two years of the program, 31 animals were examined and treated under general anesthesia. Based on the clinical and radiographic examination of the dentition, four main dental diseases were diagnosed: periodontal disease, caries, tooth fracture, and tooth attrition. Some less frequent pathologies were found like dental abscess, enamel hypocalcification, gingival hyperplasia, hypercementosis, tooth luxation, tooth dysplasia, root resorption, abrasion.

Four NHPs out of 31 (13%) had no serious dental pathology except calculus, plaque, mild gingivitis slight abrasion or missing teeth. Scaling and polishing was the only treatment needed in these cases.

Periodontal disease was the most common disease. Calculus and plaque were present in every animal combined with mild to moderate gingivitis in 21 NHPs. The 10 others (32%) had periodontal disease stage 2 or more with a total number of 46 teeth affected.

Caries was observed in 12 out of 31 NHPs (38%). Forty-four caries in total were observed mainly on molar (43 teeth), rarely on premolar (1 teeth) and never on incisor and canine (Figure 1). Tooth fracture was a very common occurrence. A total of 30 teeth were fractured in 20 animals (64%).

Twenty two teeth with attrition (Figure 2) including pulp exposure were found in 8 NHPs (26%) and affected mainly the canine (8), but also some incisor (2).

In this case series, seven out of 31 NHPs (22%) showed one or several incisors with hypercementosis. Finally, 12/31 NHPs (39%) had incomplete dentition and a total of 22 teeth were missing: incisor (8 teeth), canine (9 teeth), premolar (1 tooth), and molar (4 teeth).

**Discussion**
Periodontal disease is a major problem in dogs and cats and also in humans; NHPs have been
used as a model of periodontal disease for years with Macaca sp. demonstrating naturally occurring periodontal disease that increases with aging. (Colmery & Frost, 1986)

Dental caries, also known as tooth decay, is a breakdown of teeth due to activities of bacteria. The weight of sugar containing food in the monkey diet and also the use of sweets as reward can explain the high prevalence of caries detected compared to studies with animals living in the nature. (Wang, Turnquist, & Kessler, 2016)

Attrition is the wear off of dental hard tissue due to tooth-on-tooth contact (figure 2). Honing is a natural behaviour of male cercopithecoids to improve their capacity in defence of individual or troop against predators, in fighting among individual males within or between troops and as part of “threat” gestures. (Walker, 1984)

Tooth fracture, especially complicated crown fracture of the canine and incisor teeth is a common finding in NHPs. Fight, hit against walls or any other hard material, mastication on hard substance (corn, nuts, wood, stone …) are the most causal factors.

Hypercementosis is a non-neoplastic condition in which excessive cementum is deposited in continuation with the normal radicular cementum. The most potential factors are genetic, periodontal disease, occlusal forces and endodontic stimulation.

Gingival hyperplasia, also sometimes described as gingival enlargement is an abnormal, excessive growth of the periodontal tissues. The 3 specimen in this study with generalized gingival hyperplasia were treated using gingivectomy and tooth cleaning only.

Missing teeth may have different origin: inheritance, congenital, extraction, avulsion or sometimes, the crown is absent but a root remnant is still visible on x-ray.

Conclusion

The dental care program performed in the NHPs research colony proved necessary and valid as all NHPs were diagnosed with quite a number of periodontal and dental pathologies of varying severity.

These painful conditions are often associated with local or systemic infection and need to be addressed and treated rapidly. This case series emphasise the importance of using x-rays in the diagnostic of pathologies, treatment and follow-up of procedures.

References

Dental disease in the Iberian wolf: evaluation of a museum collection

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In some wild canids there is a lack of knowledge about dental pathology. This study aimed to evaluate its prevalence in Iberian wolves from the MUHNAC.

Sixty-five samples (61 skulls and 4 jaws) collected in Portugal between 1977 and 1995 were analysed. Sample comprised 19 females, 22 males and 23 of unknown sex. The studied parameters, registered in a dental chart and then evaluated by dental radiography, were: dental absence, periodontitis, wear, fractures, supernumerary or persistent deciduous teeth and periapical lesions.

Among 2589 studied teeth, 12.4% (n=1280) of maxillary and 11.1% (1309) of mandibular teeth were absent. 23.7% of maxillary teeth had mild and 4.6% severe of wear and in mandible, 26.0% had mild and 4.5% severe wear. Fracture was more detected in maxilla (1121, 4.5%) than in mandible (1164, 3.0%). Seven periapical lesions and 7 root fusions were observed.

Only 7.9% (1032) of maxillary and 12.0% (1055) of mandibular teeth did not show periodontitis, 308 showed periodontitis in all males and 104 was significantly affected in females (p=0.020). A significant relationship was found between females and wear in 106 (p=0.059), 305 (p=0.031), 404 (p=0.018) and 406 (p=0.019). Tooth wear and age can be related but there are many variables to consider, therefore, dental x-ray could be proposed as a tool for age determination.

These results contribute for the knowledge of the dental disease in the Iberian wolf, which is a target species of multiple conservation measures.
Dental disease in mice-like (Myomorpha) rodents

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Rodents comprise the largest mammalian group with more than 2200 different species. Dental disease in herbivorous pet rodents is extensively reported in the literature, however dental disease in mice-like rodents (Myomorpha) is described in much lesser extent. The aim of the presentation is to describe the anatomy and dental disease in privately kept mice-like rodents presented to the authors’ clinic. As all the cheek teeth in rats, mice, gerbils and hamsters are short crowned (brachyodont) with multiple cusps and have true roots, the most common diseases seems to be dental caries and parodontopathies.

Rodents comprise the largest mammalian group with more than 2200 different species. Order Rodentia is further dived into five suborders (taxonomic 2016) Hystricognatha (cavia-like rodents - guinea pigs, chinchillas, degus), Myomorpha (rat- or mice-like rodents – rats, mice, hamsters, gerbils), Sciuromorpha (squirrel-like rodents – prairie dogs, chipmunks, squirrels), Anomaluromorpha (African springhares, Beecroft’s flying squirrel, flightless scaly-tailed squirrels) and Sciuravida (gundi). The most commonly kept exotic companion rodents are guinea pigs, chinchillas, degus and rats. In lesser extent, hamsters, gerbils, mice and prairie dogs can also be seen in veterinary practice.

Anatomy

Dentition in mice-like rodents (rats, mice, hamsters, gerbils) is monophyodont (the animals develop one permanent set of teeth) and heterodont (teeth have different shapes and functions). The dental formula is 2x (I 1/1, C 0/0, P 0/0, M 3/3) (table 1).

Incisors. Rodents belongs to Simplicidentata, as they have a single pair of well-developed incisors on each jaw. Incisor teeth are continually growing and erupting (elodont) and open-rooted (aradicular) in all rodent species, with the enamel thickest on the lingual surface, thinning out on mesial and distal aspects toward the lingual surface, where it is absent. This configuration of dental tissues gives a sharp chisel-like occlusion. About one-third of the incisor is erupted, while two-thirds seats in the alveolus. The maxillary clinical crowns are much shorter than those of mandibular incisors. In rodents, the incisors erupting 2–5 mm per week. Thea rate of eruption is associated with the way of life (burrowing, non-burrowing), feed, age and many other factors including medication. In rats, incisors in 10-week-old animals erupting in average 3.8 mm/per week and in 18-week-old animals erupting 3.1 mm/per week (Harari et al. 2005).

In general, rodents have reduced tooth numbers with a long diastema between the incisor teeth and the cheek teeth. The cheek folds separate the gnawing apparatus (incisors) from the caudal part of the oral cavity. The mandibles and mandibular cheek tooth arcades are frequently wider (anisoganthia) in comparison with the maxilla and maxillary tooth arcades. This gives rodents their typical head appearance.

Molars. Rat-like rodents have anelodont molar teeth. They are truly rooted (with a limited growth period), single or multiple rooted, and are not worn during normal chewing activity. They are brachyodont (short crowned) with multiple cusps. In commonly kept rat-like rodents, the size of teeth is different with the first molar largest teeth and last molar smallest teeth in the oral cavity. Molars have a limited period of growth and are short-crowned with typical long and narrow tooth roots (brachyodont). Check teeth have similar structure to human teeth and the tooth is anatomically
divided into the clinical crown, neck and root/roots). Each mandibular cheek tooth is in occlusion with the corresponding maxillary cheek tooth.

**Table 1**: Selected anatomical specification of the dentition of rats, mice, gerbils and hamsters (Capello 2005, Jekl 2009)

<table>
<thead>
<tr>
<th></th>
<th><strong>Incisor</strong></th>
<th><strong>Molars</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rats</strong></td>
<td>The apices of the maxillary incisors extend for two thirds of the diastema</td>
<td>The mandibular M1 has four to five roots, M2 has 4 roots and M3 three roots. Maxillary molars have two roots. The molar crowns are divided into lobes by transverse fissures and possess cusps.</td>
</tr>
<tr>
<td><strong>Mice</strong></td>
<td>The apices of maxillary incisors reaching up to three-quarters of the diastema</td>
<td>The cheek teeth have 3-4 roots.</td>
</tr>
<tr>
<td><strong>Gerbils</strong></td>
<td>The apices of maxillary incisors reach up to two thirds of the diastema</td>
<td>The occlusal surfaces of all molars are almost flat and without cusps or fissures. Each of the first molars has three roots, each of the second molars has two roots and the third molars have one root.</td>
</tr>
<tr>
<td><strong>Hamsters</strong></td>
<td>The apices of maxillary incisors reach to one half to two-thirds of the diastema</td>
<td>The molar crowns are rectangular and flat with small cusps on the occlusal surface. The mandibular molars have two roots, maxillary M1 has four roots and M2 and M3 three roots. The cheeks are occupied by the cheek pouches, which are situated between the skin and masticatory muscles.</td>
</tr>
</tbody>
</table>

**Diagnostics**

Dental disease is diagnosed by combination clinical orofacial examination, oral cavity examination under general anaesthesia, oral cavity endoscopy and by radiography/computed tomography (Jekl and Knotek 2007, Capello 2016, Jekl 2016).

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.

**Dental disease in rat-like rodents**. The prevalence of dental disease in rat-like rodents was not yet described. Even that carries and periodontal disease in rats is seen very commonly at the authors practice and that these species are commonly used as a periodontal model for human diseases, recent retrospective article about diseases did not mentioned oral cavity diseases at all (Bakaletz 2004, Rey et al. 2015).

**Incisor malocclusion**. Overgrown and fractured incisors with lateral mandibular shifting are seen most frequently. The maloccluded incisors can penetrate the soft tissues of the upper or lower jaw, and acute or chronic inflammation and abscess formation ensues. Such lesions could lead to inanition through mechanical interference with food intake. The highly mobile mandibular sym-
Physic permits the abnormal forces created by such malocclusions to rotate the mandibles, so that the mandibular incisors tend to bypass the maxillary teeth laterally, with the maxillary incisors curving into the oral cavity.

Incisor depigmentation and enamel hypoplasia is commonly associated with periodontal inflammation and with pseudo-odontoma formation. Incisor depigmentation is also physiologically present after enhanced incisor growth after its fracture.

**Dental caries and paradontopathies.** The development of caries requires multiple interactions involving anatomy, physiology, diet and bacterial flora of the host. Periodontal disease and tooth decay in mice-like rodents are very common secondary to high sugar diets.

In many cases, food impaction of the interproximal coronal spaces and between cheek and dental arcades may be seen. Foreign material and impacted food introduce bacteria into gingival sulci resulting in bacterial colonisation of the periodontal tissues and a pronounced inflammatory reaction (Jekl 2009). In severe cases, this may result in periodontitis, osteoresorptive lesions and abscess formation. The most commonly involved teeth in case of osteomyelitis and odontogenic abscess formation are incisors teeth, especially in rats (Jekl 2016).

**Neoplastic lesions.** Spontaneous oral cavity tumours in rodents are rare. At the authors practice maxillary osteosarcoma, fibrosarcoma and melanoma. Pseudo-odontomas can also develop, especially in rats (Slootweg et al. 1996).

**References**


Mans C, Jekl V. 2016. Anatomy and disorders of the oral cavity of chinchillas and degus. Veterinary
Apical incisor elongation in rabbits – Is epiphora always present?

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Epiphora is by the definition an overflow of tears onto the face. Epiphora is in general caused by an overproduction or and inadequate removal of tears. In rabbits, it is frequently due to an inadequate removal of tears by lacrimal drainage caused by extramural compression/blockage of the tear ducts by apical elongation of the maxillary incisors (Williams 2007). Periapical maxillary cheek
teeth pathology can be also a reason. In cases of conjunctivitis and keratitis, epiphora is present due to overproduction of tears from the eye irritation (Florin et al. 2009). The aim of the paper is to describe apical incisor elongation and extramural nasolacrimal duct obstruction in total of 40 pet rabbits older than 2 years.

Twenty rabbits were presented to the authors’ clinic apparently healthy for elective procedures (sterilization, boarding) and another twenty rabbits had anorexia, weight loss and/or excessive salivation. Oral cavity and teeth/skull was examined using stomatoscopy and dental/skull radiography (DV, LL, LL-oblique view, Jekl and Knotek 2007, Jekl 2013). Dacryocystography with the use of 0.5 ml of contrast iodine media (non-diluted iomeprol) was then performed for the visualisation of the nasolacrimal duct (Jekl 2013). Ophthalmic examination consists of the evaluation of periocular structures, the cornea, anterior eye chamber, iris, pupil, iridocorneal angle, ciliary bodies, vitreous and retina using adpection, oculoscopy and fluorescein staining (Jekl et al. 2015).

In 20 ill rabbits, mild to severe dental disease was diagnosed with mild to severe maxillary incisors elongation and nasolacrimal duct external compression. Unilateral epiphora was diagnosed in 50% (10 from 20 animals) and bilateral epiphora in 25% (5/20). Epiphora was always associated partial or total nasolacrimal duct obstruction, which was seen on contrast radiographs of the nasolacrimal duct. From twenty apparently healthy rabbits, the maxillary incisors elongation and nasolacrimal duct external compression was diagnosed also in all rabbits which was consistent with signs of an early stage of dental disease (minimal apical cheek teeth elongation, interdental space widening). No signs of epiphora was seen in any of these animals.

Dental disease is very common in rabbits (Capello 2016); however maxillary incisor elongation is in literature mostly mentioned in association with epiphora (Williams 2007), but not as one of the signs of the early stage of dental disease. It seems, that contrast nasolacrimal duct study may be promising method of early stage of dental disease diagnostic, as it is simple and easy done procedure. In that stage, dietary change can have still some effect on the dental disease progression. However, more studies on higher number of animals are needed to confirm this hypothesis.

References


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Distribution of tooth substances in cheek teeth of domestic horses

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Hypsodont equine cheek teeth (CT) erupt continuously to compensate occlusal wear. Therefore parts of the tooth crown resting initially in the alveolus become revealed at the occlusal surface with age. Hitherto it is unclear whether, and to what extent, the amount of the dental substances changes along the tooth crown, and thus the composition of the occlusal surface changes with age.

Maxillary (n = 20) and mandibular (n = 16) CT were scanned using micro-computed tomography. On equispaced (10 mm) horizontal levels the area of dental substances was determined. Absolute amounts and relative contents of enamel and dentine were statistically analysed.

In apical direction the total dental area (dentine + enamel) decreased, however not statistically significant in upper CT. The relative content of enamel significantly decreased while the relative content of dentine significantly increased.

The results indicate a continuous reduction of the enamel content at the occlusal surface with age. This suggests age depended altering of wear resistance and age depended altering of capacities for ingesta particle size reduction during mastication. Remarkably, the obtained findings in domestic horses are contradictory to findings in wild equids (Plains Zebra), which show increasing enamel contents in apical direction. However, functional and clinical interpretations should consider further parameters, e.g. hardness and alignment of dental substances and therefore future studies are intended.

Morphology of the dental pulp in equine incisors

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Removing hard substances from the occlusal surface of incisors during dental treatment can lead to pulpar exposure and iatrogenic caused pulpitis. Therefore, anatomical data about pulp morphology including subocclusal dentine thickness is required.

Fifty lower incisors and 51 upper incisors from 13 horses of different breeds, sex and age were scanned using micro-computed tomography. Subsequently, detailed 3D models of the teeth were prepared. Using a set of reliable anatomical marker points, measurements of the subocclusal dentine thickness were performed and the shape of the pulp cavities was described.

Upper and lower incisors feature a Y-shaped pulp cavity which is composed of two pulp horns placed in labiodistal and labiomesial position to the infundibulum. At the base of the infundibulum the pulp horns fuse to form the so-called pulp canal. The pulp canal features a mesiodistally flattened tube-like shape. In upper incisors it is mostly unbranched whereas in lower incisors small
side branches often occur. The subocclusal dentine thickness ranged from 0.7 mm to 11.7 mm. The distance between the pulp horns and the labial aspect of the teeth ranged from 3.5 mm to 9.0 mm. The morphometric results indicate a subocclusal dentine thickness of less than 10 mm in the majority of the investigated teeth. The morphological data elucidated marked differences in pulp canal anatomy between upper and lower incisors. This might be of significant relevance for endodontic treatments.

**Occlusal angles in equine incisors and cheek teeth**

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Optimal equine feed intake relies on a healthy dentition. Among other characteristics an ideal angulation of the teeth is crucial for a physiological mastication. However, normal occlusal angles of equine cheek teeth and incisors are discussed controversially in literature.

A method was developed to perform measurements by using detailed 3D-models of 20 equine heads which were constructed from CT-datasets. Within virtual 3D-models anatomical landmarks were identified and reference planes for the skull and for the mandible were determined. Subsequently, reference lines and reference planes were constructed for each individual tooth. Finally occlusal angles were measured in relation to the reference planes and additionally to anatomical landmarks, i.e. the jaw bars and the facial crest.

Check teeth showed mean occlusal angles from 15° to 20° with stepwise increase from rostral to caudal. Statistically no differences between jaw quadrants were detected. Incisor showed mean occlusal angles from 33° to 45°; lower jaw incisors showed significantly steeper angles than upper jaw incisors. Although no significant difference between the left and right side of the skull was detected, all individual horses showed left - right asymmetries.

Even though relatively wide natural ranges of occlusal angles were detected, there are constant relations between different groups of teeth. The lower jaw bars appear suitable for determining the angulations of lower incisors under clinical conditions.

**Towards a better understanding of occlusal fissures in the equine cheek tooth: prevalence and association with dental wear**

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**Reason for performing study:** Fissures of the occlusal surface of equine cheek teeth are commonly encountered during routine oral examination. Their etiology and relevance to dental disease are still largely unknown.
Objectives: To determine the prevalence (age-related, gender, etc.) and characteristics (location, involvement of enamel, dentine and/or cement) of fissures on the occlusal surface of cheek teeth. In addition their association with wear disorders and the molar table occlusal angle is examined.

Hypothesis: It was hypothesized that the occurrence of occlusal fissures is influenced by masticatory forces. Therefore it is expected that their prevalence shows a distinct distribution along the occlusal surfaces and that abnormal dental wear or occlusal angle would have an inducing effect.

Methods: One hundred and forty-three horse heads were obtained from a slaughter house and for which no medical history was available. Age was estimated based on the occlusal wear pattern of the mandibular incisors. Gender was determined according to the presence or absence of the canines. All wear disorders and other dental pathologies were recorded on dental charts. The occlusal angle of each cheek tooth was measured using both the malleable wire and stiff hinge technique.

Results: Occlusal fissures were found in 72% (103/143) of examined skulls with more than one tooth affected in 64.3% (92/143) of cases. In 27.1% (885/3262) of all cheek teeth one fissure was documented with 10.3% (336/885) of teeth displaying more than one fissure. Male horses and horses younger than 13 years demonstrated a significantly higher (p = 0,002) and lower (p < 0,05) prevalence of fissures respectively.

Fissure distribution between mandibular and maxillary teeth was comparable (54.1% and 45.9% respectively). Mandibular fissures were found more often on the buccal side of the tooth (p< 0.001) whereas maxillary fissures were more common on the palatal side (p = 0,186). The highest frequency was recorded at the level of pulp horn #4 (59.2%) in maxillary cheek teeth, and pulp horn #1 (47.4%) and #2 (26.0%) in mandibular teeth. Mandibular 08, 09 and 10 were overrepresented whereas no predilected teeth could be identified in the maxillary arcades. Two main fissure types were identified. Type 1 fissures involve the (center of) occlusal secondary dentine and run to the enamel or across into the peripheral cementum. Type 2 fissures are located within primary dentine, enamel and/or cementum but not secondary dentine. Type 1 fissures that reach the peripheral enamel were the most prevalent fissure type (39.5%).

No significant correlation was found between the presence of wear abnormalities or the occlusal angle of the cheek teeth, and the prevalence of fissures.

Conclusion: Occlusal fissures are commonly encountered in equine cheek teeth. Despite specific predilection places for their occurrence which might assume a mechanical origin, no association was found with dental wear or occlusal angle. Further histological and ultrastructural studies are warranted to elucidate their possible role in dental disease.

References


**Extraoral endodontic treatment and replantation of equine cheek teeth: Anatomical, histological and molecular biological considerations**

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Replantation of teeth after avulsion as well as intentional replantation after extraoral endodontic treatment has been described in human dentistry. Severe post-operative problems arise from poor periodontal regeneration due to inflammation, root resorption and ankylosis. Experimental studies showed that residuals of infected pulp and microorganisms are able to escape – even after efficient apical sealing – through dentinal tubules when these are opened by resorption of the lateral walls of the dental root.

From these data a catalogue of requirements for successful replantation has been derived and compared to current knowledge of equine dental/periodontal anatomy.

The intraalveolar part of a potentially replanted equine tooth features a wall of dentine covered with enamel and cementum – in contrast to brachydont teeth which feature dentine and cementum. It is assumed that the more robust architecture of the dental wall prevent lateral leakage.

Due to the need of continuous tooth eruption, the equine periodontium has developed superior regenerative capacities. This has been proven by studies showing periodontal stem cells, high amounts of proliferating cells and continuous matrix remodeling. Recently, molecular biological studies documented characteristics of the equine periodontal cells resembling those found in developing tendons. Based on these scientific data tooth replantation in the horse is considered as a challenging but promising therapeutical approach.
Extraoral endodontal treatment and replantation of equine cheek teeth. Part 2: Technique and materials

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¹ Equine dental clinic, Bleidenstadter Weg 7, D-65329 Hohenstein, Germany; ² Equine Dental Clinic Ltd, Wimborne, Dorset, BH21 5BX, UK.

Introduction

Endodontic treatment of equine cheek teeth is still a big challenge. Root canal treatment from the occlusal surface is an advanced approach with good clinical results (Lundstrom BEVA 2012) but is not widely used because of its difficulties in endodontic diagnostic and instrumentation.

Another approach is retrograde endodontic treatment after bone removal and apicoectomy. This technique is described by different authors⁹,¹⁵. The problems of this approach are the difficulties in keeping the area dry for treating the endodontic system and the difficult instrumentation.

Extra corporal retrograde endodontic therapy in freshly extracted cheek teeth is easier to perform compared to the previous listed techniques but the periodontal ligament becomes ruptured because of the required dental extraction. Success of this procedure depends very much on the periodontal regeneration after replantation of the treated tooth. First results show that periodontal regeneration is possible and can lead to functional replanted teeth with regular eruption. In human dentistry this is a very old technique with a high success rate (78%-96%¹²).

Materials and methods

Cases were presented to one of the author’s for oral extraction because of clinical signs of pulpitis like intraoral fistula and periapical abscesses.

If the affected tooth was extracted orally without fracturing the tooth or obvious damage of the alveolus and the crown including the reserve crown of the tooth was longer than 40 mm the case was selected for extra corporal retrograde endodontic therapy.

Procedure

• After extraction the teeth were rinsed with sterile lactated Ringer solution and wrapped with sterile gauze soaked with a sterile penicillin solution (100ml lactated Ringer + 100mg Benzyl penicillin) so the periodontal ligament was protected and kept wet. (As an alternative a cell culture medium was used instead of lactated Ringer solution.)
• Granuloma and fistula tracts were removed from the alveolus. The alveolus was checked for bone or tooth fragments.
• Now the apical parts of the teeth with roots were dissected with a diamond disc under water cooling with sterile saline solution to get a good access into the pulp chamber / pulp canals and the bottom of the infundibula.
• Pulps or necrotic material in the pulp canals was removed and pulp canals were cleaned with hedstrom files. If the pulp canals were too narrow they were enlarged with a 3mm drill under water cooling with sterile water. In cases of a patent infundibulum the bottom of the infundibulum was removed and the cement or compacted food material in the apical part of the infundibulum was removed to a depth of 10mm.
• Pulp canals and if opened the infundibulae were filled and flushed with warm sodium hypochloride (3%) to remove organic material and to sterilize the cavities. For flushing the occlusal surface was directed upside so the fluid didn’t contaminate the periodontal ligament.
• The cavities were finally flushed with sterile saline solution to remove the sodium hypochloride and were dried with compressed air.
• The deep and narrow pulp canals close to the occlusal surface were filled with a dual curing, self-etching and self-adhesive wet bond resin cement (Embrace WetBond Resin Cement™).
• After light curing the surface of the resin cement the remained walls of the cavities (including the enamel wall of a maybe involved infundibulae) were prepared with a self-etch adhesive (Adper Prompt™ or Scotch Bond™) that was light cured.
• All cavities were filled now with a self-curing composite material (Luxa Core™).
• After 4 minutes setting time the tooth was repositioned in the flushed and cleaned alveolus.
  (As alternatives in some cases pulp canals were filled with wet bond resin cement only or with other dentin replacement materials, also one author was using MTA for pulp canal filling in combination with other materials or alone)
• The clinical crown was fixed to the adjacent teeth with self-adhesive cement (Embrace™ or Composite (Luxa Core™).
• Horses were fed 2 weeks with slushy feed and grass.
• Horses kept on antibiotic treatment for 10 days

Results of this procedure are subject of part 3.

References
Standing surgical apicectomy and retrograde root canal therapy of cheek teeth using grey original Portland cement (OPC) in three horses

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**Reasons for performing study:** Endodontic root canal therapy (RCT) in the horse is not widely performed due to lack of long term studies showing evidence of success of procedures that can preserve the dentition. Preservation of a cheek tooth prevents complications of dental extraction such as mesial drift with potential problematic diastema, antagonist overgrowth, as well as preserving the maximal masticatory function and balance of the dental arcades. Horses treated by endodontic therapy are also able to continue exercise preventing a potential break in the competition schedule. Surgical apicectomy and retrograde endodontic therapy is an approach that has not previously been reported in the standing horse. Success rates under general anaesthesia have been reported to be in the region of 55%1. Mineral trioxide aggregate (MTA) has been reported widely in human dentistry to be a material suitable for a variety of endodontic procedures including orthograde and retrograde root canal therapy and is currently thought of as the material of choice due to qualities of osteoinduction, bacteriostasis and calcium ion release promoting reparative dentine formation. Cost of MTA is high, almost prohibitive for obturation of the large pulp and root canals in the horse. Original Portland cement (OPC) is extremely cheap, widely available and has been documented in many studies to be chemically identical to MTA, available in standard grey or white forms. This is the first study to document use of OPC for endodontic therapy in the horse.

**Objectives:** Report the short and long term follow-up of cases treated by standing surgical apicectomy of a cheek tooth, using advanced imaging to assess the quality of the obturation.

**Study Design:** Retrospective study.

**Methods:** Three horses (ages 6, 8 and 9 years) were treated for apical abscessation of the Triadan 207 tooth by standing surgical apicectomy and retrograde root canal therapy performed under continuous rate infusion sedation and regional anaesthesia. A periosteal flap was created over the apical region of the tooth, the bone overlying the tooth and the apex of the tooth removed using a fissure bur and high speed dental handpiece. The pulp canals were removed using endodontic broaches and files, before canal disinfection, drying and obturation using gas sterilised OPC applied using a Lentulo spiral filler and low speed handpiece, followed by routine surgical closure. Surgical time was recorded as 2.5-3.5 hours.

**Results:** All three horses developed abscessation of the surgical site between 2 and 4 weeks following surgery. In the first two cases, it was assumed that the treatment had failed and the teeth were extracted orally, one at the request of the owner. In the third case, the surgical wound was
flushed ‘to and fro’ with saline via an 18G needle and developed no further complications. Follow-up of this case over a 4 year period has shown that the horse returned to full competition (showjumping) and has had no complications or adverse clinical signs. Computed tomographic examination at 4 years post surgery has shown normal appearance of overlying apical alveolar bone and acceptable apical obturation. No occlusal defects were noted oroscopically at 4 year follow-up.

**Conclusions:** OPC can be considered a potential cheap, readily available and successful endodontic obturation material in the horse. Standing surgical apicectomy is a complex and intricate and time consuming procedure with high risk of surgical wound sepsis, however the 4 year follow up in the cases treated successfully shows there is potential for further research using this material for endodontic therapy in the horse.

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### Extraoral endodontal treatment and replantation of equine cheek teeth. Part 3: Case series

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**Reasons for performing study:** Extra-corporeal root canal therapy and replantation (ERC-TR) is an endodontic technique that has been described to allow full endodontic therapy to be performed on cheek teeth, taking advantage of the wide apical foramina to allow pulpectomy to be performed more quickly and completely than is easily achievable from a conventional orthograde approach. Preservation of a cheek tooth prevents complications of dental extraction such as mesial drift with potential problematic diastema, antagonist overgrowth, as well as preserving the maximal masticatory function and balance of the dental arcades.

**Objectives:** Report an update on cases to assess success rates and help formulate treatment protocols; combine results with histopathological findings of failed extracted teeth to further aid analysis of technique.

**Study Design:** retrospective multicentre study

**Methods:** Information regarding breed, age, gender, presenting signs, imaging findings, case selection protocol, treatment technique including materials used for endodontic obturation, response to treatment, success rates and follow up data was collected of horses treated by ERCTR.

**Results:** 21 cheek teeth (CT) in 21 horses were reported treated by ERCTR with mix in age, breed and gender. The mean follow-up period was 16 months, range 4 to 32 months. Of 21 CT treated, 8 teeth were maxillary, 13 mandibular. Analysis showed success was recorded in 13 cases in total (62%), 4 maxillary (50%) and 13 mandibular (62%). Failures were reported to have recurrences of bony apical swelling (n=4), apical abscessation (n=1), loss of stability (n=2). Case selection altered during the case series with 3 cases being selected earlier in the series which were later considered not suitable (clinical crown fracture n=1, no adjacent tooth n=2). Excluding these teeth returned success rates of 66% maxillary, and 83% mandibular.

In the cases recorded as successful, resolution of presenting clinical signs (e.g. apical swelling) resolved in most cases after 3-12 months.
Conclusions: ERCTR appears to be a potentially successful treatment for endodontic disease of CT in horses. Combining the findings of this study with histopathologic data from failed extracted teeth will help to further develop this technique.

A review of equine dental fractures

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Fractured teeth are commonly encountered in both first opinion and dental equine practice. Only a small percentage of horses with dental fractures show clinical signs such as oral pain, masticatory problems, facial swelling, or pyrexia. Teeth may be fractured due to trauma, dental disease (idiopathic fractures), or iatrogenically. Fractured teeth may be described in several ways: according to their cause: traumatic, idiopathic, iatrogenic; by the dental tissues/anatomy involved: enamel infraction (crack), enamel fracture, crown fracture, crown-root fracture, root fracture, alveolar fracture; and by involvement of the endodontic system: complicated or uncomplicated. Fractured teeth with no known history of trauma have previously been classified in the equine dentistry literature as idiopathic fractures; that is those with no definite aetiology. Incisor and canine crown fractures (both complicated and uncomplicated) occur commonly due to their unprotected location and are usually compound or transverse in configuration. In contrast, traumatic fractures of the protected cheek teeth (CT) are uncommon and almost always sagittal or para-sagittal in configuration. Idiopathic fractures of CT are more common with a reported prevalence of 0.4% (Taylor and Dixon 2007), with maxillary CT and in particular the maxillary 09s over represented (Dacre et al. 2007; Taylor and Dixon 2007). Histological studies have shown reduced dentin in 25% of CT with idiopathic fractures, indicating prior pathological changes to pulp as a predisposing factor (Dacre et al. 2007). These idiopathic CT fractures are therefore usually a consequence of dental disease; infundibular caries, infundibular hypoplasia, peripheral caries, or pulp necrosis. Equine CT fracture configurations include: midline sagittal fractures, where the fracture line runs through the infundibula in a rostro-caudal direction (Fig. 1a; Dacre et al. 2007); lateral slab fractures, where the fracture line runs in a sagittal plane through pulp horns one and two (Fig. 1a and 1b; Dacre et al. 2007); medial slab fractures, where fracture lines run through either pulp horns three and four, three and five or three, four and five (Fig. 1a and 1b; Dacre et al. 2007). Lateral slab fractures are the most common CT fracture, possibly because this represents a weak point across the crown (Dacre et al. 2007). Midline sagittal fractures through both infundibula in maxillary CT with infundibular caries/hypoplasia are also common, especially of the 09s (Dacre et al. 2007).

The presence of fractured teeth may be evident from a thorough history, clinical signs and a clinical examination. A full oral examination under chemical restraint, aided by a head-light, head-stand and an oral mirror is invaluable. Additional diagnostic aids include oral endoscopy, radiography and computer tomography.

The consequences of fractured teeth are many and include: further fracture, tooth loss or exfoliation, pulp necrosis, pulp canal obliteration, external/internal surface resorption, external/internal inflammatory resorption, osseous resorption, traumatic or infection-related loss of alveolar bone, apical/per-apical infection, periodontal/gingival reattachment, and tooth discoloration. Pulp
Equine dentistry is inevitably involved in all CT and many incisor and canine fractures, some have been shown to clinically resolve without the development of apical infections. However, in many cases the resultant pulpitis results in pulp necrosis and infection extends to the apex and peri-apical area. Treatment options for fractured teeth include: conservative treatment and monitoring, extraction (exodontia), and tooth preserving techniques (restorative and endodontic techniques). Any fractured teeth should be left in situ, if there is any concern regarding associated supporting bone fractures as removal if necessary can take place later, once osseous healing has occurred. Conservative treatment includes anti-inflammatory and antibiotic drugs, splinting if possible, management of any associated malocclusions, and radiographic monitoring for the consequences of dental fractures. Extraction is indicated if there is no resolution of clinical signs or evidence of apical infection. All teeth with a complicated fracture require either extraction or an attempted tooth preserving technique which include: dentin restoration and sealing, pulp capping, partial pulpotomy, apexification, pulp extirpation (pulpectomy) followed by obturation (root canal treatment). Any tooth preserving technique requires diligent follow-up and repeated imaging. Prevention of midline sagittal fractures secondary to infundibular caries/hypoplasia has been reported using restorative materials, but further peer-reviewed research is required to validate this technique further. All treatments/techniques have advantages, disadvantages and associated complications, plus possible insurance considerations for clinicians to consider on a case by case basis.

References


Equine dental fractures may be classified by the tooth, dental tissues through which the fracture plane passes, the involvement or otherwise of the pulp (e.g. complicated versus uncomplicated), the orientation of the fracture plane (e.g. sagittal, parasagittal, oblique) and the proposed aetiology (e.g. infundibular caries related). The prevalence has been reported as between 1 and 6%, with the most common fracture planes being through pulps 1 and 2, and sagittal through the infundibula. Clinical signs are often reported as being absent, however close observation of mastication or measurement of lateral mandibular excursion to cheek tooth contact (LMCT) often shows asymmetric readings.

Oral examination in cases of fractures should be performed orosopically and many cases will require radiography for full assessment and treatment planning. A proposed protocol for classification and management is as follows:

1. Uncomplicated crown fractures (UCF), no apical change radiographically, no displacement, no periodontal disease (PD) – monitor, no treatment required.
2. Complicated secondary dentine fractures (2DCCF) e.g. buccal slab fracture with no vital or non-vital pulp exposure – if as above, no treatment required.
3. Complicated crown fractures (CCF) exposing vital or non-vital pulp – if no apical change radiographically, reparative dentine bridge formation likely within pulp or root canal, endodontic therapy / pulp restoration possible to prevent future caries and progression to further pathological fracture.
4. CCF with apical periodontitis radiographically or discharging sinus tract (oral or cutaneous) – extraction recommended or endodontic therapy.
5. Infundibular caries related fracture (ICF) e.g. sagittal – likely to be marked apical periodontitis / apical abscessation – extraction recommended.

Fractures are commonly incidental findings and appear to be causing little or no clinical signs, however deeper investigation may reveal evidence of pulpitis and periodontitis resulting in pain that the horse is disguising. Placing fractured teeth into one of the above categories is usually possible using oroscopic examination and radiography alone, however in some cases additional diagnostics such as mastication assessment, LMCT measurement, computed tomography (CT) or gamma scintigraphy may be required to fully assess the potential impact the fracture is having on the horse. Treatment strategies are increasingly involving restorative and / or endodontic methods. Cases treated using such methods should be assessed at regular intervals to assess the integrity of the crown along with continued assessment of the apical region.

Early identification of fractured teeth which have evidence of ongoing dental disease e.g. pulpar caries from occlusal exposure of non-vital pulps will allow an informed choice to be made concerning early intervention e.g. for extraction with a crown more stable than may be the case some years later after progressive caries of exposed pulps and / or infundibula, and demineralisation and weakening from lack of pulp vitality has occurred.
Standing oral extraction of maxillary cheek teeth fractured in a sagittal plane (infundibular caries associated fractures)

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Fractures of maxillary cheek teeth are commonly encountered in equine dental practice. Most commonly fractures involve the buccal pulp horns and have been termed “parasaggital” fractures. The second most commonly seen maxillary fractures are fractures in a sagittal plane running through the infundibulae and believed to be predisposed by cemental hypoplasia and caries. Extraction of fractured teeth has been identified as complicated and cited as reasons for failure in several papers. The procedure for extracting teeth with fractures in the sagittal plane by compressing the two fragments together and removing the two fragments together, has been described by Dixon and Easley.

This is a retrospective study looking at the extraction 304 cheek teeth over a ten year period (2006-2016). Extraction of 33 maxillary cheek teeth with fracture in a sagittal plane were identified, carried out in 30 surgeries in 29 patients. The mean age at presentation was 15.8 years with a range of 7 to 30 years. 76% of the cases were geldings. The maxillary 09 were most commonly affected (55%), with the maxillary 10 were second most commonly seen (21%). Maxillary 06’s (9%), 07’s (9%) and 08’s (9%) accounted for the remaining cases. 5 cases presented with concurrent sinusitis.

The surgery was conducted using a previously unpublished technique of individual elevation and removal of the independent fragments. The mean total surgery time was 1.3 hrs with a range of 30mins to 4hours. The longest procedure for a single tooth extracted orally was 2 hrs.

Complete oral extraction in two pieces was accomplished in 60% of cases. Buccal fragmentation was the most common intraoperative complication (18%). Retained root fragments removed by elevation was encountered in 15% of cases. Overall successful oral extraction was accomplished in 94% of cases.

Two cases (6%) required further surgical techniques. One case had a standing Steinman pin repulsion of retained fragments. One case had a standing minimally invasive transbuccal extraction to remove the buccal fragment.

Mean follow up was 2.4 years with a range of 4months to 8 years. Post-operative complication involving alveolar sequestrum was encountered in one case (3%) which was removed at a three week recheck.

The five cases with concurrent sinusitis, 2 responded to medical therapy alone, 2 were treated with trephination, MSB fenestration and lavage and one failed to respond to medical therapy so was treated with trephination two weeks later.

Three cases (9%) developed contralateral fracture at a subsequent date, including one which had received restorative therapy.

Complete extracted teeth were available from 14 cases for examination. The palatal fragment was shorter than the buccal fragment in all cases. The mean depth of the rostral infundibulum was 25.9mm (16-37mm) and caudal infundibulum was 28.6mm (19-39mm). The infundibulae were classified as narrowing, straight-sided or widening. 18% of infundibulae tapered, 21% were straight-sided and 61% were widening in conformation. Based on suggested techniques for restoration of infundibular cemental defects and caries, in cases where fracture is likely the depth of the infundibulum would preclude effective debridement with burrs in 93% of cases. Further proposed techniques using Hedstrom files which taper would make effective debridement unlikely in at least...
61% of cases.

Based on this study, extraction of maxillary cheek teeth with sagittal fractures should not be considered a complicated procedure. Whilst restorative therapy may be beneficial in preventing fracture is unlikely to be able to treat teeth to the same standards for caries prevention as expected in brachyodont teeth. The need for and success of the treatment remains unestablished.

References


Correlation of imaging and pathological findings in equine maxillary cheek teeth apical infection

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Objective: Apical infection of the equine maxillary cheek teeth are a common cause of equine paranasal sinus disease and maxillary bone infection, but it can be difficult to accurately confirm the presence of such infections by clinical and radiographic examinations. The use of computed tomography (CT), that removes the superimposition of adjacent anatomical structures on imaging, should greatly improve the accuracy of diagnosis of these disorders. The objective of this study was to correlate radiographic and CT findings in horses with maxillary cheek teeth apical infections with the pathological findings in the extracted maxillary cheek teeth.

Methods: Clinical findings, radiographic and CT findings were compared with gross pathological and histological examinations of the extracted maxillary cheek teeth. For the latter examinations, the extracted teeth, were photographed, sectioned and the sections photographed, and then histologically examined at 4 sites.

Results: Thirty one maxillary cheek teeth were diagnosed with apical disease, primarily on the
basis of CT imaging. Gross pathological and histological examinations showed pulpar pathology, including necrotic or empty pulp chambers, food containing pulp chambers and changes in the adjacent dental tissues and periodontal membrane. Comparison of imaging and pathological findings showed radiography to correlate with pathological findings in less than 70% of cases, whilst CT correlated with pathological findings in over 90% of cases.

**Conclusion:** This study confirmed the increased accuracy of CT over radiography in the diagnosis of equine maxillary cheek teeth apical infections.

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**Age-dependent positional relations and possible ascending infections of selected equine cheek teeth portrayed by 3.0 Tesla magnetic resonance and computed tomographic imaging**

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As cheek teeth and neighbouring structures alter with increasing age, the knowledge of age-related changes is essential to confirm diagnoses. For dental imaging, computed tomography (CT) and magnetic resonance imaging (MRI) offer the benefit to produce images without superimposition.

The aim of the study was to highlight age-related endodontic and positional changes between cheek teeth, the sinuses and the infraorbital canal (IOC). Therefore CT and MR images of the maxillary 08s and 09s and their adjoining structures were acquired. The study population consisted of nine horses in three age groups.

MRI provided an excellent depiction of soft endo- and periodontal, CT of hard dental and bony tissues. Regarding age-related changes, negative correlation between dental age and pulp dimensions was found. Common pulp chambers were depicted in a third of the teeth with a median dental age of 2 years. Almost all examined dental alveoli were localised below the maxillary sinus. The alveoli with no or just partial contact to the sinus, were either positioned directly below the IOC or contained a common pulp chamber. For the distance between dental alveoli and the IOC an age-related correlation was measured.

The present study provides information about the dental and periodontal age-related morphology and their visibility via different imaging techniques. These results aid to evaluate further clinical cases and to scope on possible ascending infections originating from the teeth.

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Computed tomographic assessment of equine maxillary cheek teeth anatomical relationships and movements, and sinus volumes

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Maxillary cheek teeth apical infections and sinus disease are common problems in horses, but little objective information is available on some anatomical aspects of these structures. The aims of this study were to assess age-related changes in the rate of eruption and rostral drift of cheek teeth; the relationships of the individual maxillary cheek teeth to the different sinus compartments and to the infraorbital canal, and to assess the volumes of the 7 individual sinus compartments.

Computed tomographic (CT) and gross examination were performed on 60 normal equine cadaver heads that were placed into 3 age-groups. The intra-sinus position of cheek teeth, length of reserve crowns, relationship of cheek teeth apices to the infraorbital canal and assessment of rostral drift (as assessed by relationship of the Triadan 11s to the orbit); and assessment of sinus compartment volumes were assessed from CT images of these heads.

The findings included that in contrast to expectations, Triadan 10 alveoli lay fully or partially in the rostral maxillary sinus (RMS) in most cases. The infraorbital canal lay directly on the medial aspect of the alveolus in young horses. The rate of rostral drift of the Triadan 11s’ and of eruption of cheek teeth were quantified in the different age groups, as were the volumes of the individual sinus compartments. This new information will be of value in the diagnosis and treatment of equine maxillary cheek teeth and sinus disorders.

Radiographic anatomy of the equine incisors teeth from 3 to 60 months Gold: radiography vs computed tomography

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Introduction

The pathologies of the incisors teeth are frequent in horses. Bibliographic references showed detailed information about the different radiographic techniques and the pathologies of those teeth, however no works were reported that described methodically the anatomical radiography of the incisors or their evolution in young animals. Besides, no computed tomography of incisors could be found.

The aim of this study was to describe the normal anatomic structure of the incisors from 3-60 months using both x-ray and CT scan images.
Material and methods

Fourteen cadaveric heads (seven males and seven females) were obtained from horses of unknown breeds and aged from 3 to 60 months (22.93 ± 4.39 months SEM). A European EVDC Diplomat determined the horse’s age. The horses were humanely euthanized for reasons unrelated to the head and thus the heads were harvested at the atlanto-occipital joint. None of the horses had a history of dental diseases. The study was performed at the Veterinary Teaching Hospital at the University of Córdoba (Spain).

Radiologic Study

The radiologic study was performed with a stationary x-ray machine (Odel model C306-20, Monza, Italy). Radiographs were processed by computerized radiology (Fuji Computed Radiography, Capsule XL, CR-IR 356, Tokyo, Japan). The obtained images were stored in DICOM format for further study.

Intra-oral radiographs were taken with the cassette between the incisors, as far caudally as possible. The X-ray beam was directed at 60-80° from the dorsal planes (which runs parallel to the hard palate), depending on the conformation of the incisors, using a rostrocaudal-caudoventral oblique to image the maxillary incisors/canines and a rostroventral-caudodorsal oblique to image the mandibular incisors/canines. The beam was centered on the Triadan 01s (central incisors) (Barakzai
Figure 2. 48 months. Intra-oral projection of the maxilar (a), axial plane at the level of 603 (b) and 3D reconstruction en rostral (c and d) and caudal aspect (e). At this age the 102-402 and 202-302 do not touch to each other. The incisives (03) and the canine teeth (04) are still forming (L: Left side).

Technical factors were 60-70 kVp and 2.4 mAs.

Lateral projection was taken in order to evaluate dysplastic or retained deciduous incisors of the premaxilla and rostral mandible (Butler y col, 2008; Barakzai 2011). Technical factors were 67-75 kVp and 2.4 mAs.

Dorsoventral projection was taken in order to eliminate maxillary/mandibular fractures. Sometimes the projections were taken with laterally displaced mandibles in order to see better the corner incisors (Barakzai, 2011). Technical factors were 70-80 kVp and 6 mAs.

Lateral 30°dorsal-lateroventral oblique projections of the cheek teeth were review in order to have more detailed information on corner incisors (Barakzai, 2011). Technical factors were 68-74 kV and 6 mAs.

CT Study

CT scans of the 14 heads were performed with a helical CT scanner (CT Hi Speed CT/e Dual; General Electric Yokogawa Medical Systems LTD, Hino, Japan). The heads were positioned prone, with the mandibles flat on the table. Technical factors were 120 kVp and 50 mA, respectively. Contiguous 0.6-mm transverse slices were made from the level of the incisive bone to the occipital condyles. To enhance bone structures, a wide window was used (window width: 2877 Hounsfield units; window level: 168 Hounsfield units). The original CT data were transferred as DICOM images to
an image analysis with DICOM viewer (Horos v.1.0.5 32-bit, Open Source) to perform image study. The original transverse slices were reformatted into the sagittal and dorsal planes. The window was also adjusted as required to better define bone margins. Three-dimensional (3D) reformatted renderings were developed to allow excellent spatial recognition of complex anatomic structures.

**Results**

**3 months (n=1):** In the intra-oral radiographs we can observe all the erupted deciduous incisors (with a large mineral content and scarce internal structure) 01s and 02s but not 03s, because they are still forming in the bone; also it is possible to observe the open apex. It is possible to clearly define the infundibular enamel, which is characterized by being deep and wide and with cementum in the inner part. The periodontal ligament is thick in the premaxillary (incisive) bones and even thicker in the mandible. The lateral projection only shows the different degrees of eruption between the deciduous incisors. The CT scan shows not only greater detail, but also that the union between the incisive bones and the mandibular symphysis is not fully formed. Both the premaxillary and mandibular bones show that they are still not fully developed in their trabecular pattern.

**10-12 months (n= 5):** At this age all the incisors have erupted, but are radiolucent in radiographs, and clearly show the infundibulum and pulpar canal inside the root, and centrally positioned. The 03s (corner) incisors have erupted, but are not fully developed and do not touch, and the mandibular teeth are a bit more developed that their corresponding maxillary teeth. We can observe the central incisor permanent tooth germ 01 with the maxillary teeth being more rostral, while the corresponding mandibulary teeth are rounder and larger. In the CT scan we can see further development in the mandibular symphysis, as well as with the trabecular pattern.

**18 months (n=1):** As this stage of development all the deciduous incisors are in contact. In the tooth germs of 101, 201, 301 and 401 the enamel is developed. The CT scan shows the trabecular pattern is fully developed and the mandibular symphysis is completely fused (Figure 1).

**24 months (n=1):** The radiographs show teeth which are almost the same as at 18 months, except for the degree of development in the internal structure of the permanent incisors. The only difference is the stage of development of the tooth germs of the central incisors that is more advanced, and the size of the deciduous central incisors crowns that will be smaller.

**33 months (n=3):** The permanent incisors 01 have already erupted and with 02 teeth we can also observe a triangular shape in the tooth germ, the shape being more triangular, the enamel is visible and the infundibulum is conical in shape. In the CT could be observed that the permanent incisors 01 have bigger size than the deciduous incisors present, with a bigger infundibulum and pulp chamber. In the tooth germs of the 02 incisors it could be seen the infundibulum, the enamel and the cementum; and it could also be observed the 03 permanent tooth germs starting to develop, with no visible structures.

**36 months (n=1):** In the radiographs it could be observed the permanent incisors 01, the deciduous 02 and 03 incisors, and also the permanent incisors 02 and 03 developing inside (in different stages). In the lateral oblique views and in the occlusal ones it could be observed also the canines tooth germs (04) that presents a big pulp chamber and are not erupted. In the CT it could be observed the advanced development stage of the 02 tooth germs that are next to erupt in some months. The 03 teeth germ has not differentiated materials yet. With this technique is more clear the development of canine teeth, to have an idea of when they will erupt.

**46 months (n=1):** The radiographs show the permanent central incisors (01) that are completely developed; the permanent 02 are also erupted, but not totally developed and not in contact yet, with the development of the mandibular more advanced than the maxillary ones. Deciduous incisors 03 are also present, with short crowns and the permanent incisors 03 developing under them; enamel’s shape with a wide infundibulum, and a big central pulp chamber are evident inside the permanent ones. It could be also seen the tooth germs of the canines, more developed, with a clear enamel’s
shape and a big central pulp chamber inside them. In the lateral radiographs it could be seen the permanent 03 that are clearly formed. In the CT scan are more clearly seen that the permanent incisors 02 are not in occlusion. The permanent incisors 03 could be clearly seen in the radiographs and in the CT scan, but not in the live horses because they have not erupted yet. (Figure 2)

60 months (n=1): In this radiographs it could be appreciated that all the permanent incisors have erupted and are in occlusion, in all them could be observed the open apex, with a narrower space in the case of the incisors 01 than in the 02 and 03. It could be clearly observed all the structure of the permanent incisors with the peripheral and infundibular enamel, the dentin, the cement and a wide central pulp cavity.

**Discussion**

Previously reported papers described methodically the radiographic techniques of the incisors and different pathologies (Barrat, 2007, Butler et al, 2008, Barazkay, 2011). It is well described the anatomy (Dixon, 2011) and radiology (Barakzay, 2011) of the incisors in foals, but not at different ages.

Computed tomographic examination of equine dental structures (Puchalski, 2006, Saunders and Windley, 2011; Simhofer y Boehler, 2011) focused attention on cheek teeth and temporomandibular joint but not in the incisors teeth at different ages.

In a previous paper we studied the changes present in the dentition of two foals with Wry nose. CT scan provided plenty information about bone asymmetry and its dental effects that were not observed with the X-rays (Novales y col, 2013).

Lateral projection showed limited information except the type of occlusion. Lateral 30° dorsal-lateroventral oblique projection provided information about 02 and 03. Dorsoventral projection with laterally displaces mandibles are interesting in order to see better the corner incisors (Barazkzai, 2011). Intra-oral projection give us the best radiological information on the different incisors teeth.

The CT scan provided the best information in axial slices. The information in sagittal and dorsal planes are more limited for veterinary dentistry. The three-dimensional (3D) reformatted renderings allowed excellent spatial recognition of the incisors teeth.

**Conclusion**

The correlation between X-rays and CT scan provided excellent information about the evolution of the incisor teeths in the young horse. It could be a good help to teach veterinary dentistry.

**References**


Equine dentistry


A computed tomographic and histopathological study of equine cheek teeth infundibular lesions

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Several studies have found equine maxillary cheek teeth infundibular disorders to affect most adult horses. Even infundibulae that appear grossly normal on the occlusal surface may contain areas of caries, defective cementum, or complete absence of cementum subocclusally. These defects can range from possibly insignificant small developmental cemental defects deep in the infundibulum to advanced coalescing infundibular caries leading to dental fracture.

The aim of this study was to characterize maxillary cheek teeth infundibular disorders by computed tomographic, and histopathological examinations of affected teeth. One hundred maxillary cheek teeth that contained 200 infundibulae were extracted post-mortem from 30 horses, including 82 teeth with and 18 without occlusal surface infundibular caries. All teeth were examined visually and imaged by computed tomography (CT) to detect the presence and appearance of any subocclusal infundibular cemental abnormalities. Computed tomography showed 182/200 (91%) infundibulae to have infundibular lesions deep to the occlusal surface. No statistically significant association was found between the presence of subocclusal infundibular defects or the presence of visible occlusal infundibular lesions. As the subocclusal cemental lesions appear to be unrelated to the presence of occlusal surface lesions, the relationship between infundibular cemental lesions (both occlusal and subocclusal) and the development of clinical sequelae remains poorly understood.

Eight maxillary cheek teeth were then imaged using micro-computed tomography (microCT) which provided much finer details of infundibular lesions. MicroCT images were also used to guide the sites of sectioning of teeth for histopathological analysis, which found that the appearance of infundibular cementum was much more variable than its appearance on standard CT or microCT. The cementum of many infundibulae showed extensive sites of former vasculature that were not filled with cementum. Other areas contained moth-eaten cement which often contained plant material and cellular debris, independent of the appearance of the occlusal surface of the infundibulum. No histological evidence of previous vasculature or of haemoglobin breakdown products were found in infundibular cementum. Analysis of the Hounsfield Units (measurement of density of tissues on CT scan) and their relationship to the histological appearance of the same tissues may allow us to determine if an infundibulum contains normal or hypoplastic cementum, or impacted feed material without more invasive investigatory methods.

This study also proposes a relationship between the presence of developmental infundibular cemental lesions and later caries formation. Even in those infundibulae with no apparent occlusal surface infundibular caries, the subocclusal region often contained hypoplastic cementum and, often, impacted feed material at the most apical aspect of the infundibulum on histological examination. Therefore, there must be a communication between the apical portion of the infundibulum and the occlusal surface for this to occur, even in those that appear unaffected by a vascular channel defect.
or infundibular caries. It is likely that subocclusal cemental lesions, particularly areas of apical cemental hypoplasia, become impacted with feed material even before they are exposed on the occlusal surface, which may allow severe (Grade 2 or 3) infundibular caries to form subocclusally long before that portion of the tooth is exposed.

Effectiveness of the infundibular debridement and restoration of equine maxillary cheek teeth as assessed by computed tomography

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Equine maxillary cheek teeth each contain two crescent-shaped infundibule that extend for most of the crown length. These enamel infoldings evolved to increase the exposed surface enamel in the central portion of the maxillary cheek teeth in order to compensate for the more extensive infolding of peripheral enamel in the mandibular cheek teeth. Theoretically, infundibulae should be completely filled with normal cementum, but recent studies have shown that this is rarely the case, with up to 90% of cheek teeth infundibulae incompletely filled with normal cementum, varying from porous and discoloured cementum to gross necrotic food and caries of infundibular structures. Dental caries is defined as a demineralization of calcified dental tissues and destruction of the organic components of the tooth due to bacterial action. The progression of infundibular caries often leads to the midline sagittal fracture of maxillary cheek teeth, invariably followed by periapical infection of the tooth and paranasal sinusitis, often requiring exodontia of the tooth.

To prevent the progression of caries and to improve the mechanical strength of affected teeth to prevent fracture formation and/or apical infection, restoration of carious infundibulae has been performed. This procedure involves the removal of food and debris from carious infundibulae followed by disinfection of the infundibulum, and then filling the defect with composite materials used for human endodontic procedures. The cleaning was initially performed via high-pressure micro-abrasion with fine aluminium hydroxide particles, but this technique alone was shown to be ineffective. Techniques have since been developed using dental drills to more effectively remove feed material and carious cementum from affected infundibulae which, anecdotally, appear to be much more effective in removing debris from deep infundibulae. The aim of this study was to evaluate the effectiveness of a dental drill technique at removing debris from carious infundibulae and also to assess the effectiveness of filling of the cleaned infundibulae with endodontic restorative material via CT scan following effective cleaning.

The heads of 13 adult horses of different breeds with unknown clinical histories, aged by their dentition and from clinical records were selected from a local abattoir at the postmortem room of the R(D)SVS Veterinary School. 21 teeth were then extracted and stored in formalin on the basis of having grade 2 or grade 3 infundibular caries evident on their occlusal surfaces, either in one or both infundibulae. All 21 teeth were then imaged using computed tomography to determine the location of any infundibular cemental lesion. 36/42 infundibulae available were suitable to undergo debridement and restoration ex vivo. Each carious infundibulum was cleaned of loose food debris using a dental pick, high- and low-speed dental drills, and pressurised distilled water followed by use of Hedstrom files. All teeth were then examined again visually, were removed from the mount, and were imaged by CT to assess the completeness of the debridement. The use of dental drills in this
study greatly improved the success of infundibular debridement, with 86% of treated infundibulae completely debrided.

Thirty infundibulae were sterilised with a combination of Calcium EDTA and sodium hypochlorite, and then underwent infundibular restoration. A single component light-cured, self-etching adhesive was spread over the surface of the defect followed by a flowable dental composite. Following restoration, the 30 restored infundibulae were imaged by computed tomography with the presence of defects in the filling along with the volume of the restoration and filling defects (air bubbles) in the restoration. In 29/30 infundibulae, the restoration effectively filled the apical extent of the cleaned infundibulum. Some type of filling defect was present in 80% of restored infundibulae, including air bubbles within the restoration and linear defects at its junction with the infundibular wall. However, the restoration would hopefully prevent further food impaction into the infundibulum and, in conjunction with disinfection of infundibulae with sodium hypochlorite, would help prevent further caries development as well as mechanically strengthening the tooth, although microleakage around dental fillings often leads to recurrence of caries in humans.

Using a combination of high- and low-speed dental drills is an effective method to clean infundibulae of necrotic food and degrading cementum. Current techniques used for restoration are able to fill the depth of the infundibulum, however many defects still remain within the restoration that may affect its mechanical integrity. Peer reviewed studies involving long-term follow-through and or case-control studies have not been published to date. Other concerns remain regarding the long-term value of infundibular restoration techniques in horses as opposed to humans or small animals, including the durability of the composite when undergoing significant occlusal and shearing forces and the obvious defects found deep within the infundibular filling even when meticulously performed. Further studies are needed to determine when and if infundibulae should be restored, and if the current techniques used for restoration are effective in vivo.

Establishing risk factors for peripheral dental caries in the western australian horse population

Kirsten Jackson, Marc Tennant and Erin Kelty

Background: Peripheral caries has a high prevalence within the Western Australian (WA) horse population and is a cause of considerable dental pathology and pain. At present, risk factors for the condition are poorly understood, making treatment and prevention difficult.

Objectives: To assess the prevalence, severity and potential risk factors involved in peripheral dental caries in horses in Western Australia.

Study design: Cross-sectional epidemiological study.

Methods: A client survey of 500 WA horses was performed in 2 sections; the first was completed by the client, asking about the horse’s signalment, diet and husbandry conditions. The second section was completed by the veterinary dentist and contained information about the oral health of the patient. A multivariate logistic regression model was used to assess risk factors associated with the presence of caries.
**Results:** Overall, caries were present in 58.8% of surveyed horses. Breed was found to be significant, with thoroughbreds being more likely to have the caries than other breeds. Dietary risk factors included feeding oaten hay, with meadow hay being protective. Horses with more access to quality pasture all year around were less likely to have the caries compared with horses without access to grazing, as were horses on bore water compared with horses on rain or scheme water. There was also found to be a strong correlation between peripheral caries and periodontal disease.

**Conclusion:** Management factors that may help prevent or improve peripheral caries include more access to quality pasture, using bore water, feeding meadow hay and avoiding oaten hay.

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**Epidemiological, microbiological and pathological study of peripheral caries in UK horses**

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Equine peripheral caries (PC) is believed to be caused by acidogenic bacteria which use fermentable carbohydrates as a substrate to form acids that gradually destroy the calcified dental tissues. In contrast to infundibular caries, PC is a not very well studied disease in horses, but its recognition and/or prevalence seems to have increased over the last decade. Peripheral caries can cause abnormal dental wear, tooth fracture, apical infection, diastema formation and periodontal disease and because these can be painful conditions, PC can seriously affect the welfare of horses.

The aims of the study were to determine the prevalence of PC in UK horses as well as finding potential risk factors for its development; to gain insight into the aetiopathogenesis of PC by establishing which bacteria are involved in the disease process and by examining the carious lesions histologically and ultrastructurally.

Questionnaires and dental charts were sent out to 19 veterinarians and 6 dental technicians and 706 completed forms were returned and their data were analysed using R software. Dental plaque samples were taken by swabbing the palatal aspect of maxillary cheek teeth of horses and the biofilm samples were processed using conventional and molecular techniques.

The results showed that peripheral caries is a common disease in the UK (51.7% prevalence), with regional differences in prevalence. Cheek teeth diastemata and multiple concurrent dental disorders and infundibular caries were identified as potential risk factors for the development of PC. However, no major link with diet was observed. The molecular bacteriology study allowed many different bacteria to be identified and it is currently being investigated whether there were significant differences between caries affected and control cheek teeth.
Genetic study of congenital brachygnathia of thoroughbred horses

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Introduction

Parrot mouth is a problem that affects 2-5% of foals to varying degrees (Easley and Schumacher, 2010). Horses with an overjet may appear outwardly normal at birth but as the incisive bone drifts ventrally creating an overbite between birth and 4 months of age the condition become noticeable. Even minor deviations in the alignment of the jaws can create abnormal tooth wear, problems with eating, and interfere with use of the bit. The condition is thought to have both hereditary and environmental components. Evidence for hereditary influences have been described for Thoroughbred horses (Reviewed in DeBowes and Gaughan, 1998; Hennig and Steckel, 1995).

The condition exists in other species and genetic studies have implicated genes as a contributing factor. A study in sheep implicated genes on sheep chromosome 2 (OAR2) and suggested a recessive mode of inheritance (Shariflou et al., 2012). Studies in humans implicated the gene MATN1 (Jang et al., 2010). Studies of the Swiss horse breed, Franches-Montagnes, implicated a region on horse chromosome 13 (ECA13). The authors noted that the results implied a complex genetic inheritance, probably with involvement of multiple genetic systems.

The purpose of this study was to investigate genetics contributing to parrot mouth among Thoroughbred horses. Molecular genetic tools have become available in recent years which make it possible to test relatively small numbers of horses using large numbers of genetic factors to uncover evidence for hereditary effects. One of the most common approaches is called genome wide association studies (GWAS) and was used for the three studies cited in the previous paragraph. This is an approach that became available following the completion of the whole genome sequence of the horse. Sequencing studies led to the discovery of more than 1 million genetic variants occurring in the DNA of horses. The variants are identified as changes in the identity of a nucleotide base at a specific position. Such a variant is referred to as a single nucleotide polymorphism (SNP). Assay tools were created to assess the presence and absence of SNPs among horses. Dividing the groups into those with parrot mouth and those without parrot mouth makes it possible to ask the question whether any of the SNPs are more common among one group than the other. When a difference in the distribution of SNPs occurs at a statistically significant level, this constitutes evidence for a hereditary effect by genes in that region. Additional studies are necessary to identify the genes responsible for the effect.

Materials and Methods

Cases: 25 thoroughbred horses were identified with parrot mouth as defined by meeting the following three criteria:
- A complete incisor over jet with no upper and lower incisor occlusal contact
- The upper 2nd premolars must have some degree of rostral malocclusion
- No history or outward signs of mandibular or maxillary trauma

Controls: 125 controls were selected from among a set of 467 Thoroughbred horses tested as controls in other projects. None of the horses had been examined for brachygnathia and reflect an
unselected population of Thoroughbred horses. Initially, horses were compared with the cases using principal component analysis; 147 that appeared genetically most distant from the controls were removed from the set. Subsequently, horses were removed at random to reduce the number to 125.

**Testing:** DNA samples were tested on the Illumina SNP70 chip. The controls and cases were tested at different times at Geneseck (Lincoln, NE). Initially, 69,681 SNPs were tested. SNPs with call rates less than 95%, MAF less than 0.05, greater than 2 alleles and which exceeded HWE with P< 0.001 were culled, resulting in a set of 44,091 SNPs used for analyses.

**Analyses:** Data were analyzed using the Golden Helix software (Bozeman, MT) “SNP and Variation Suite 7” v. 7.7.6. Analyses were run for basic allele test (D vs d), genotype test (DD v. dd v. Dd), Additive model (dd=> Dd => DD), Dominant model (DD, Dd v. dd), recessive model (DD vs Dd , dd) where D is minor allele and d is major allele and comparing haplotypes using a moving window of 5 SNPs.

**Results**

The distribution of the 44,091 SNPs among the control horses and the horses with parrot mouth were compared. The data was analyzed for evidence of differences between the two groups as a consequence of recessive genes, dominant genes or additive action by a gene. In no cases did the differences between the two groups achieve statistical significance as indicated by P values less than 5 x 10^-7. We did observe strong peaks reaching P values of 1 x10^-6 on horse chromosomes 5 and 22. We did not observe evidence for differences between the two groups on horse chromosome 13.

**Discussion**

Our results did not implicate any region of the horse genome as being associated with parrot mouth in Thoroughbred horses with statistical significance. The large differences observed on chromosomes 5 and 22 were intriguing and bear further investigation.

One of the advantages of our study was the use of Thoroughbred horses because of their genetic homogeneity. If the cause of parrot mouth among Thoroughbred horses was a simple recessive, we had the power to detect the effect. However, it is doubtful that we would be able to detect the effect of dominant gene action or complex genetics at a statistically significant level with this small number.

We did not confirm the report by Signer-Hasler and co-workers (2014) for an association on horse chromosome 13. Furthermore, their results did not suggest an effect on horse chromosome 5 and 22. The large number of horses in their study and the statistically significant association on chromosome 13 are compelling. The differences between the two tests may be a consequence of random variation between results, the power of their test and differences between the breeds for the hereditary nature of parrot mouth. Indeed, Signer-Hasler and co-workers (2014) noted that they could not explain the results based on a simple mode of inheritance and suggested involvement of multiple loci.

The complexity underlying the results of the Signer-Hasler study and the intriguing results with the Thoroughbred suggest further investigations with Thoroughbred horses and attention to these regions is warranted. This approach will also benefit from the recent development of a tool to assay 760,000 SNP as compared to the 49,000 SNPs tested in this study.

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Lateral mandibular excursion to cheek tooth contact (LMCT) measurement as a predictor of dental pathology in the horse

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Reasons for performing study: Hypothesis: horses with dental pain alter mastication patterns to avoid contacting the pathological region; unilateral pathology may result in contralateral mastication, and an uneven LMCT reading. This test may demonstrate chronic dental pain, and be used as an aid to assessment of dental pathology in the absence of other clinical signs, or diagnosis of chronic dental pain in cases with less obvious diagnostic imaging findings.

Objectives: Report measurements of LMCT in 129 referral and routine dental cases and analyze results against pathology found. Methods: 129 horses of mixed age, sex and breed that underwent dental examinations over a 2 month period were measured for LMCT by simple measurement with a hand held ruler prior to full oroscopic and radiographic examinations under standing sedation.

Results: For 68 horses with symmetrical LMCT, the hypothesis was positive in 90% of cases, those horses having no or bilaterally symmetrical pathology. LMCT was generally bilaterally reduced in cases with pathology, compared to those without. In 61 cases of uneven LMCT, the hypothesis was positive in 78% of cases, those horses having marked unilateral dental pathology. Those with the highest differences in LMCT measurement generally had the worst pathology scores.

Conclusions: LMCT measurement appears to be a simple method of demonstrating altered mastication patterns due to dental pathology in the horse, proposed to be a result of chronic dental pain.
Celebrating 100 years of maxillary nerve analgesia: What have we learnt?

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With the discovery of the local anaesthetic effect of cocaine in 1884, the era of local and regional anesthesia began in human and veterinary medicine. A technique to insert a needle to the maxillary nerve of the horse for the purpose of desensitising the horses' ipsilateral forehead and upper molar arcade was first described by Bemis in 1917. The maxillary nerve block of major importance for performing upper cheek tooth extractions in the standing sedated horse and is considered essential in diagnosis of idiopathic headshaking. Bemis' entered a long needle (> 7cm) perpendicular to the skin just ventral to the facial crest at the level of the lateral canthus of the eye until the pterygopaltine bone was touched. The same technique is still widely used by equine practitioners, but modified approaches have been established since then, which aim for more accuracy and less side effects. The needle may be advanced obliquely from caudolateral beneath the zygomatic arch in the direction of the last molar tooth on the opposite side to reach the nerve entering the maxillary foramen, also, to avoid inadvertant puncture of the maxillary artery and it's branches, a perpendicular needle insertion with lesser advancement has been suggested. These approaches rely solely on external anatomical landmarks for needle advancement to the maxillary nerve. The variety of descriptions of these techniques found in the literature imply inconsistencies in needle placement and the rather long distance from skin to the nerve trunk makes this nerve block inherent for inaccuracy and adverse effects. Experience of the clinician and the repetitive use of this nerve block seem to be of upmost importance to reach the closest circumference of the nerve with the needle tip and, to avoid puncture of surrounding vessels.

Haemorrhage of the maxillary, infraorbital, malar, sphenopalatine, major and minor palatine and buccal artery, as well as the transverse facial and infraorbital vein may occur and cause severe haematomas of the periorbital region with dorsal displacement of the retrobulbar fat body. The use of less traumatic needles, such as epidural needles instead of spinal needles, may reduce vessel damage. If acute hemorrhage occurs it is recommended to position the head high for several minutes to reduce the extent of hematoma formation. Cool packs can be applied and the horse should be treated with anti-inflammatory drugs until the swelling resolves, which usually takes 2 to 4 days. Other adverse effects have been reported and they are related to the traumatic effects of the procedure itself or caused by induced infection. They range from conjunctivitis, blepharospasm, third eyelid prolapse to more severe consequences, such as exophthalmus or meningoencephalitis. Touching the nerve fibres with the needle tip provokes head jerking movements in some horses, these may sometimes be explosive defense reactions, so alertness should be given at all times when performing the maxillary nerve block. Contact upon the nerve with the needle should be avoided, also because traumatic disruption of nerve fibres may lead to permanent neuropathy.

Inadvertent intra-vascular local anaesthetic injection may cause severe central nervous system crisis, ataxia or collapse. Transient blindness can be noted when the anesthetic molecule is inadvertently injected into the optic cone, or hemorrhage of bulbar vessels may lead to permanent blindness or

Ultrasound guided approaches have been introduced in order to reduce adverse effects. Real-time visualisation of needle advancement to the nerve in the plane of the ultrasound beam allows avoidance of inadvertent vessel puncture and precise deposition of local anesthetics. An ultrasound
Equine dentistry

A machine with a microconvex transducer must be available and the procedure may be time-consuming. The visualisation of the needle with ultrasound-guidance may be enhanced using needles with an ‘echo-coated’ surface, thus rendering the technique more efficient, although this has not been scientifically confirmed.

The anaesthetic molecule used varies between authors of related publications. Lidocaine and mepivacaine are widely used and different volumes of local anaesthetic are stated to be injected ranging from 5ml to 40ml. Most clinicians use in between 10ml and 20ml of local anaesthetic. The optimal anaesthetic molecule and volume remain to be determined in further studies.

The embedding of the large diameter nerve trunk (~1cm) in mostly fat tissue and it’s direct contact to the sphenopalatine bone plate on its medial side must be considered in particular. It may be beneficial to use local anaesthetic molecules which have low lipid solubility, e.g. Bupivacaine, in order to prolong the time of action. The thick diameter and the walling-off by the sphenopalatine bone may prevent complete diffusion into the core and medial fibres of the nerve and this could be one explanation why some clinicians state inefficiency in desensitisation. Other explanations are injection of insufficient anesthetic volume, impermeability of the epineurium or pre-existing neuropathy. The buccal nerve innervates parts of the cheek and variations or alternatives in sensory pathway may exist.

The maxillary nerve block is a mainstay in modern equine dentistry and without it’s application many standing procedures would not be feasible. Nevertheless, adverse effects of variable incidence and severity can concur and must be considered when performing maxillary nerve analgesia. Its efficacy improves with understanding and practice of the techniques of approaching the maxillary nerve.

References

Ultrasound-guided equine dental surgery

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Ultrasonographic imaging has long been used in imaging of many body systems of the horse, especially the musculoskeletal, abdominal, cardiac, thoracic, ophthalmic and recently the upper respiratory tract. Ultrasonographic assessment of the head has usually been limited to examination of swellings and suture line periosteal reactions. However, with the increasing use of transbuccal extraction techniques, the practice of ultrasonography in equine dentistry is increasing and may be of use in surgical planning and guidance.

Facial and mandibular swellings

Ultrasound is commonly used to assess the architecture and anatomy related to facial and mandibular swellings, some of which might be associated with periapical infections (Dixon et al 2014). Firm mandibular swellings related to the bone or adjacent to it are easily examined using ultrasonography in a standing and sedated horse. If present, draining tracts may be identified, or their path through the tissues determined for surgical planning.

Ultrasound-guided MTE cannula placement

The MTE extraction technique requires placement of a cannula through the tissues of the equine cheek, and avoidance of multiple neurovascular and ductal tissues (Stoll et al 2011). With a good knowledge of the anatomy of the equine head many of these structures can be located using a combination of palpation and visualisation in most horses. In some patients, especially those considered over weight, this might be difficult. Additionally, in some horses there are branches of the main neurovascular structures than may be overlooked using this method alone. Ultrasonographic assessment, often using a routine linear probe, can reveal many of these structures and access to Doppler functions can identify vascular structures that may otherwise be neglected. Following placement of a catheter, the parotid duct can be identified using transcutaneous ultrasound examination.

Along with identification of the tooth or dental remnants by palpation and radiography, thorough ultrasonographic examination of the face prior to cannula placement can allow mapping of the safest location. In some cases this may result in less than optimal angulation and approach to the dental tissues, but should prevent severe haemorrhage and potentially career-ending nerve damage.

Ultrasonographic interdental space location

Placement of intraoral wires in the cheek teeth interdental spaces is used in a number of situations, including rostral mandibular or maxillary bone fractures, premaxilla fractures, incisor avulsions and correction of severe growth abnormalities. The wires are often passed though a needle inserted transbuccally. This reduces the risk of metal fatigue caused by the bending that would usually result from placing them intraorally. As with the placement of a transbuccal cannula, it is often prudent to use ultrasound to identify the underlying neurovascular and ductal tissues to avoid intra- or post-operative problems.

Additionally, the identification of the interdental spaces can easily and accurately be identified using transcutaneous ultrasonography. If performed in a sterile manner, this can provide a very qui-
ck and accurate placement of Steinmann pins and large gauge needles in the interdental spaces as close to the gingiva as possible. This technique, not only increased the efficiency of the procedure, but also can help to reduce damage to adjacent tissues and collateral morbidity.

**Mandibular and maxillary fracture location**

Many fractures of the head and jaw are amenable to repair in the standing horse, using a variety of fixation methods. Diagnosis of the injuries is usually made using radiography, scintigraphy, computed tomography, or a combination of these modalities. Correct placement of implants in essential and mapping of the fracture site intra-operatively is usually advantageous but difficult. Radiography of the head is notoriously limited due to superimposition of structures and angulation that may result in confusion regarding fracture configuration. Intraoperative CT would likely be expensive and time consuming. Sterile transcutaneous ultrasonography can provide the surgeon with a clear indication of the location of fracture margins and fracture fragments. As discussed previously, it will also provide essential location of adjacent neurovascular or ductal tissue before insertion of implants.

**Ultrasound guided local anaesthesia**

Local anaesthesia of regions of the head, to allow surgical procedures to be performed in the standing sedated horse, can be facilitated by ultrasound-guided injections. Determination of the nerves emanating from the infraorbital canal and mental foramina, may be useful in some individuals where palpation is retarded by facial swelling or obesity. In addition, a number of techniques have been described to facilitate accurate provision of a maxillary nerve block (O’Neill et al 2014, Notrott et al 2016), and help prevent inadvertent vascular trauma.

**References**


Ultrasound-guided Inferior alveolar nerve block in the horse: a validation of the extra-oral approach in cadavers

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**Introduction:** Blinded techniques to desensitise the inferior alveolar nerve (IAN) include an intra-oral, extra-oral oblique and vertical approaches with a success rate of 100%, 73% and 59% respectively. It has not been determined whether an ultrasound guided extra-oral approach to the IAN is feasible and if a low volume would avoid desensitising the lingual nerve.

**Objectives:** To develop a low volume ultrasound-guided extra oral IAN block technique and determine if differing volumes would influence stain uptake by the relative nerves.

**Methods:** An ultrasound guided approach to the IAN block was conducted with a microconvex probe and an 18g 15 cm length spinal needle using a small (2.5mls) and a large volume (5mls) of solution containing equal measures of an iodinated-contrast and methylene blue mixture. Accuracy was assessed by contrast seen at the mandibular foramen on computed tomography (CT) and methylene blue stain uptake by the relative nerves on dissection.

**Results:** Assessment by CT and by dissection determined a success rate of 78% and 65% respectively. 65% of the injections had inadvertent staining of the lingual nerve.

**Conclusion:** The technique is challenging and is no more accurate than previously published blinded techniques. Any extra-oral approach to desensitise the IAN is likely to also block the lingual nerve.

Facial suture periostitis: not such a rare condition

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**Reasons for performing study:** Suture exostosis is an intriguing and not uncommon pathology that should be included in the differential diagnosis of horses presented with facial swelling. Affected horses gradually develop a uni- or bilateral, firm, non-painful swelling in the frontal region of the head with the exact localization dependent on the affected suture line. This swelling is generally self-resolving and is likely to be only of cosmetic importance unless secondary epiphora develops.

The disease is commonly reported in complication lists of reviews on sinus disease or as singular case reports with idiopathic appearance. However, reviews on large case series are not available.
Additionally, the exact etiopathology has not been clarified.

**Objectives:** Report on large collection of cases in order to clarify etiopathogenesis and improve treatment.

**Study Design:** retrospective multicentre study

**Methods:** Information regarding breed, age, gender, history of trauma / surgery / sinus pathology, imaging findings, treatment, response to treatment and follow up data was collected of horses reported with suture exostosis.

**Results:** 42 cases were reported with mean age of 10 years and with mix in breed and gender. Analysis revealed the cases could be grouped in 4 entities: 16 developed following sino-nasal surgery, 8 following trauma, 5 with underlying sinus pathology and 13 idiopathic. No statistical difference in age, gender nor breed amongst groups was identified.

In 24 cases a sequester was identified and removal was needed for resolution. Other treatment consisted anti-inflammatory or no treatment. Resolution was obtained in most cases after 3 months to 1.5 year.

**Conclusions:** The etiopathogenesis of suture exostosis seems to consist of different entities. Before concluding in an idiopathic case, identification of an underlying cause is important. Particularly identifying the presence of a bone sequestrum and/or infection is important to obtain resolution.

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**Culture independent detection of known human periodontal pathogens in equine periodontal disease**

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**Objectives:** Equine periodontitis (PD) is a common and painful disorder. Despite this, the disease often goes unnoticed by owners and is thus a major welfare concern. The aetiopathogenesis of the condition remains relatively poorly understood with few recent studies performed. Although the equine oral microbiome has recently received attention further studies are required to identify potential equine periodontal pathogens.

**Methods:** Study 1: Subgingival plaque samples from 18 horses with PD and gingival swabs from 5 orally healthy horses were collected. Bacterial DNA was extracted and precipitated using a Masterpure Gram +ve extraction kit. Previously validated primers for known human periodontal pathogens Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, Prevotella intermedia, Tannerella forsythia and Veillonella dispar were synthesised commercially and used in triplicate RT-QCR reactions.

Study 2: In addition, following DNA extraction, bacterial whole genome sequencing was performed on a different set of five plaque samples from diseased horses and 3 orally healthy swabs.
**Results:** Significant increases in abundance of *P. gingivalis* (p=0.04), *P. intermedia* (p=0.001), *T. forsythia* (p=0.006) and *V. dispar* (p=0.05) were detected by QPCR in the periodontitis samples. Over 75 species of *Prevotella* were detected following whole bacterial genome sequencing with significant increases in *Prevotella bivia* (p=0.003), *Prevotella dentalis* (p=0.006) *Prevotella denticola* (p=0.0007), *Prevotella intermedia* (p=0.003), *Prevotella melaninogenica* (p=0.002) and *Prevotella nigrescens* (p=0.003) in diseased samples. *Peptostreptococcus anaerobius* was also significantly increased in disease (p=0.00007) however no further known human periodontal pathogens showed a statistically significant change between oral health and periodontitis in the horse, following whole genome sequencing.

**Conclusion:** Known human periodontal pathogens were shown to increase significantly in equine periodontitis, including several species of *Prevotella*. Many previously uncultured species of *Prevotella* were identified by whole genome sequencing. These are likely to be equine specific and may be involved in equine PD. It is unclear whether the increased growth of these species is due to the more favourable environment created by the deep equine periodontal pocket, or whether these bacteria are important in the aetiopathogenesis of the disease and further studies are required to investigate their immunogenicity in equine gingival tissue.

**Influence of dental substances on cells of the equine periodontium**

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There are various therapies for the treatment of equine periodontal disease. In moderate cases it is recommended to fill the interdental pockets with dental substances to cover the inflamed tissue and prevent re-impaction of food after cleaning and debridement. These substances are usually adopted from human dentistry where they are used for different fields of application. The aim of the present study was to evaluate their effects in a specific equine in-vitro model with equine periodontal fibroblasts. The cells were confronted with four dental substances (*PeriCare®, Provicol®, Calxyl®, Honigum®*) for various periods of time. After that the viability was determined by MTT-tests. In parallel RNA was extracted and qPCR analyses were performed to quantify the expression of pro- and anti-inflammatory marker genes. The data were compared to untreated controls and also to cells in which inflammation was induced by lipopolysaccharide.

Results show that two substances (*PeriCare®, Provicol®*) did not harm the cells, while the other two substances (*Calxyl®, Honigum®*) had negative effects on viability and triggered expression of pro-inflammatory markers.

High biocompatibility of the applied substance is a general requirement for the treatment of periodontal disorders. To investigate more complex interactions of applied substances with the tissues of the periodontium under in-vivo conditions, subsequent clinical studies are recommended.
Are periodontics of potential value in equine dentistry? – A review of human periodontics

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Periodontics (periodontal and therapeutics) was a term that started in the 1990s and is used to describe agents used specifically in the treatment of periodontal disease. In humans and small animals, microbial plaque is recognised as the primary aetiological agent in periodontal disease. Some of the key pathogens in periodontitis are *P. gingivalis*, *T. denticola*, *T. forsythia*, *A. actinomycetemcomitans*, *P. intermedia*, *C. rectus*, as well as other gram-negative rod anaerobes, spirochetes, enteric rods, and beta hemolytic Streptococcus.

Up until recently, antimicrobials have been the mainstay of pharmacological treatment of periodontal disease. Although, some of the disease process is attributable to the presence of pathogenic bacteria, there is a lot of tissue destruction due to the host-inflammatory response.

The microbial biofilm harbours bacteria that produce harmful enzymes that break down the collagen and host cell membranes (e.g. hyaluronidase, collagenses, protease). The host immune response then produces inflammatory cytokines such as interleukins, prostanoids, tumor necrosis factor and enzymes such as matrix metalloproteinases. There are also host anti-inflammatory cytokines and enzymes, which help to eliminate the bacteria and assist in the resolution of the periodontal disease. However, in cases where there is an excessive inflammatory response, either from overwhelming bacteria or an exaggeration of the host immune response, it may lead to further destruction of the periodontium. The purpose of host modulatory therapies is to slow progression of the disease and resolution of the disease by helping to moderate the immune response and stimulate regeneration of normal healthy tissue.

**Anti-infective/antimicrobial therapy**

Antimicrobial resistance is increasing globally in all species and judicious use of antibiotics is essential for the preservation of antibiotics. As bacteria are an aetiological agent in periodontitis, the use of antibiotics would seem prudent. But identification of an exact aetiological agent in periodontal disease can be very difficult as there will be several micro-organisms involved in the process and secondarily present. The use of anti-infective agents locally will allow for a greater concentration of the agent at the infected side with minimal risks associated with systemic use. However, the number of anti-infective agents available to deliver locally is limited and in cases of severe periodontal disease systemic antibiotics are helpful. In human periodontology, the most commonly use antibiotics are penicillins (amoxicillin, augmentin), tetracyclines (minocycline doxycycline), quinolones (ciprofloxacin), macrolide (azithromycin), clindamycin and metronidazole.

**Local anti-infective/anti-microbial agents**

- **Subgingival chlorhexidine**: resorbable delivery system of chlorhexidine gluconate (PerioChip)
- **Tetracycline containing fibres**: ethylene/ vinyl acetate copolymer fibre with tetracycline
- **Subgingival doxycycline**: gel system with 10% doxycycline
- **Subgingival minocycline**: sustained released minocycline spheres (Arestin)
- **Subgingival metronidazole**: oil based metronidazole 25% gel
Host modulation therapy

The aim of HMT is to reduce tissue damage and help with regeneration of the periodontium by modifying the host immune response such that it is less destructive and more protective and regenerative.

Systemic HMT

There are various HMT therapies aimed at specific mechanisms in the disease process.

Products acting against MMPs: sub-antimicrobial dose of doxycycline have the ability to inhibit MMPs. Biphosphonates have also been found to able to block the action of MMPs.

Products acting against the arachidonic acid metabolites: NSAIDs to stop the production of cyclooxygenase via the COX-1 or COX-2 pathways as well as leukotriens via the LOX pathway.

Products acting against the pro-inflammatory cytokines: cytokine receptor antagonists, anti-cytokine antibodies etc

Products to prevent bone resorption: Biphosphonates

Modulation of nitric oxide synthase: Nitrice oxide is a free radical that may cause excessive host tissue destruction in severe inflammation

Other host modulatory therapies: Probiotics have been shown to modulate cytokine profiles, but may also have a direct effect to alter the oral bacteria

Nutrients: Vitamin E, Vitamin C, carotenoids, omega 3 fatty acids. Cranberry juice contains molecules that inhibit MMPs, IL1, IL8 and PGE.

Local HMT

The purpose of local HMT is to promote wound healing and to stimulate regeneration of lost bone, periodontal ligament and cementum such that the entire periodontal ligament can be restored.

Enamel matrix proteins: during the development of the root and attachment apparatus, Hertwig’s epithelial root sheath produces enamel related protein-matrixes. There is a commercial product that is an enamel matrix derivative (Emdogain ®) that is believed to help with regeneration of periodontal fibres and alveolar bone.

Bone morphogenetic protein (BMP): stimulates mesenchymal cells to differentiate into bone and bone marrow cells (INFUSE ® bone graft and InductOST™)

Platelet derived growth factor: increase chemotaxis of neutrophils and monocytes, stimulate fibroblasts proliferation and extracellular matrix synthesis, increase proliferation and differentiation of endothelial cells, stimulate proliferation of mesenchymal progenitor cells and differentiation of fibroblasts

Biphosphonate: prevents bone resorption and helps with regeneration of bone grafts

NSAIDs: lipophilic and well absorbed in the gingival tissues.

Hypochlorous Acid and Taurine-N-Monochloramine: inhibit production of IL6, prostaglandins and other pro-inflammatory mediators.

Cimetidine: H2-(Histamine) receptor antagonist therefore has an inhibitory effect on the immune response. It has specifically been shown to be a potent inhibitor of P. gingivalis elicited inflammation

Conclusion

The use of perioceutics in the treatment of periodontal disease is growing as new agents are being researched. However, these are used adjunct to the mainstay of periodontal disease in humans (and small animals), which is scaling in root planning (SRP). SRP alone is associated with reducing pocket depths, increasing gingival attachment and decreased inflammation. The addition of perio-
Equine dentistry results in a greater improvement in periodontal disease.

In equine periodontal disease it is imperative to identify the underlying cause (e.g. diastema, displaced tooth, wear abnormalities) and treat these first. Removal of food, debris and debridement should be standard for treatment of all periodontal disease. The use of perioceutics in horses may be useful in cases with more advanced periodontal disease, but this will need to be assessed on an individual case by case basis.

References

Chronic sinusitis secondary to dental remnants as a complication of minimally invasive tooth extraction in a 10-year-old horse

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Minimally invasive transbuccal extraction (MTE) was developed to provide a direct approach to areas that are difficult to access within the mouth (Stoll 2011). MTE is recommended in cases of fractured crowns, absent crowns, malformed and dislocated teeth which may be challenging to extract by conventional methods (Stoll 2011). However, it can be associated with a number of complications such as; fracture of the tooth, further fracture of an already fractured tooth, sinusitis, wound dehiscence, facial nerve paralysis and alveolar bone damage. This case report describes the complication of dental remnants left in the para-nasal sinuses post MTE for a fractured cheek tooth (CT) 209, and the subsequent use of a maxillary sinus flap and lavage to manage the resulting secondary sinusitis.

A 10-year-old chestnut cob mare examined for a CT fracture, was found to have a parasagittal buccal slab fracture of CT 209 involving pulp horns number 1 and 2 on oral examination under chemical restraint and confirmed on oral endoscopy. Radiographs were obtained in order to fully evaluate the tooth. An attempt to extract the tooth via oral extraction under a constant rate infusion (CRI) of an alpha-2-agonist (detomidine at 0.50 mcg/kg/min IV) and maxillary nerve block, failed due to fragmentation of the diseased crown. Therefore, MTE under oral endoscopic and radiographic guidance was indicated. During the procedure; attempted removal of the palatine root unknowingly resulted in perforation of the alveolar bone into the rostral maxillary sinus (RMS). Post-extraction despite assiduous efforts to manage the socket, a persistent, chronic purulent nasal
discharge developed after 6 weeks and the alveolus failed to fully granulate.

A computer tomography scan was performed, which revealed thickening of the lining of the left dorsal conchal, caudal maxillary, RMS and ventral conchal sinuses but no evidence of liquid or solid purulent material. Mineral opacities were evident within the RMS lining caudal to the empty alveolus of CT 209. There was a discontinuity within the buccal portion of the alveolus which indicated a small antral fistula. Based on the computer tomography scan, the dental fragments within the RMS were the most likely cause of the persistent nasal discharge and non-healing of the alveolus.

Under standing sedation using a CRI of detomidine at 0.50 mcg/kg/min IV and local anaesthetic infiltration with lidocaine, a maxillary sinus flap (ostectomy) and frontal trephine portal were performed. The maxillary septum was removed. The area around CT 210 roots were curetted and the dental fragments identified on computer tomography removed. After bulla removal the RMS and CT 209 socket were curetted further. The sinus was thoroughly lavaged with saline and the CT 209 socket packed with dental impression material. A Foley catheter was placed into the frontal portal. The day following surgery the packing was changed. The sinus was flushed with warmed saline on a twice-daily basis thereafter. On the fifth day post-surgery mild infection of the socket was present but no communication with sinus was identifiable. The socket was debrided and repacked, and the Foley catheter was removed. The horse was discharged seven days after surgery. A week after hospital discharge some oedema was present around the eye and the caudal corner of the flap wound had broken down, the staples were removed.

A month after surgery mild signs of infection were still present around the caudal edge of the flap but this appeared to be resolving. A new packing was applied in the CT 209 socket. Six weeks after surgery the alveolus had filled with good granulation tissue covering the base of the alveolus. There were no further complications and 20 weeks after surgery both the facial wound and alveolus had completely healed.

Since MTE was first developed as an alternative to conventional oral extraction various complications have been described (Manzies and Easley 2014). However, it has been shown that complication rates and long term prognosis are superior in closed extraction techniques compared to open extraction techniques (Dixon et al. 2005). Sinusitis is one of the more serious potential complications. In this case penetration of the RMS due to the presence of cementoma resulted in a secondary sinusitis developing. Conservative treatment was attempted in first instance but after a month the amount of nasal discharge worsened. Non-invasive medical treatment is rarely successful in the management of secondary sinusitis (Dixon and O’Leary 2012). The computer tomography scan enabled the surgery to be approached in a more targeted fashion with a higher degree of confidence. Removal of the dental remnants which had been acting like a foreign body and a thorough curettage of the CT 209 socket were required to resolve the sinusitis. Timely repacking of the alveolus was vital to both remove potential causes of infection and assess the progression of the healing process and endoscopic guided cleaning and debridement were needed. Assessment of the alveolus with an oral endoscope allowed an objective evaluation of the healing process. There was a mild degree of wound breakdown at the caudal margin of the sinus flap, which is not uncommon, but as in this case usually causes no long-term cosmetic problems.

References


Minimally invasive treatment of equine paranasal sinus empyema – 78 cases (2009-2016)

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Introduction: Sinusitis is an uncommon disease and may be classified as either primary or secondary. Treatment of sinusitis involves removing an inciting cause, removing inspissated exudate and sinus lavage. This retrospective study describes treatment of 78 cases of sinus empyema with minimally invasive trephination and lavage.

Materials and Methods: Retrospective analysis of horses treated minimally invasively by the author for paranasal sinus empyema was performed. All horses must have been treated by minimally invasive trephination and lavage using both a frontal and caudal maxillary sinus portal under standing sedation. Descriptive statistics were gathered for diagnosis, sinus compartments involved, presence of inspissated exudate and complications from the procedure.

Results: Overall short term and long term success of the procedure was 66% and 77% respectively. Primary sinusitis was present in 54% of cases, dental sinusitis in 41% and oro-sinus fistulae in 5%. Inspissated exudate was present in 87% of cases. Complications were minor and were either swelling/drainage from the caudal maxillary sinus site (14%) or nasofrontal suturitis (6%).

Conclusion: Minimally invasive trephination and lavage is a successful technique in around 66-77% of cases, though refractory cases may also require osteoplastic flap techniques. Complications are minimal with the most prevalent being swelling or drainage around the caudal maxillary sinus site.

Orosinuidal and oronasal fistulas after tooth extraction, Ear cartilage transplantation in a donkey and comparison to other fistula treatments

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Introduction: Periapical bone resorption as a result of apical infections and interdental bone loss as a finding in severe periodontal disease can lead to fistula formation into a nasal meatus or into a maxillary sinus if the problems are located in the maxilla.

Often not before extraction of the diseased maxillary cheek teeth, the dimension of fistulas and bone loss can be realized. Treatment can be a huge challenge.

Some methods are described to increase the healing process and to obturate fistulas\textsuperscript{1,2,3,4}. One of the difficulties is to find and harvest tissue for tissue grafts or for transposition and to stabilize the tissue to close the defect. In humans and small animals ear cartilage is used to close comparable defects and fistulas.
Material and methods: To treat three huge oronasal and orosinuidal fistulas after cheek teeth extractions in a donkey, buccal mucosa was transposed and attached to the palate. Suture dehiscence occurred in areas of large fistulas. To stabilize the grafted mucosa and submucosal tissue over the huge defects, ear cartilage was harvested in the center of the ear and transplanted into the areas of large fistulas. The cartilage was shaped larger than the size of the fistula to give it some retention in the surrounding tissue and the cartilage was completely covered with mucosa.

Discussion: Air pressure differences during breathing and sneezing put a lot of force to transposed tissue over fistulas. If the transposed tissue is not stable enough, ear cartilage seems to be a well-tolerated tissue to stabilize these areas.

References


Surgical treatment of apical disease and/or mandibular osteomyelitis in New World Camelids: 18 cases (January 2011-September 2016)

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Reason for performing study: Apical disease (AD) is a common problem in New World Camelids. Nevertheless, few studies have been published concerning the results and long-term follow up of surgical treatment.

Objectives: To report the outcome and long-term follow up of surgical treatment for apical disease and osteomyelitis of the jaw bone in llamas and alpacas using a retrospective study design.

Methods: Medical records from January 2011 till September 2016 were used to collect disease history, examination findings as well as applied treatment strategy and short-term outcome. Telephone inquiries were performed to obtain long-term follow-up results.

Results: Of the 18 animals included in this study, 14 were female. Only 1/4 males was intact. Mean age was 4 years and 9 months (4.74 ± 3.11 years). Reported symptoms included decreased appetite (16.7%) and weight loss (38.9%). In 88.9% of the cases the detected abnormalities were located in the mandibula. Swelling was located at the maxilla in 1 animal. Another showed both maxillary and mandibular involvement. Swelling was located at the maxilla in 1 animal. Another showed both maxillary and mandibular involvement. External fistulation was visible in 10/14 animals diagnosed with AD and 3/4 animals diagnosed with osteomyelitis. Fewer animals showed oral fistulation, 4/14 and 3/4 respectively. In all animals, antibiotic treatment was attempted prior to referral which did not result in resolution of clinical signs. Osteomyelitis without apical disease was diagnosed in 4/18,
of which 3 animals were treated by surgical debridement and 1 animal was treated conservatively using antibiotics and NSAID’s. Long-term follow-up information (20 ± 12 months) is available for 3/4 of these cases. Both treatments resulted in a long-term disappearance of infection in all. However, in the one case treated conservatively and another case treated by surgical debridement, apical disease developed in the contralateral mandible 12 months post-treatment.

Apical disease combined with osteomyelitis was diagnosed in 14/18 animals. Euthanasia was performed in 3 of these given the severity of mandibular damage in these animals. In the remaining 11/14 cases with confirmed apical disease, surgical treatment included periapical curettage (1), oral extraction (3), lateral transcortical approach (LTA) and resulting repulsion (1) or LTA and subsequent extraction following periodontal ligament breakdown with dental elevators and burrs (6).

Two months after the initial treatment, 2/11 animals showed persistent fistulation and evidence of spreading infection. However, further follow-up for these animals was lost. Long-term follow-up information (22 ± 14 months) was available in 9/11 cases. In 2 of these animals in which 2 teeth were removed using a lateral transcortical approach, fistulation continued for 2 months after the start of the treatment but resolved after continued flushing and/or debridement. In all other 7 animals, healing was straight-forward.

**Conclusion:** The majority of llamas and alpacas admitted with a facial swelling were diagnosed with apical disease. The surgical treatment of animals diagnosed with apical disease and/or mandibular osteomyelitis, resulted in excellent long-term results in this study.

**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 (Traub-Dargatz and Dargatz 1994; Dias and Neto 2013). The jugular veins are usually affected because they are the most commonly used site to access venous circulation (Dolente et al. 2005). 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 (Dolente et al. 2005). 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 (Dolente et al. 2005). Penetrating buccal ulcers have been reported as a rare cause of jugular TPH in a horse (Matsuda et al. 2005). To the authors knowledge there is no reference in the literature on

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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 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 (Barakzai 2009) 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


Palatability in dogs of a breath-freshening product containing pomegranate, inulin and essential oils

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To ensure a high level of compliance, products dedicated to daily dental hygiene should be palatable. Cooldent® is a breath-freshening complementary feed for dogs which contains pomegranate concentrate, inulin and essential oils. The objective of this study was to assess the palatability of Cooldent® in dogs, even after extended storage.

Four one-day trials (A, B, C, and D) were conducted in an independent research centre experienced in performing palatability trials. Thirty one, 36, 35 and 35 healthy adult dogs of various breeds were included in trial A, B, C and D respectively. Each dog received one tablet from a freshly made box (trial A), and from boxes stored for 3, 12 and 24 months (trial B, C and D, respectively). Boxes were stored at 25°C. Two criteria were used to assess palatability: prehension and total consumption. Prehension was defined as the act of taking the product spontaneously into the mouth, independently of whether it was then consumed. Total consumption was defined as the act of swallowing more than 95% of the quantity of product offered.

The results showed that Cooldent® was taken spontaneously by 87% to 100% of the dogs (27/31, 34/36, 36/36 and 33/35 in trial A to D respectively). Total consumption ranged from 80 to 86% of the dogs (25/31, 30/36, 31/36 and 28/35 in trial A to D respectively).

In conclusion, Cooldent® was taken spontaneously and totally consumed by most dogs even after a 24-month storage period, which should promote a high level of compliance over time.

Intraoral x-rays survey for rabbits: Avoiding superimposition by using a bisecting angle technique

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This poster describes a way of obtaining images of non-superimposed individual teeth using a standard dental generator with intraoral Phosphor Storage Plates (PSP) by the bisecting angle technique. Among the advantages of this technique are visualization of dental structures, identification of early lesions and detection of occult pathologies.

The intraoral dental survey is considered to be the standard of care diagnosis in veterinary dentistry. Dogs and cats are regularly screened due to their predisposition to periodontal disease and tooth resorption lesions. With similar frequency, rabbits should also be screened due to their predisposition to Acquired Dental Disease (ADD), malocclusion and facial abscesses.

Considering that oral examination of a conscious rabbit is limited to the rostral portion of the
animal’s mouth and the majority of the tooth (the reserve crown) is subgingival and cannot be visualized during an intraoral exam, the full mouth x-ray survey should become part of the lagomorph’s annual checkup.

Current recommendations for a complete radiographic evaluation of a rabbit’s skull requires between three and six extraoral (EO) views. EO technique allows a good appreciation of elongation and malocclusion. Unfortunately, because of superimposition, individual teeth cannot be properly visualized.

In contrast, intraoral views provide excellent quality without superimposition of anatomy. The IO technique is also accessible and economical. The goal of a full mouth radiograph series is to obtain a detailed image of each tooth, which allows evaluation of individual tooth periodontium.

The equipment needed for an IO survey is listed below:

- Dental x-ray generator (wall mounted, portable, stand). Images may be obtained using a voltage of 60kVp or 70kVp, a current of 7mA, and exposure time between 0.032 to 0.063 seconds.
- Phosphor storage plates of various sizes*.
- Computer radiography imaging system: PSP scanning, computer software (conversion of images to DICOM) and a computer screen (imaging display).

<table>
<thead>
<tr>
<th>Plate Number</th>
<th>Size</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>2 x 3 cm</td>
</tr>
<tr>
<td>1</td>
<td>2 x 4 cm</td>
</tr>
<tr>
<td>2</td>
<td>3 x 4 cm</td>
</tr>
<tr>
<td>3-Slim*</td>
<td>2 x 5.4 cm</td>
</tr>
<tr>
<td>3</td>
<td>2.7 x 5.4 cm</td>
</tr>
</tbody>
</table>

For this technique the rabbit should be heavily sedated. Once sedation is achieved, the body is positioned and the head must be properly aligned. For maxillary incisors and cheek teeth the rabbit positioning should be sternal recumbency. The head and the palate are kept parallel to the table. For mandibular incisors and cheek teeth rabbit positioning should be dorsal recumbency. The ramus of the mandible should be perpendicular to the table to prevent upper airway obstruction.

The introduction and positioning of the PSP is achieved by sliding the PSP caudally until it again encounters resistance by the vertical ramus of the mandible. Do not push or force the PSP; this may result in trauma to the soft tissues.

Pet rabbit weight may vary from one to six kilograms and the selection of PSP size is directly proportional to the rabbit’s size and weight. The various PSP sizes are listed in Table 1 above and the

<table>
<thead>
<tr>
<th>Rabbit’s Wt. Kg.</th>
<th>Recommended size of PSP based on body Wt.</th>
<th>Size of the PSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 3.5</td>
<td>Incisors teeth 0-1</td>
<td>1</td>
</tr>
<tr>
<td>3.6 to 4.5</td>
<td>Peg teeth 3</td>
<td>2</td>
</tr>
<tr>
<td>4.6 to 8</td>
<td>Premolars and molars teeth 3 “Slimmer”</td>
<td>3</td>
</tr>
</tbody>
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Table 2 – Recommended plate number for specific tooth relative to rabbit weight.
The recommended PSP size for a specific tooth x-ray relative to the rabbit’s weight is shown in Table 2. When imaging the cheek teeth, the correct position of the PSP will result in the rostral end of the PSP being located behind the incisors or possibly at the level of the diastema. This positioning will ensure that the major portion of the PSP is located between the dental arcades.

For the incisors, the rostral edge of the PSP should be two-millimeter rostral to the cusp of the incisors. Whether shooting a maxillary or mandibular arcade, the PSP is placed on the dorsal surface of the tongue, as by doing so the PSP will be parallel to the hard palate and the mandibular ramus, and perpendicular to the long axis of the crowns of the cheek teeth.

Once the PSP is positioned, the x-ray beam should be aligned. With the bisecting technique, the x-ray beam is oriented perpendicular to an imaginary line that bisects the angle created by the long axis of the PSP and the long axis of the targeted teeth. Make sure that the target teeth are located in the center of the cone. In order to avoid artifacts, place the x-ray positional image device (PID) as close as possible to the rabbit’s maxilla or mandible and obtain the x-ray.

A summary of the rabbit positioning, beam direction and the recommended vertical bisecting angles are shown in Table 3.

Intraoral x-rays give the clinician a detailed status of the tooth and periodontium. The use of the intraoral dental technique also has the following additional benefits:

- The clinician may diagnose rabbit’s dental pathologies at earlier stages;
- Earlier adjustments in feeding habits; and
- Changing the recommended frequency of occlusion equilibration to prevent the progression of ADD.

Resorption, lysis, ankylosis, dysplasia, periapical lesions, cortical perforation and periapical lesions, facial abscesses, and nasal disease are some pathologies that can be confirmed with dental x-rays.

Images obtained by the intraoral technique can be used in combination with extraoral views to evaluate other skull structures and complement the information of the occlusion table status. The learning curve to obtain full mouth intraoral x-rays should be minimal considering that many vete-
Rinarians are familiar with the bisecting technique in cats and dogs.

*A list of references is available upon request.

### Autologous platelet rich plasma and hidroxiapatite in mandibular exodontia sites in dogs. Preliminary results

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Platelet rich plasma (PRP) is known as a source of growth factors to stimulate bone formation and soft tissue healing. Hidroxiapatite (HXA) is the main mineral component of the bone, and synthetic apatite has become a common osteoconductive material. This study aimed to evaluate the efficacy of PRP in bone regeneration when mixed with HXA and grafted in mandibular sockets. Alveolar sockets (32) from 5 canine patients who had to undergo extraction of birradiculated mandibular teeth (16), were used. During the surgery, after autologous PRP preparation, a mixture of PRP-HXA or HXA was placed in different sockets of each patient; other alveolar sockets were only filled with PRP or left without filling (control). Data for bone tissue healing, were recorded around 30, 60, 90, and 180 days; density was analyzed (gray scale: histogram) with Image Tool® 3.0 (UTHSCSA) in digitalized radiographs (3 areas of 100 pixels² per socket). Additionally soft tissue healing (Landry’s index) was recorded around 10 days. Mean values of bone density collected between 30 and 90 days for PRP-HXA and PRP, were significantly higher compared to HXA and without filling, respectively (p<0.05); beyond 90 days no differences were found. Sites where PRP was used, exhibited faster soft tissue healing and less inflammation. PRP could be helpful postoperatively in promoting early soft tissue healing and bone regeneration (up to 3 months), both mixed with HXA and as sole filler, in extraction sites in dogs.

### Anesthetic efficacy of 4% articaine with epinephrine in oral nerve block in dogs and cats

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Articaine has been widely used in human dentistry; however this has not been the case in veterinary dental anesthesia, possibly due to a lack of clinical studies regarding its action and side effects.
The goal of this work was to assess onset of action, duration and analgesic efficacy of articaine with epinephrine in oral nerve block of dogs and cats undergoing periodontal disease treatment and multiple tooth extractions. The study included 18 dogs and 15 cats, ASA groups II and III, from the Veterinary School University Hospital. For this purpose, 4% articaine with epinephrine was used, considering the toxic dose as reference (7 mg kg⁻¹). Extraoral approach for the maxillary and inferior alveolar blocks was performed with spinal needle of adequate size according to the patient, injecting 0.5-1cc of 4% articaine, considering toxic dose and patient size. Monitored parameters included: heart rate, respiratory rate, hemoglobin saturation, temperature, systolic, diastolic and mean blood pressure. Results showed that the mean time of onset of pulpal anesthesia was 15-18 minutes and the duration was 150-180 minutes. In all the cases, articaine lowered isoflurane requirements to maintain surgical plane and side effects were not observed. It can be concluded that 4% articaine combined with epinephrine is a safe and effective alternative for use in oral nerve block for canine and feline patients undergoing dental or oral surgery, even when maximum reference doses are exceeded.

**Comparison of enamel relative thickness in dog teeth depending on crown size. Preliminary report**

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Tooth enamel is responsible for protecting the dental crown from potential traumas and fractures. Enamel thickness varies according to the sector of the crown, being thicker at the cusps. There is a great variability of the morphology of dog’s teeth, but there is no information about the relative thickness of the enamel on this species. Thus, the aim of this study was to determine the enamel relative thickness according to the size of the crown. A total of 116 permanent dog teeth were selected and divided into three groups: small crown (which includes upper and lower first premolars teeth and third molars teeth), medium crown (that includes premolar teeth in general) and finally a group of large crown (which includes canines teeth and upper and lower carnassial teeth). Teeth were sectioned in a vestibular-palatal / lingual direction in order to be observed with 20X binocular microscope with an incorporated scale (0.05 to 5 mm). The enamel and the crown thickness was measured, the relative thickness of each tooth was calculated, and the information obtained was statistically processed (ANOVA, Bonferroni, p <0.05). Enamel relative thickness in small crown teeth was statistically greater than the relative thickness of large crown teeth. It can be concluded that the larger the crown size is, the thinner the enamel relative thickness is.
The effect of using a dental chew on oral health of dogs

Inmaculada Castillo1, Lorena Castillejos1, Ana Cristina Barroeta1, Isabel Castellanos Mayado2 and Luis Alberto Martínez Luna2


Periodontal disease is the most common disorder affecting adult dogs. It is a cause of tooth loss, halitosis and has been associated to systemic diseases. Plaque is the primary cause of periodontal disease, so its control is essential to prevention. Daily oral hygiene is the basis at home care and best option is the combination of active and passive methods. The objective of this study was to evaluate the effects of using a daily dental chew in canine oral health. For this purpose a trial with 14 adult beagle dogs was performed during 50 days. On day 1, dental cleanings were made under general anesthesia. Dogs rest the following 20 days to recover gingival health. Then, oral examinations were performed and oral photographs were taken under sedation. Plaque, gingivitis, calculus and halitosis were evaluated by scoring system. Then, animals were randomly divided into control group (without dental chew) and dental chew group (dogs receiving daily a dental chew). After 28 days, on day 50, oral examinations (observer and photos) were performed for each dog, under the same conditions as in the initial evaluation. After the test, animals of dental chew group had significantly (p=0.0340) less plaque than control animals. Besides, animals receiving a daily dental chew showed a tendency (p=0.0931) to have better breath compared with animals of control group. This study suggested that a dental chew can be used as a daily passive homecare alternative for reduce plaque and halitosis.

Study of the teeth of dogs (Canis lupus familiaris) and periodontal components through the diaphanization techniques

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Introduction

In the routine of veterinary care, oral diseases appear with important casuistry. The literature shows that these diseases can affect up to 85% of the animals over three years old (Cavalcante, Taffarel and Fernandes, 2002). Or, in a more conservative percentage of 75% of dogs between four and eight years old (Gioso, 2003). There is a prevalence in older small animals (over seven years) (Venturi, 2006). Looked at this way, we clearly see the importance of the study of dental dog anatomy to combat these diseases as a way of qualifying the professionals.
Goals

Identification of the tooth anatomy of Canis lupus familiaris and its dental components, through the diafanization technique, as proposed by Spaltejelz (1906) and applied to dentistry by Prinz (1913), with reported changes. This technique allows us to further study of dental structures to facilitate the treatment of diseases that affect dogs, specially giving a three-dimensional view of the structures.

Methodology

The piece was obtained from donation made by UHAC (Unidade Hospitalar de Animais de Companhia – Hospital of Pets) of PUC-PR. The first step consisted in the dissection of the piece, followed by hot maceration with Hydrogen Peroxide and washing for 2 hours. Then proceeded to 48 hours drying and immersed in 3% hydrochloric acid for 30 days. The piece was again washed for 2 hours and immersed in hydrogen peroxide for another 2 hours. Then, 2 hours washed preceded dehydration made with battery of alcohol (70%, 80%, 96% and 98%) for a week in each. The diafanization was performed with xylene PA followed by methyl salicylate associated with the benzyl benzoate. For one week each.

Discussion and results

We were able to obtain with the technique, a relevant material, with ideal clearing and necessary decalcification, dehydrated and diaphanized in such a way that provided the obtaining a piece that shows all anatomical structures in a tridimensionally way and sharply differentiated.

Conclusion

The technique is ideal for the study of dental anatomical structures. This knowledge is necessary for the proper and qualified preparation of the professional in the treatment of oral diseases of the dogs.

Study of the teeth of cats (Felis catus) and periodontal components through the diaphanization techniques

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Introduction

In the routine of veterinary care, oral diseases appear with important casuistry. The literature shows that these diseases can affect up to 85% of the animals over three years old (Cavalcante, Tauffarel and Fernandes, 2002). Or, in a more conservative percentage of 65% of felines between four and eight years old (Gioso, 2003). There is a prevalence in older small animals (over seven years) (Venturi, 2006). Looked at this way, we clearly see the importance of the study of dental cat anatomy to combat these diseases as a way of qualifying the professionals.
Goals

Identification the tooth anatomy of Felis catus and its dental components, through the diafanization technique, as proposed by Spaltejelz (1906) and applied to dentistry by Prinz (1913), with reported changes. This technique allows us to further study of dental structures to facilitate the treatment of diseases that affect cats, specially giving a three-dimensional view of the structures.

Methodology

The piece was obtained from donation made by EQUALIS – Ensino e Qualificação Superior. in this case, a baby male cat, SRD. The first step consisted in the dissection of the piece, followed by hot maceration with Hydrogen Peroxide and washing for 2 hours. Then proceeded to 48 hours drying and immersed in 3% hydrochloric acid for 30 days. The piece was again washed for 2 hours and immersed in hydrogen peroxide for another 2 hours. Then, 2 hours washed preceded dehydration made with battery of alcohol (70%, 80%, 96% and 98%) for a week in each. The diafanization was performed with xylene PA followed by methyl salicylate associated with the benzyl benzoate. For one week each.

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Conclusion

The technique is ideal for the study of dental anatomical structures. This knowledge is necessary for the proper and qualified preparation of the professional in the treatment of oral diseases of the cats.

Orthodontic treatment with fixed appliances (straight-wire technique) of cross-bite of domestic dog

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To the veterinary clinic came a patient, dog, German Shorthaired Pointer, male, age 13 months. On the basis of history and clinical examination filed and abolished pharmacologically awareness was found to exist bite alternating arch covering the upper teeth 101, 201 and the lower arch within the 301,401.

The change is the result of a clash of the incisal edge of the teeth in upper and lower dental arch during playing with hard elements, eg. rubber balls, sticks. His loss of the incisal edge incisors 101,201,301,401 led to shorter crowns. The aim of treatment was to obtain an anatomical arrangement incisors 101, 201, 301, 401.

During the orthodontic treatment was used Straight-Wire Technique and thin-wire fixed applian-
ces. During the treatment under general anesthesia was established orthodontic brackets on the teeth 101-103, 201-203 purpose of tilting forwards of teeth 101, 201. Within the the lower arch (303, 403) bonded orthodontic brackets. Between them established elastic power chain. Using the elastic power chain was tilted teeth and closed the gaps. The inspections were made: after 2 weeks, and then every 4 weeks. The target result was obtained after 12 weeks of treatment.

The next stage of dental treatment is to restore of the incisal edge 101, 201, 301, 401 using light cure resin based composites.

Morphologic and immunohistochemical study of feline oral squamous cell carcinoma: p63 and PCNA

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Oral squamous cell carcinoma (OSCC) is a malignant neoplasm derived from stratified squamous epithelium, being the most common malignant tumor in cats over 10 years old. Feline OSCC occurs especially at the gums (40-50%), followed by the tongue (2-10%) and tonsils (2-15%).
Similar to humans, this tumor is locally invasive and difficult to treat as it is often diagnosed at an advanced stage.

This study reunited the following objectives: evaluation of clinicopathological characteristics at the time of diagnosis and their relationship with prognosis, determined by the overall survival time, and the relation of the same histopathological characteristics and prognosis with the expression of the nuclear antigen of cellular proliferation (PCNA) and p63 protein.

The clinicopathological characteristics included age, gender, tumor location, T classification, N classification, tumor stage, the World Health Organization (WHO) Grading System, the Broder’s Histopathological Grading System, the Annerothen’s et al. Multifactorial Grading System and the Bryne’s et al. Deep Invasive Cell Grading System in 20 cases of feline OSCC. The prognosis was evaluated through the overall survival time and the PCNA and p63 expression by the immunohistochemical staining with anti-PCNA (clone PC-10, Dako) and anti-p63 (clone 7 JUL, Novocastra) antibodies.

The primary location of the tumor appears to be a good survival predictor (p=0.032).

The most relevant histopathologic grading systems in the prediction of prognosis of patients with OSCC are the WHO (p=0.009) and the Broder’s (p=0.015) grading systems.

The PCNA expression was statistically associated with T classification and tumor stage (p=0.005), WHO Grading System (p=0.012) and Broder’s Histopathological Grading System (p=0.013). The expression of p63 seems to be a predictive indicator of metastatic regional lymph nodes (p=0.048).
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