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Pedodontics – Start ‘em out Young!

Heidi B. Lobprise DVM DAVDC

Good dental care should be a consideration throughout the pet’s life – from cradle to grave, especially with smaller dogs. A thorough examination at every visit can help monitor the sequence of growth and tooth eruption, or if abnormalities arise.

Eruption

With most dogs and cats, the deciduous teeth will erupt during 3-6 weeks of age, and the permanent teeth erupt between 4-6 months of age, with individual variations. The most important fact to realize is that two teeth (deciduous and permanent) should not be in the same place at the same time: the deciduous tooth should have exfoliated by the time the permanent tooth in is occlusion. Some permanent teeth do not have corresponding deciduous teeth, but both are formed as ectodermal epithelium pushed into the ridge of developing mesothelium. Developing teeth are very sensitive to any noxious stimulus. Dental formulas are as follows:

Dog
- Deciduous  $2 \times (3/3i; 1/1c; 3/3p) = 28$
- Permanent  $2 \times (3/3i; 1/1C; 4/4P; 3/2M) = 42$

Cat
- Deciduous  $2 \times (3/3i; 1/1c; 3/2p) = 26$
- Permanent  $2 \times (3/3i; 1/1C; 3/2P; 1/1M) = 30$

At times there is persistent tissue over the tooth that is interfering with eruption. A tough gingival covering (operculum) can halt movement, but simple excision of the tissue over the tooth may allow further eruption, if the apex is still open. If bone is present (embedded tooth) the bone should be carefully removed without injuring the crown beneath. If the apex is already closed, it is unlikely that additional eruption will occur.

Retained or persistent deciduous may cause the permanent one to erupt into an abnormal position. Most will erupt lingual to the deciduous tooth, though the maxillary canine will erupt rostral to its deciduous counterpart. Persistent (retained) deciduous teeth are a common cause for permanent base narrow (linguoversion) mandibular canine teeth or rostroversion maxillary canines.

Dental abnormalities

Missing or extra teeth

If a tooth is visibly missing – or the deciduous tooth is still in place – the area should be radiographed. If the tooth is truly missing, it should be recorded, and some retained deciduous teeth remain stable if the succedental permanent tooth is not present. Breeds with dermal dysplasias (Chinese Crested dogs) often will have multiple missing permanent teeth and the remaining deciduous teeth may be their only functional dentition.

If the teeth are unerupted or embedded instead of missing can eventually form a dentigerous cyst. Cells around the neck of the tooth that are normally lost during eruption can cause significant cystic changes and may be minor, but if left undetected, extensive osseous changes can occur, to the extent of pathological fracture of the jaw. While any unerupted tooth can form a dentigerous cyst, the mandibular first molar of brachycephalic dogs (Boxers, Bulldogs) are most commonly affected.

If the presence of extra teeth (supernumerary) causes any crowding of teeth, predisposing the area to pe-
Periodontal disease, then extraction may be the best option. Some breeds such as Boxers, are known for having supernumerary teeth, particularly incisors, and if crowding is not an issue, they can be kept.

**Abnormal tooth formation**

Many teeth can have abnormal formation, from microdontia and macrodontia to extra roots and variations in shape. Two adjacent teeth that fuse together during development are called fusion teeth, and there will be a reduced tooth count with one larger tooth, often with a double crown. Gemination teeth are formed when a tooth tries to ‘twin’ itself, but the separation is incomplete. A ‘double crown’ will also be present, but the proper number of teeth will be present. Sometime the roots will be fused, or sometimes three roots will be present instead of two. This is most common in the mandibular fourth premolar in cats.

Any disruption in the normal architecture of a tooth during development can be termed ‘dilaceration’, from the development of curved or twisted roots to abnormal crown formation. If the enamel and dentinal layers don’t form properly with an invagination of the enamel into the dentinal layers, this ‘dens-in-dente’ lesion often results in pulpal exposure, non-vital pulp and the need for extraction. A variation of this malformation can be found in the mandibular first molar of small breed dogs. A disruption in the eruption and maturation typically results in defects between the crown and roots, abnormal root structure (converging, wide pulp), pulpal stones and bone loss extending from the apex or all around the root structure.

Changes to enamel are typically the result of some noxious stimuli or damage to the enamel organ during formation such as a fever, infection or trauma. Often thought of as enamel hypoplasia (which is actually thin enamel), the true lesion is a hypocalcification of the enamel. Once erupted, this soft enamel will become pitted, discolored, wear off easily and often be associated with abnormal root structure as well. Lesions may be focal or limited if the insult was discrete or short in time (trauma, short disease), or generalized with more extended disease (distemper).

Discrete crown lesions can be restored with composites, but more generalized disease benefits from removal of abnormal enamel (scrubbing), smoothing the remaining edges and placing a bonding agent on the exposed dentin. With the roughened enamel surfaces, plaque and calculus form quickly, so regular home care and professional cleaning and treatment is necessary. If roots are affected (sometimes completely gone), stability of the remaining crown is assessed. If the tooth structure is non-vital or unsound, then the tooth should be extracted.

**Occlusion**

A normal occlusion is typically defined by a ‘scissor’ bite (maxillary incisors slightly rostral to mandibular incisors), the mandibular canine fitting into the space (diastemal) between the maxillary third incisor and canine, and the mandibular molars and premolars occluding just to the inside of the maxillary premolars and molars. If a malocclusion occurs with the deciduous dentition, with mechanical interference to jaw growth, then those teeth need to be extracted. They must be removed in advance of the permanent teeth erupting into the same position. Incisors are best extracted at 8-10 weeks, and canine teeth at 10-14 weeks. Maxillary deciduous incisors can get ‘caught’ behind the mandibular ones (rostral cross bite), which can then slow down the growth of the maxilla. Deciduous mandibular canines can be deviated lingually or distally, hitting the palate and causing mechanical interference with the forward and lateral growth of the mandible. Brachycephalic kittens can present with many variations of maloccluded canine teeth as well.

Careful extraction (interceptive orthodontics) is done to remove the physical interlock. Once these are removed, however, the jaws will grow into correct position only if genetically coded; if the permanent jaws are destined to be abnormal (Class II or Class III malocclusion), extractions won’t change that.

Another reason to extract these deciduous teeth in a timely fashion is that the permanent teeth will erupt into an abnormal position if the deciduous teeth are retained. Persistent deciduous maxillary incisors will cause the permanents to erupt further lingual/palatal, potentially resulting in a rostral cross bite. If the maxillary canine is retained, the permanent erupts further forward/mesial/rostral, sometimes closing the diastema, and secondarily causing the mandibular canine to be displaced. The most common malocclusion, linguoversion (base narrow) mandibular canines can be caused when the persistent deciduous tooth caused the permanent to erupt lingual to it.
Acquired problems

Periodontal disease

Periodontal disease is not very common in young animals, though a juvenile periodontitis has been described. A transient peri-coronitis can occur when teeth erupt, sometimes with a proliferative gingival margin in some cats. Retained deciduous teeth can cause crowding and increased plaque and tartar accumulation.

Fractured teeth

Fractured deciduous teeth can have infection that can cause damage to the underlying tooth buds, so they should be extracted. Immature permanent teeth can also fracture, and since the root structure has very thin dentinal walls and an open apex, attempts can be made to keep the pulp vital with procedures that remove the exposed part of the pulp (vital pulpectomy) and medications placed to help stimulate a dentinal bridge to protect the remaining pulp (pulp capping).

Oral developmental problems

Primary cleft palate is often associated with unilateral cleft lip, while secondary midline cleft palates often present more critical problems for the pet, particularly the newborn. If the patient can be maintained on tube feeding until further maturation, many of these lesions can be repaired. Hypoplasia of the soft palate can cause issues with swallowing, or substances refluxed into the nasal cavity.

Microglossia is a rare but lethal malformation of the tongue with abnormal margins not fimbriated and nursing is not successful. Tight lip in Shar Pei dogs can result in the lower lip covering the mandibular teeth and even interfering in jaw growth. Craniohypoplasia (CMO) seen in some terriers (West Highland White) is seen as a periosteal proliferation that can be extensive to the point of encompassing the TMJ and limiting jaw movement. While these often resolve on their own, symptomatic relief for pain and discomfort can be advantageous.

Possible systemic effects of periodontal disease

There are many human studies which have investigated the effects of PD on systemic health, but, to the best of the author’s knowledge, there are only a handful of veterinary studies looking at this association.

DeStefano\(^1\) found that men and women aged 25-74 years old with periodontitis had a 25% increased risk of mortality from all causes. In man, research is currently looking at the association between PD and cardiovascular disease, pulmonary disease, diabetes mellitus, rheumatoid arthritis (RA), other chronic diseases and preterm low birth weight infants (PLBW). In veterinary studies, an association between PD and heart, liver and renal disease has been suggested\(^2\).

Pathways linking PD to systemic diseases

Biological plausibility: To demonstrate an association between PD and systemic diseases, there needs to
be some biologic explanation of how PD contributes to organ disease.

Five pathways linking PD to systemic effects have been proposed.

1. Infection theory: The colonisation of oral bacteria in another site of the body via transport in the bloodstream or lymphatic system. It has been reported that in human patients with periodontal inflammation, a Streptococcus sanguis protein associated with platelet aggregation and bacteraemia associated with Porphyromonas gingivalis may contribute to some acute thromboembolic events. Also, oral bacteria have been found in atheromatous plaques in blood vessels. Whether these oral bacteria contribute to the atheroma formation or are just bacteria caught up in the fatty plaque formation is difficult to ascertain. Infective endocarditis can be due to oral Streptococcus sanguis/oralis/mutans (viridans streptococci) colonising diseased heart valves. Viridans streptococci can aggregate platelets and this is thought to contribute to the pathologic progress of the heart valve lesion.

2. Distant injury: Distant injury may occur directly from circulating oral microbial toxins or indirectly through the elevation of the acute-phase response, including C-reactive protein, haptoglobin, alpha 1-antitrypsin and fibrinogen. The liver, in response to the systemic challenge of organisms, secretes acute-phase proteins (a predictable response by the liver to infection or inflammation). This acute-phase response is triggered by blood-borne oral lipopolysaccharide (endotoxin), and oral bacteria which elicit the release of the cytokines interleukin-6 and tumour necrosis factor alpha (TNFa). These mediators act on the liver to induce the production of acute-phase proteins by the liver. Acute phase proteins especially C-reactive protein appear to be associated with an increased risk of myocardial infarction in “apparently healthy” individuals. CRP further stimulates the body’s immune system and activates the complement system, so it is designed to further stimulate the immune response. CRP is now often used as a marker to determine whether inflammation resolves after medical treatment.

3. Distant inflammation: PD can induce changes in immune functions that result in metabolic dysregulation of serum lipid metabolism through pro-inflammatory cytokines. Locally produced pro-inflammatory cytokines and TNFa may exert systemic effects by predisposing the patient to a systemic disorder such as atherosclerosis.

4. Molecular mimicry: This is where the sequence of peptide chains in a micro-organism is like the sequence of host peptides resulting in cross reactivity of B and T cells (autoimmunity). These B and T cells can then react with host cells, producing antibodies against the pathogen but also to the host, leading to tissue pathology and destruction. The periodontal pathogen, P. gingivalis, has been incriminated in this molecular mimicry pathway, leading to increased risk of atherosclerosis in man.

5. Gut dysbiosis: Oral bacteria that are swallowed can lead to gut dysbiosis. This causes an imbalance in the gut flora. There are too few beneficial bacteria and an overgrowth of bad bacteria and yeasts. In man and animals, the gastrointestinal tract is one of the largest interfaces between the outside world and the internal environment. In man, from mouth to anus forms a nine-metre-long tube, constituting the body’s second largest surface area, covering approximately 250-400 m². Over a normal lifetime, approximately 60 tons of food will pass through the gastrointestinal tract.

Cardiovascular disease associated with severity of PD in dogs

An observational retrospective study consisting of two equal cohorts of dogs was carried out. 59,000 dogs with various stages of PD were in the first cohort and 59,000 dogs with no PD were in the second cohort. Records were reviewed for up to 5 years, based on standardised electronic records kept at Banfield Veterinary Hospitals across the USA.

The authors suggested “that PD was associated with cardiovascular related conditions such as endocarditis, mitral valve insufficiency and cardiomyopathy. Chronic inflammation is probably an important mechanism connecting oral bacteria with systemic disease.”

The authors also found that “dogs with stage 3 PD (subjectively based on clinical exam) were 6 times more likely to develop endocarditis than non-PD dogs.”
The authors described the limitations of this study, including the staging of the PD, which was based on clinical examination in the conscious animal; no periodontal probing or intraoral radiographs were performed. The authors also stated that the presumptive diagnosis of cardiovascular related disease was based on such findings as heart murmur, abnormal pulse, a detectable arrhythmia, fainting or coughing. Very few diagnostic tests were performed to look at any possible cardiac disease.

Renal disease associated with severity of PD in dogs and cats

Association between chronic kidney disease (CKD) and severity of PD in dogs and cats

A retrospective longitudinal study was performed based on electronic records at Banfield Veterinary Hospitals across the USA.

There were two equal cohorts; the first consisted of 164,706 dogs with PD, stages 1 (gingivitis no attachment loss or AL), 2 (<25% AL), 3 & 4 (>25% AL) and the second cohort consisted of 164,706 dogs without periodontal disease based on clinical examination. The dogs were followed for a period from 2002-2008.

A diagnosis of CKD was based on blood urea nitrogen (BUN) and creatinine with the serum creatinine >1.4mg/dl and a diagnosis code of chronic renal failure in the records. The findings in this study showed that the chance of a diagnosis of CKD increased with increasing severity of PD in the dogs. The hazard ratio of 2.66 was found for dogs with PD stages 3 and 4, compared to non-PD dogs. The highest risk was for dogs with increasing age and decreasing body weight especially dogs <4.5 Kg. The study also found that treating the PD with professional care reduced the risk of azotaemic CKD by 23%.

In older cats, periodontal disease is common, and periodontitis can contribute to reduced appetite and weight loss. Additionally, the presence of periodontitis has been identified as a risk factor for development of CKD in cats. In this study, Finch established a categorization system for dental disease and where possible applied this to the clinical findings recorded at initial evaluation. The veterinarian examining the cat awarded a calculus index of 0 – 3 and a gingivitis index of 0 – 3. These were combined, and the sum of the index formed the dental disease category.

This valuation was performed on clinical examination in the conscious animal, rather than based on periodontal probing +/- intraoral radiographs. In my opinion, this could well have overestimated the amount of periodontal disease present which would have affected the dental disease category within the study.

Other systemic effects of periodontal disease in dogs and cats

Numerous studies have shown that a transient bacteraemia occurs in dogs after a dental procedure. It is also accepted that during episodes of active periodontitis, periopathogens and their toxins enter the bloodstream. However, very few studies have been looked at the association of PD and organ involvement in dogs and cats. DeBowes showed an association between PD and morphologic changes in renal glomeruli and interstitium, myocardium and hepatic parenchyma. However, there was no significant association between PD scores and lung histopathology scores. The authors concluded that their results supported the hypothesis that PD can have systemic effects on other organs.

A more recent study conducted in thirty-eight client owned dogs looked at the association between the concentration of systemic inflammatory parameters (including serum C-reactive protein, urine protein: creatinine ratio, blood pressure, microalbuminuria), and severity of PD. The PD was then treated appropriately; the study looked at the changes in these systemic parameters.

This study showed that increases in concentrations of systemic inflammatory markers were positively related to the severity of PD. After periodontal therapy, there was a significant decrease in the concentrations of some of these inflammatory markers (especially CRP).

The study showed that PD leads to systemic inflammation that is significantly reduced with appropriate periodontal therapy. The authors concluded that further research was required to fully understand the significance of these changes.

A retrospective and observational canine study looked at post mortem changes in dogs with moderate to advanced grades of periodontal disease. This study tried to demonstrate that inflamed periodontal tissues present a 'periodontal disease burden’ to the host and the extent of this inflammatory disease burden is likely to affect the degree of associated pathological change in distant organs. Post-mortem investigations including periodontal assessment, standard necropsy, and organ histology were performed on 44 mature toy and mi-
niature Poodles that died naturally or were euthanized based on clinical disease. Animals with gross primary
organ pathology were excluded. The periodontal disease burden was estimated from the total surface area of
inflamed periodontal pocket epithelium using six probing depth measurements for each tooth and the tooth
circumferences (measured with floss).

84% (37/44) of the dogs had histopathologic changes in the atrioventricular valves. There were significant
changes in the left AV valve, which related to severity of the measured periodontal disease. There was
a greater chance (1.4 times) of worsening left AV valve histopathologic changes for each cm² surface area
of periodontal disease burden (calculated on the surface area - 1/6 circumference of the tooth at the enamel
bulge multiplied by the probing depths greater than 1 mm (6 measurements made per tooth). The sum of
the 6 multiplications would indicate the area of currently or previously inflamed pocket epithelium).

Because >1 mm was used as a measure of abnormal probing depth instead of > 3 mm, it is my opinion
that there could be an overestimation of the periodontal disease burden in this study.

The authors concluded that the results showed a link between the estimated ‘periodontal disease burden’
resulting from plaque-bacteria associated periodontal disease.

Conclusions

Proving the link between cause and effect of chronic diseases (causality), such as PD, is not easy. As PD
is chronic and slowly progressive, people/animals studied over a long period of time may be exposed to a
multitude of potential causes making determination of a particular cause–effect link most difficult. The body
of evidence is conflicting in its results and it is still impossible to state that PD is a true risk factor for other
systemic diseases such as cardiovascular disease or renal disease.

There is no doubt that periodontitis can cause an increase of systemic markers of inflammation such as
CRP. Also, it is accepted that after treatment of periodontitis, a number of these inflammatory markers can
return to normal or near normal levels. The question still remains: are these inflammatory markers or other
mediators of inflammation or even the bacteria themselves causing other organ damage? If one also intervenes
and effectively treats PD, can this help or resolve the organ damage?

References on request

The articular process of the mandible and the mandibular fossa of the temporal bone form the temporo-
mandibular joint. An articular disc separates the joint into two compartments, (1) a dorsal temporal and (2) a
ventral mandibular compartment. The articular surfaces of the condylar head and glenoid fossa are covered
by dense fibrocartilage. A fibrous joint capsule surrounds the joint and has a well-developed ligament laterally.

Because the fossa and the condyle do not match perfectly, the joint is capable of a hinge-like movement
and as well some lateral-medial excursions. The joint is well protected by the zygomatic arch dorsally and the
attached masseter muscles laterally, the digastricus muscle ventrally and the pterygoid muscles medially and
caudally. This configuration of bone and muscle protects the joint from trauma.

The diseases that affect the TMJ can have developmental or traumatic causes. Dependent on the origin,
the symptoms encountered on the physical examination might vary. With all oral pain, salivation is common-
ly encountered. Pain and tenderness can be elicited on either direct TMJ palpation or on attempted manipu-
lation of the jaw. Crepitation over the joint is occasionally felt. If trauma is suspected, then facial contusions,
abrasions, laceration of the chin, and ecchymosis and/or hematoma formation in the TMJ area are visible

Differential diagnoses for curtailed jaw function

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either externally or orally. Bleeding from the external ear canal can be visible indicating the disruption of the tympanic plate of the bulla by the posteriorly displaced condyle. Facial asymmetry may be the result of a mandibular ramus foreshortening caused by the overlap of the proximal and distal condylar fracture segments. Deviation of the mandibular midline is seen with luxations and as well condyle fracture.

**Clinical signs, differential diagnosis and treatment**

*Malformations or dysplasias* of the condyles and fossa are often seen in the Bassett Hounds, Saint Bernards and Irish Setters. The condition affects the TMJ bilaterally and it leads to joint instability, osteoarthrosis and open mouth jaw locking. The mandible locks when the animal yawns since the condyle subluxates out of the fossa and the coronoid process of the mandible deviates laterally under the zygoma. The animal presents salivating and the jaws rigidly fixed in an open position. On examination the jaws cannot be closed and a mild subcutaneous swelling can often be palpated under the zygoma of the affected side. The mandible lateralizes to the ipsilateral affected side. The jaws can either spontaneously reduce or the jaws are manually reduced under anesthesia. A firm downward medial pressure is placed on the displaced coronoid as the mandible is opened further.

The radiographic signs of TMJ dysplasia on a VD projection are an irregular joint space and an oblique versus transverse orientation of the condyle head to its neck. On the lateral oblique view the glenoid fossa can appear very shallow. The treatment for a locking coronoid is to resect the ventral portion of the zygoma and or a bilateral condylectomy.

Since the TMJ is well protected along its lateral surface by muscle and bone, most condylar fractures are sustained from anterior forces. This can be seen in the high-rise syndrome where the animal on impact hits with the head and chin. Often the jaws are partially open at the time of trauma, and the symphysis is separated. The condyle, as it is jammed caudally against the glenoid fossa, usually fractures at its neck. The symptoms of a fractured condyle are severe pain on opening the jaw, salivation, and ecchymosis of the pharyngeal arch and sclera. Depending on the extensiveness of trauma this can be either unilateral or bilateral. If unilateral, the mandible shifts to the ipsilateral side of the fracture. Crepitus can be felt over the joint area.

**Luxations of the TMJ** either occur traumatically or spontaneously. In the latter, this can either be due to a shallow dysplastic fossa or a malformed condyle. It can also be from extreme joint laxity, which occurs in edentulous animals. When the caudal teeth are missing the lower jaws lateral excursions become greater. The well-formed lateral TMJ ligament becomes stretched or torn by each lateral excursion, which allows the condyle to eventually luxate out of the fossa. Often these older animals have locking coronoid processes, which spontaneously reduce only to relock when the animal yawns.

In traumatic luxations, the condyle more frequently luxates dorso-cranially. This occurs in a subclinical unstable joint. The mandible is opened excessively for example when placing an endotracheal tube which forces the condyle over the rostral rim of the fossa. The dorsal contracture of the temporal and masseter muscles pulls the condyle forward and up. When viewed anteriorly, the symphysis shifts contralaterally to the side of the luxation. This type of luxation can either be reduced in an open or closed procedure. In the latter, a large dowel is placed between the caudal cheek teeth of the luxated joint. As the jaws are closed the mandible is forced ventral and then caudal to reduce the condyle.

Contrary to the above luxation, the caudo-ventral luxation is less common. The mandibular symphysis deviates posteriorly to the ipsilateral side as the luxation. These more severe luxations cause significant damage to the joint capsule and ligament. Reconstructing the normal condyle-fossa relationship can only be done openly. Pre-drilling a hole with a #1 round bur through the lateral aspect of the condyle and the ventral border of the zygoma, allows a non-absorbable suture to be passed through the holes and tied. This will
secure the condyle in the fossa. Eventually the joint will fibrose subsequent to the trauma and be functional.

Extra-oral dental radiographs can be used to image the feline TMJ. In a medium size dog, however, the standard 8-10 radiographic film or a Number 4 occlusal dental film should be used. A VD projection compares the position of the two condyles and any changes of joint space. This image also allows a good view of the orbit and the coronoid process. A lateral projection, on the other hand, views the condyles individually and their location with respect to the fossa. When taken in an open-mouth stress position, any green stick fractures of the vertical or horizontal ramus or condyle fractures will be more evident. The lateral oblique technique involves placing the animal in lateral recumbency with a rolled towel under its neck. The tip of the nose is directed 20 degrees down. The head is rotated obliquely 20 degrees to prevent superimposition of the two condyles. The x-ray beam should be directed through the TMJ at the level of the caudal zygoma.

**Diseases mimicking tmj disorders**

*Dropped jaw* is a mandibular paralysis that has similar symptoms to the diseases, which affect the TMJ directly. The etiology of this disorder is unknown. It does not have age or breed specificity. The motor portion of the trigeminal nerve and its ganglion are bilaterally affected with a nonsuppurative inflammation. The animal presents with excessive drooling and inability to close its mouth. A Horner’s syndrome may be present. Clinical differentiation from the TMJ disorders is possible. The jaws can be closed without resistance or pain and there is no lateral shifting of the mandibular symphysis. There is no definitive treatment, however, the condition usually spontaneously resolves.

*Masticatory myositis* involves the temporal and masseter muscles of mastication. These muscles are antigenically different from other skeletal muscles and contain 2M muscle fibers. The disease is thought to be of an autoimmune nature and affects large breeds of dogs. It does not appear to have an age or gender predilection. The acute clinical signs are reluctance to chew, inappetence and trismus (jaw clenching or grinning). Laboratory tests might show an increase of the serum globulins and a presence of circulating serum autoantibodies to the 2M muscle fibers found in the Masseter and Temporal muscles. The immune complex formation results in necrosis, phagocytosis and fibrosis of affected muscles. The use of corticosteroids up to 10-days prior to blood collection may produce false negative results.

CT scans with contrast agents are useful in aiding the appropriate sites for muscle biopsies. These biopsies allow for the determination of the extent of tissue damage and the amount of fibrosis present. Immunohistochemical staining of the muscle sample may show immune complexes surrounded by inflammatory tissue which is indicative for the disease. The muscles are symmetrically affected, and often there is increased warmth felt on palpation during the acute phase. Recurrent episodes are common, and this leads to a progressive contracture and atrophy of the muscles. The skull and jaw become very defined and “chiseled” in appearance.

A favorable outcome is early diagnosis and aggressive treatment with immunosuppressive agents. Prednisone 2 mg/kg PO bid during the acute phase is used until jaw functions is regained and the CK levels have returned to normal. At this point a taper is established to every other day over a 4-6 months period with no more than a 50% decrease in the dose every month. Some patients require a lifetime of low dose treatment versus those that be successfully weaned off the medication. Depending on the side affects of long term prednisone therapy, Azathioprine can be considered in addition to the steroid therapy if the patient is unable to tolerate the side effects of corticosteroids or are refractory to prednisone alone. It is usually dosed at 2 mg/kg PO q24-48hours for several months duration. Side effects of Azathioprine is bone marrow suppression and hepatotoxicity and therefore needs monitoring of the CBC and hepatic enzymes.

*Acute inflammatory diseases of the fauces and the orbit* often present as an animal’s reluctance to eat or open their mouths. Salivation is seen often with oral foreign bodies lodging at the fauces or the angle of the jaw. Foxtails and wood splinters cause inflammation and infection. If they perforate the oral mucosa and migrate, a unilateral draining tract is seen. If they perforate into the retrobulbar space, an exophthalmus is seen. Abscessation of the zygomatic salivary gland often causes exophthalmus and pain on jaw opening. Oral swelling behind the 2nd maxillary molar in the dog and purulent discharge from the salivary duct indicate that an abscessed gland might be present. Due to the increased pressure of an enlarged gland in a confined space, the globe can deviate. There is protrusion of the 3rd eyelid. Depending on the cause of the inflammation/infection, systemic antibiotics should be administered. Skull radiographs can potentially show radio-dense foreign bodies, which can be tracked to their origin. A contrast CT scan can be helpful in evaluating the retrobulbar space.
Macro photography is defined as extreme close up photography in which the size of the subject in the photograph is the same size or greater than the original object.

The technique can conveniently be used for taking pictures of dental objects. Today there are many cameras and lenses available that are suitable to be used for taking pictures in veterinary dentistry. Even the build in lens of a smart phone is so advanced it could be used for that purpose.

My goal is not to go over all these different cameras but rather explain what to expect from the different types of cameras.

Many cameras have standard a lens with a macro option on it. They are very nice for a quick shot of an oral problem. However, the problem with most systems is the ambient light.

The light from the room or the dental lamp, is frequently coming from the wrong direction and doesn’t give a nice result for a lot of situations.

This is the case for all the cameras that are not assisted by a led-light or a ring flash.

The other problem is the dynamic range of the picture taken. You get a lot of shadows around the object that you want to photograph. This causes the exposure meter to over expose the central point of the image which is frequently a tooth in dental photographs. For other tissues this is not a big issue.

Another problem that I frequently encounter is the sharpness of the image. With a simple camera and not enough ambient light, the diaphragm of your camera will have to be open almost completely. The shutter speed will be long 1/15 second is no exception.

This will cause the picture to be blurred without any depth of field.

Especially if you want to publish pictures for an article this is not an ideal situation.

How can we improve the quality of our pictures?

What I do in practice is use 2 different cameras.

A waterproof pocket camera for most standard situations so I can clean the whole camera after finishing. At this moment there are only two brands of waterproof pocket cameras commercially available. They are in the price range from 400 to 500 euros so quite affordable.

Secondly a more professional full frame camera with ring flash and specially designed macro lens for things that I consider extraordinary or that I could possibly use for a publication. I probably don’t have to tell you that I make mistakes in choosing the right camera, or don’t want to take the heavier camera out of its case when I feel that I run out of time.
In order to make it more understandable to everyone I will explain some technical details.

ASA and ISO

In photography, ASA and ISO are both measurements of film speed, or sensitivity to light. ASA is a scale created by the American Standards Association, but it is no longer widely used. Now, most film is labeled by ISO, which was created in 1987 by the International Organization for Standardization.

Film speed

Fast film, labeled with a high ISO or ASA number – 1,600 or above – offers high levels of light sensitivity that give photographers the ability to shoot with faster shutter speeds or at higher f-stops. High-speed film offers particularly useful performance in low-light situations, although these images often turn out grainy and with higher contrast. By contrast, slow film – ISO or ASA 100, for example – requires longer exposures or lower f-stops. It also produces higher-quality photos.

These same performance characteristics apply to images shot with equivalent ISO/ASA settings on digital cameras.

Dynamic range

In photography, the “dynamic range” is the difference between the darkest and lightest tones in an image, generally pure black and pure white. It's more often used to talk about the maximum dynamic range a camera is capable of. In macro photography of the mouth the dynamic range of a camera is important because the parts behind the object you photograph tend to be too dark easily.

Diaphragm

A diaphragm is a camera component within a lens comprised of overlapping metal blades (the iris) that open and close to change the size of the opening (they allow different levels of light to pass through to the sensor – thus controlling the aperture (or f-number) and depth of field of an image – and the aperture hole of the lens. The higher the f-number the smaller the hole for the light to pass through.

Shutter speed

In photography the shutter speed is the unit of measurement which determines how long the shutter remains open as the picture is taken. The slower the shutter speed, the longer the exposure time. The longer the exposure time the higher the chance of motion blur.

Ring flash

a type of electronic flashlight in which the light source is arranged in a ring around the lens in order to produce a light without shadows, logically this can compensate for the lack of dynamic range of a camera

Led light

Led light can be used as a ring light with continuous light but can also be used as a ring flash

Full frame camera

Full-frame digital cameras use a sensor that’s equivalent in size to 35mm film (36 x 24mm), and is the largest “consumer” format you can buy without moving up into the specialized realm of medium format. Full-frame sensors are typically found in high-end DSLRs and, increasingly, mirrorless cameras.

They have advantage but they are bulkier and heavier.

Mirrorless camera, also called direct camera

This is a camera that uses the sensor directly to show you the image you are about to take. The cameras have different sizes of sensors.

A full frame camera without a mirror will be less bulky but the price will be higher than a comparable DSLR camera.

Your phone as a camera

A smart phone has a smaller lens and sensor than most of the commercially available cameras.
Micro Four thirds cameras
Smaller direct cameras with smaller sensors compared to the full frame cameras but even these sensors are a lot bigger than the sensor of a smartphone.

DSLR camera
Digital single-lens reflex camera

A review of crown preparation, impression materials and impression techniques
A. Perry

This presentation will provide an overview of current literature and techniques in the preparation of the crowns of strategically important teeth, the canine and cranial teeth, to accept fitment of a full metal jacket cast prosthesis. Additionally, common impression materials and the techniques pertaining to their use will be examined. The review will include presentation of a minimalist preparation technique used in practice by the author and practical step by step acquisition of high quality impressions.

Traumatic injuries to the strategically important teeth are common, fracture or concussion may result in compromise of tooth endodontically. Endodontic treatment is founded on the elimination of battery from the endodontic system and hermetically sealing this from further bacterial ingress. Micro leakage of restorations is reported to play a significant role in failure of root canal therapy. Endodontic treatment may also weaken teeth, and this may be especially significant for teeth where high masticatory forces are commonly exerted. Traumatic loss of crown components, such as the buccal bulge, may predispose that tooth to the development of periodontitis. Behavioural abrasion may lead to structural weakness of a tooth or near pulp exposure. These are examples of clinical pathology which, in certain circumstances, may benefit from the fitment of a full metal jacket crown to provide increased resilience to future wear or trauma, decrease micro leakage and recreate normal or near normal anatomy.

Crown preparation refers to the process of creation of a marginal and axial reduction of the crown’s surface. This process creates space in which to place the prosthesis without increasing the dimensions of the tooth which may interfere with normal occlusion. The crown preparation should achieve a final form that is anatomically sympathetic to the original tooth’s shape. The preparation should achieve a shape which will have increased retentive properties. Preparation also allows correction of any morphology, such as undercuts, that would prevent an unfettered insertion path of the prosthesis so that the form of the tooth and prosthetic conform as closely as possible to allow distribution of loading forces. The preparation should act as a clear guide for the laboratory technician as to the shape and position of the prosthesis.

There are many different options for the position and shape of the marginal preparation. The margin may be placed supra- or sub-gingivally. Successful long term preservation of teeth is reliant on management of periodontal health. Plaque retentive structures, especially sub gingival, are likely to promote the development of periodontal disease. Aesthetically, sub-gingival preparation may be preferred in the aesthetic zones of human arches where oral health compliance is high although there a report that gingival recession is common. Supra-gingival margins are commonly utilised in animal patients where function is the primary concern. The shape of the margin must allow for close adaptation of the margin of the prosthesis to the crown of the tooth and for certain materials provide support. Shoulder, chamfer, bevel and feather are margin shapes that can be utilised in our patients, theses will be illustrated photographically.

A recent study to the success rate of prosthetics crowns reported a failure rate of 14.7%, subdivided into failure of the adhesive (4.4%), and due to fracture of the tooth (10.3%).

Preservation of tooth structure in the preparation of a crown should be a clear goal. Removal of dentin,
and potentially enamel, will weaken the tooth and decrease the surface area of the tooth. Maintenance of surface area is important as it is related to the potential retention of the prosthesis, a larger surface area results in increased adhesion and friction to resist occlusal forces. Ceramic prostheses are inherently more fragile than metal alloy and require the use of shoulder or beveled margins to provide sufficient support and protection. Chamfer or bevel margins have been primarily advocated in veterinary dentistry with a margin depth, and resulting axial reduction, of 0.5 to 1mm. The least destructive margin preparation is a feather margin and modern metal prosthesis can be adapted to such a margin. Some authors have raised concerns as to the ability of laboratory technicians to be able to accurately identify feather type margins, but this is not the author’s experience.

Human dentists advocate axial reduction to achieve near parallel walls to increase the retentive nature of the tooth's form. Convergence angles of below 15 degrees are advocated. Convergence angles of 15% in canine and cranial teeth, especially mesio-distally, is highly destructive or not achievable in dogs. One study examining the effect of convergence angle on retention found it to be less significant than previously thought especially with crown height/diameter greater than 1.6. Crown height/diameter has more impact of retention with mean height/diameter of failed prosthetics were 1.16 and non-failures were 1.96. Convergence angle becomes more significant as the height/diameter decreases.

When height/diameter ratio is unfavourable sub-gingival placement of the prosthesis' margin or crown elongation techniques may be considered although may predispose to failure of tooth preservation. The use of 1mm deep axial grooves have been shown to increase dislodgement forces by approximately 6 times for teeth with unfavourable height/diameter configurations. These dislodgement forces would exceed the average reported bite forces of naturally stimulated dogs.

Height/diameter ratios greater than 1.8 may be associated with an increased risk of tooth fracture and so some reduction of the crown height may be indicated if there is minimal height loss due to trauma. This reduction must be weighed against the loss of surface area for adhesion.

Once the crown is prepared appropriately a detailed, dimensionally accurate and stable impression must be taken for a stone model to be subsequently poured allowing design and refinement of the planned cast prosthetic by the laboratory technician. Impression materials are liquid or putty consistency when applied to the tooth surface and the undergo a setting reaction. They are removed from the tooth's surface once they are solid and compression resistant. The impression must be free from voids or discrepancies and detailed inspection once the impression is carefully removed is important with repetition of the process if details of the preparation are distorted. The impression material must be sufficiently elastic to allow for removal of the impression without tearing and the ability to retain the set shape. Stone models are most accurately reproduced in a laboratory setting, the impressions must have sufficient longevity of structure to reach the laboratory without distortion.

The most commonly used impression materials are those based on the precipitation of alginate or the polymerisation of silicone materials. Polymerisation may be by condensation or addition reactions, condensation results in the loss of ethyl alcohol and as a result significant shrinkage will occur making these materials less accurate. Addition polymerisation will release hydrogen but the addition of palladium or platinum to the material scavenges the gas and prevents it from affecting the poured stone model. Alginate is highly influenced by moisture and will both loose water by evaporation or imbibe it, both instances will result in deformation of the impression. Degeneration of alginate impressions will occur rapidly, and so rapid stone pouring is needed for them to be accurate.

Addition vinyl polysiloxane materials provide the most accurate and most resilient and stable impressions with appropriate levels of elasticity for fine detail impressions needed for capturing crown preparations. They are presented in differing viscosities, such as light body, heavy body or putty. The material must be contained within a rigid tray, the tray may be perforated or have an adhesive applied to it so that the impression material is appropriately retained. Examples of trays will be presented. A heavy body or putty material, with high viscosity, is used to provide strength and structure to the impression is combined with a light body, with a high viscosity, allowing accurate detail capture and flow into the details. The two phases bind together within the tray to form the final impression. The putty and wash technique, where the high viscosity phase is used to create a custom tray which is enlarged during setting and once set is reapplied to the tooth with light body, has most frequently been advocated by previous authors in veterinary medicine. This technique was designed for use with condensation polymerisation materials to minimise the potential for shrinkage. An alternative technique, a two-phase single step process, will be presented which is successfully used in the authors clinic.
Prosthodontic crown preparation principles, materials, techniques and cementation

Patrick Vall DVM DA VDC & Kipp Wingo DVM DA VDC

A 50-minute lecture will begin with Patrick Vall, DVM, DA VDC discussing selection guidelines for metal crown preparation cases. Present terminology will be clarified and reviewed. Basic principles and properties of preparations, such as height:diameter ratio, line of draw, margin location and finish lines will be discussed. Required equipment and materials needed for the procedure will be reviewed. Most importantly, the crown prep procedure will be reviewed and demonstrated with case examples.

The lecture will continue with Dr. Kipp Wingo, DVM, DA VDC reviewing dental impression materials and techniques for obtaining dental impressions. The lecture will conclude with a review of available dental cements and their application in cementation of full veneer crown restorations.

It is highly recommended that participants of the crown preparation and impression wet lab attend this lecture.

ATP of maxillo-facial lumps and bumps

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Animal Dental Centers of Annapolis, Columbia, Towson Maryland and York Pennsylvania

ATP has been coined as assessment, treatment and preventative. For our purposes, the “TP” will signify “treatment plan” since prevention often depends on the lump’s diagnosis which might not be preventable.

In order to have a more focused approach when dealing with these lesions, the practitioner needs to adhere to an evaluation sequence which helps develop a rule out diagnosis.

Exophytic lesions are a term that encompasses all masses regardless of type and etiology. By definition it is any pathologic growth that projects above the normal contours of the maxillo-facial surfaces.

The lump’s qualitative characteristics are important to establish possibly the mass’s origin. The physical characteristics of the mass that need evaluation are the following:

- **Color**
- **Consistency**
- **Surface of the Mass**: Smooth indicates that it arises beneath the squamous epithelium or in the mesenchyme; example being a salivary gland, abscess or cyst. If the mass is rough or corrugated it originates within the squamous epithelium like a papilloma or a squamous cell carcinoma.
- **Mobility** indicates that the lump can emanate from the cutaneous, subcutaneous or submucosal tissue. A skin mass might be connected to deeper underlying pathology via a mobile fistulous tract. This is often seen with parula or “gum boil” which exits submandibularly from a mandibular tooth abscess.
- **Missing teeth** or partially erupted teeth with an associated soft to fluctuant protuberance can indicate an odontogenic cyst. If the swelling is firm to hard in consistency and there is no evident tooth as seen with odontomas a primary tumor of the tooth should be suspected.

Beneficial to assessing the mass is its placement into the following groups:
- A. infections, B. foreign bodies, C. cysts, D. inflammatory hyperplasias and E. neoplasias.
A. Infections of underlying dental structures can often present as skin masses. The location of these swellings can be suborbital in the case of a non-vital, abscessed maxillary P4 carnassial tooth or a rostral sub-mandibular swelling from the mandibular canine tooth. The treatment plan would be to perform intraoral radiographs to rule out a non-vital tooth and then either extract it or perform endodontic therapy to prevent further bacterial apical drainage into the surrounding bone. Careful curettage of the alveolus would eliminate potential cystic retention secondary to the granuloma.

B. Foreign body granulomas. They can be superficial and visible on routine oral evaluations or buried deep within the connective tissue of the oral cavity or skin. The treatment plan initially for deep sites is to perform an incisional or punch biopsy to determine the type of lesion. If it returns as unspecific inflammation then an “enbloc” resection should follow.

C. Cysts are non-inflammatory lumps. Anatomically they are composed of three structures: a. central cavity which is filled with fluid, cellular debris, keratin or mucus b. Epithelial lining which is either keratinized or nonkeratinized stratified squamous c. Cyst wall of fibroblastic connective tissue divided into odontogenic cysts and developmental. This epithelium stems from either 1) rests of Malassez epithelium derived from the tooth root’s sheath 2) enamel epithelium which is a residual tissue surrounding the crowns of the tooth after enamel is complete 3) remnants of the dental lamina which originate from the oral epithelium and remain in the tissue.

- The odontogenic cysts are categorized into A. periapical cysts which proliferate in response to inflammation secondary to tooth death. Radiographically the cyst is rounded and well circumscribed. This is called cortication.
- Dentigerous cysts develop from the enamel epithelium that surround the impacted tooth’s crown. The cyst encapsulates therefore only the crown and not the tooth’s root.
- Eruption cysts are odontogenic cysts similar to a dentigerous cyst. The tooth crown has erupted through the bone but not the gingiva. There is a fluctuant swelling of the alveolar ridge above the non-erupted tooth.
- Odontogenic Keratocyst derives from the epithelial remnants of the dental lamina and behave like benign neoplasms. It can occur as multiple cysts and has a rapid growth potential and a high recurrence rate.

Treatment plan for Eruption cysts is to perform an elliptical gingival incision around the tooth’s crown and perform an apical reposition flap thereby exposing the adult tooth and draining the cyst. In the case of dentigerous and keratocyst curetting the cyst’s epithelial lining should be undertaken. If it is a calcifying cyst, an “enbloc” resection of the jaw should be done.

D. Salivary gland disorders are usually of the reactive type as a result of injury or infection. Obstructive sialadenitis occurs either due to the stricture and narrowing of the ductal lumen or blockage by an object(s) such as a sialolith (s). Eventually the increase pressure causes atrophic degeneration and necrosis of the glandular parenchyma.

When a salivary duct tears the acinar cells will continue to secrete into the surrounding connective tissue. Depending on the mucocele’s location, the names imply position i.e. pharyngeal mucocele, cervical mucocele and ranula (sublingual swelling).

Treatment plan for all mucoceles is to initially drain the mucin, followed by extirpation of the mandibular- sublingual gland complex. Ranula’s can be marsupialized.

E. Reactive inflammatory hyperplasias histologically show chronic inflammatory reactions where there is an endothelial proliferation and an in growth of capillary vessels.

- Fibrous gingival hyperplasia is the most common form in this category. This causes an increase production of collagen which resembles scar tissue. This is an exuberant overgrowth of collagen and fibroblasts.
  Treatment plan is to perform a gingivectomy of the hyperplasia either with a scalpel or electrosaw. Any calculus on the tooth or root surfaces which were originally covered by the excessive hyperplasia, should be scaled and then polished.
- Epulids are the most common benign masses of the oral cavity. They are now called peripheral odontogenic fibromas “POF”
- Acanthomatous ameloblastoma is a true localized neoplasia which invades the bone and moves
adjacent teeth.

Treatment plan: Since most clients prefer to have the lump removed with one anesthetic procedure, and the type of mass is often unknown at the time of surgery, performing an en bloc resection of the tooth, bone and at least 1 cm of normal tissue would be a logical approach.

- **Proliferative Periosteitis** is a condition that is seen from stimulation by a low-grade infection causing the periosteum to become reactive. The bone that is produced is less dense and is deposited in a layered pattern of thin bone which lacks a cortex. This type of bony swelling is seen often in relation to the feline’s canine tooth which is undergoing root resorption.

- **Eosinophilic granuloma** is a condition of unknown etiology which affects both cats and dogs although in felines it is a fairly common lesion. The eosinophilic granuloma can be single or multiple in its expression. Most common sites are the roof of the mouth, tongue and lips. Since allergic phenomena might be the trigger mechanism for lesion development, flea control, plastic bowl removal, food trials and intradermal testing should be considered. Food allergy and food storage mite allergy can simultaneously be tested for by feeding a hypoallergenic canned diet for four to six weeks.

Treatment plan: If after the above allergic phenomenon has been ruled out and treated Intralesional injections with Depomedrol can bring them under control with subsequent management with methylprednisolone orally to maintain remission. Cyclosporine has been proven effective in the treatment of the complex although it is off label. Doses of 2-5 mg/kg daily and then tapered once the response is visible.

**F. Malignant Neoplasia:**

The third or 4th most common area to find malignant lumps is the oral cavity. These originate from either the dental tissue odontogenically (Acanthomatous ameloblastomas) or involve superficial structures of the epithelium like the Squamous Cell Carcinoma (SCC) or the mesenchymal origin: Fibrosarcoma, Malignant Melanoma, Osteosarcomas.

- Fibrosarcomas are frequently encountered in small breed dogs ages 7-10 years and 4-5 years of age in large breeds. German shepherds, Golden Retrievers and Labradors are the most commonly affected breeds. Usually they are a slow growing mass that appears almost benign in it’s growth pattern. However, a distinct entity of this group, is the histologically low-grade biologically high grade fibrosarcoma seen in Golden Retrievers. These have a very rapid growth rate with local aggressive invasion and a higher metastatic potential. Cats are not as commonly affected by the FSA.

- Squamous Cell Carcinoma (SCC) is the most common oral malignancy in cats and is considered the second most common in dogs that are 8-10 years of age. Usually the gingiva and buccal mucosa are the preferred sites for the SCC. In cats and dogs sublingual presentations are not uncommonly seen. The SCC is locally aggressive and regional and distant metastasis is more common later in the progression of the disease.

- The SCC appears as an erosive corrugated pink to red fleshy mass. As the tumor progresses it invades the bone and causes lysis and tooth mobility and resorption.

- In general rostral mandibular SCC has a more favorable prognosis than the other affected areas. A variant of the SCC is seen in young dogs as histologically an “invasive papilloma” or other pathologist read it as a papillary SCC. This mass should be considered aggressive and excised with good clean margins.

- Osteosarcoma (OSA) of the dog is commonly encountered however in cats it is less common. Usually large breed dogs ages 7-10 years old are more represented. The oral OSA appears locally aggressive but slower to metastasize than the above tumors. The prognosis for dog’s with oral OSA compared to appendicular OSA is better due to the lower metastatic potential. The mandible involvement has a more favorable median survival rate of 14-18 months versus the maxilla which is 5-10 months. An aggressive surgical approach with wide margins is the best solution.

- Oral Malignant Melanoma (OMM) is considered the most common oral malignancy in older dogs between 9-11 years. Cocker spaniels, German Shepherds and other canines with heavy pigmentation of the oral mucosa are highly represented. The biologic behavior pattern of the OMM is focal invasion of the mucosa and underlying dental and bone tissue with early metastasis to the regional lymphnodes and lungs. Classic dark pigmentation of the surface as well as amelanotic pink to red tumor surfaces is often seen.

Treatment plan: For all malignant neoplasia, the larger the en bloc surgical resection with 1-2 cm margins, is consi-
Radiation should be considered in areas where the tumor resection is incomplete or palliative. In the case of the OMM a canine melanoma xenogenic DNA vaccine is available. Using the xenogenic Tyrosinase mounts an antitumor response. This vaccine is considered essential for promoting a longer survival rate. Initial treatment requires 4 doses at 2-week intervals followed by booster doses at 6-month intervals.

**To cut is to cure: oral surgery daily practice**

Heidi B. Lobprise, DVM, DAVDC

**Extraction Decisions**

Sometimes it is easy to decide when to keep a tooth and when to extract, but at other times, the choice is not as obvious. Of the three criteria to evaluate, examining the tooth in question is the first step. If periodontal attachment loss is greater than 50% or the pulp is compromised or there is extensive tooth resorption, then it is typically best to remove. If periodontal disease is moderate, then you consider the relative importance of the tooth and if the disease around it can impact a more strategic tooth. For instance, if either the fourth premolar or second molar adjacent to the large mandibular first molar can compromise the health of that important tooth, it may benefit the patient to extract the smaller tooth, thus giving better access to treat the adjacent surface of the first molar. If the decision is still up in the air, the health of the patient is to be considered: any patient with an ongoing systemic issue (heart murmur, diabetes, renal disease) would likely benefit more from an extraction that will remove the source of infection in one visit, as compared to extended anesthetic times and more frequent procedures. And third, consider the owner: if an advanced periodontal procedure or root canal is to be done, are they willing to consider the additional expense, and be committed to thorough home care and regular re-treatments? If not, then again, extraction may be optimal.

**Requirements**

**Equipment**

- Periosteal elevator –
  - Molt #2 and Molt #4 – for elevating flaps
  - Serrated periosteal elevators for debridement
- Means of sectioning –
  - High speed handpiece/unit is preferable, but sectioning teeth can be done with a low-speed unit, just have someone dripping water on the site for cooling
  - Set up regular maintenance schedule, including daily oiling
  - Sectioning burs – replace regularly, they get dull quickly
    - 700L – dog teeth
    - 699 – cat teeth
    - #2 or #4 – round burs for coarse alveoloplasty; diamond burs for smoother alveoloplasty
    - 12-fluted burs for gingivoplasty
- Dental elevators
  - Winged, not too thick – to fit in the PDL space
  - SHARPEN on a regular basis, even during the procedure
  - If used and sharpened regularly, they will wear down and will need to be replaced
- Dental luxators – flat – thinner, more delicate – be careful not to bend
- Extraction forceps – small breed forceps
- Blade – 15C
- Suture – 4-0 to 5-0 poliglecaprone
  > Reverse cutting for dogs
  > Tapered for cats
- Magnification – visibility, light, better posture
- Radiographs

**Steps of Extractions**

**Flaps**

With few exceptions (very loose incisors, premolars where envelope flaps are sufficient), most extraction sites benefit from full thickness mucoperiosteal flaps with releasing incision(s).

- Flap design – broad base, not directly over bone defect if possible
  > Extend releasing incision just past mucogingival junction, into alveolar mucosa
  > Maxillary canine – two releasing incision
  > Maxillary fourth premolar – one releasing incision mesially (rostral)
  > Mandibular canine – T- or Y-shaped distal incision, mesial incision
    — Follow the ‘path’ of the root – angled lingually
    — Elevate buccal flap completely
    — Elevate lingually to expose distal aspect of root
  > Maxillary first molar – if extracted on its own, a flap will not be reasonable
- Flap elevation and release
  > Debride gingival margin before elevating – cut 1-2mm away
  > Periosteal elevation to lift full thickness flap off of bone – past MGJ
    — Only elevate as far as you need for adequate access
  > Use blade or iris scissors to snip the fibers of the periosteum on the under side of the flap

**Alveoloplasty/Sectioning**

- Maxillary Canine
  > Make a groove at mesial and distal aspects of the root – place for elevator – to the widest part of the root, then connect across
- Mand Canine
  > Remove bone from buccal, distal and lingual surfaces, as well as a groove at the buccal-mesial aspect
- Multi-rooted teeth
  > Shave away buccal bone until furcation is visualized
  > Using crosscut fissure bur – section from furcation through the crown
    — Max fourth premolar – one cut from furcation into developmental groove; second cut from furcation mesially to remove ‘diamond’ shaped piece of crown
- Access to furcation between two mesial roots now visible, section those two apart
  — Mand first molar – section from furcation to just past mesial crown, but not at too much of an angle
  — Max molars – section palatal root away from two buccal roots, then separate the two buccal roots

**Elevation – the goal is to fatigue the periodontal ligament to the extent that the tooth can be elevated from the socket**

- Advancing the sharpened tip of the dental elevator down the root, in the periodontal ligament space, with rotational hold, is the best force to use
- Elevating in between crown portions with the fulcrum of force below the alveolar ridge – teeth may break
- Elevate tooth/section against adjacent tooth – make sure that tooth is very stable
- Gently grasping the tooth/segment with the extraction forceps and putting rotational force can
help fatigue the ligament and/or tell you where you need further elevation

• If there is no movement and Radiographically the PDL was healthy, remove more buccal or interseptal bone.
  > In the maxilla, additional buccal bone removal is reasonable (window washer movement of the bur on the bone surface)
  > In the mandible, particularly of small dogs, preserve as much buccal bone as possible (cortical bone)
    — To access adjacent roots, remove one first, then remove the cancellous bone that was in between the roots to get better access for elevation without having to remove buccal bone

• Once fully elevated, radiograph to confirm

**Finishing**

— Elevate the lingual/palatal mucosa once the tooth is gone for better exposure for alveolo plasty and to facilitate suturing
— Smooth any rough edges of the alveolar bone (alveoloplasty)
— Curette any debris or infected tissue from the alveoli
— Determine if any bone graft material is needed

• Small breed dog – mandibular canines and first molars, incisor?
• Osseoconductive or promotive?
  — Scarify any epithelial edges
  — Simple interrupted, bite through palatal, lingual mucosa first, then buccal flap

**Periodontal and soft tissue management**

• Extracting an adjacent, less strategic tooth allows you to better manage remaining teeth
  > Mandibular canines and first molar, maxillary canines and fourth premolars
• Open root planing of proximal tooth surface exposed with adjacent extraction
• Debridement of granulation and pocket tissue
• Resection of redundant tissue – wedge resection with gingivoplasty/thinning
  > Closure of attached gingiva in a more apical position to minimize pocket depth

**Complications**

One of the most important resources in performing extractions is a load of patience. As soon as you lose focus or are distracted, that’s when you hear the ‘crack’. If that sound is a root tip breaking off, go through these steps to manage the situation:

• On radiographs – was the PDL intact and healthy
  > Elevation should continue – more bone may have to been removed
    — Buccal bone removal at maxillary teeth – ‘shave’ the cortical bone away to expose the root further
    — Mandibular teeth – try to preserve buccal bone, but remove the cancellous bone that was in between the teeth for better access
    — Palatal root – dig a trench around the root and make sure there are no overhangs
  > If there is any periapical bone loss (and the pulp is dead or infected), the root HAS to come out
    — Avoid aggressive elevation toward the apex – the root could punch through into the nasal cavity or mandibular canal
    — Work the root tip from side to side – use a root tip pick

• If the root tip goes into the nasal cavity or mandibular canal, every effort should be made to remove it THEN! – this is your best chance to remove it while it is still loose and not encased in scar or fibrous tissue
  > Take radiographs at several angles to localize where the tip is
  > Open the hole it pushed through even more (watch for important vessels)
  > If you can gently grasp it without damaging other structures, attempt to do so – but it will usually move further away
Once the hole is wider than the root tip without overhangs, uses copious water to flush the area, and adjust the head to allow ventral drainage.

Many times you won’t even see the tip flush out – so re-radiograph often.

If you hear the big ‘crack’ – the jaw breaking – hopefully you had pre-operative radiographs and have told the owner that the jaw could be fragile. If this is a pathological fracture due to extensive periodontal disease, it will be a difficult area to stabilize, as the affected teeth usually have to be extracted anyway. Sometimes a partial rostral mandibulectomy is the best option for the patient.

Summary

With the right equipment, training and patience, extractions in practices can be successful surgical procedures with minimal complications. Often these patients will clinically be much healthier once the infection in their oral cavities have been managed with extractions.

Knowledge of the anatomical details of the periodontal ligament (PDL) is important to have in mind in order to understand the physiological changes that happen in the bone when we try to move a tooth.

The periodontal ligament is approximately 0.5 mm wide and consists of:

- Sharpey fibres is made of type 1 Collagen
  - The fibres run parallel from cementum to lamina dura in the alveolar bone slightly angled apically
  - Act as elastic attachment of the teeth to the bone

- Cellular elements consists of:
  - Blood vessels though poorly vascularised
  - Free nerve endings and pressure-receptors
  - Mesenchymal cells like fibroblasts + osteoblasts

- Tissue fluids act as a shock absorber due to the semi-porous walls of the alveolus allowing tissue fluids to be squeezed out when the tooth is under hard pressure

During chewing the teeth and the PDL is under intermittent short (≤1 sec) heavy forces (1- to 50 kg in humans) the bone of the mandible bends since the fluid is not compressible and the tooth is not displaced. If heavy forces are maintained for more than a 1 sec, the fluid is squeezed out and the tooth will become displaced in the socket and the PDL compressed against the bone. Pain will be elicited after a few seconds. When sustained force is heavy, blood vessels occlude. Pain and sterile necrosis of the PDL will occur in the compressed area and result in undermining resorption of the alveolar bone at the compressed side of the tooth, which slows down tooth movement that happens in steps. When sustained force is light, cells in the PDL survives and frontal resorption takes place continuously by osteoclasts at the compressed area and bone build-up by osteoblasts at the tension surface.

Teeth can move in five different ways: tipping, translation, rotation, extrusion and intrusion. The forces needed for the different types of movement vary and depends on the size of the roots.

The duration of the forces exerted on the teeth can be either continuous, interrupted or intermittent.
Continuous forces are the most optimal but also almost impossible to achieve.

In the veterinary orthodontic treatment, other teeth are used as anchorage. Anchorage is defined as resistance to unwanted tooth movement. The anchor value is almost identical to the root surface area of the tooth. In general, the tooth or teeth to be moved must be pulled from anchor teeth with a larger anchor value or the types of movement forced on to the anchor tooth/teeth will demand higher forces to take place compared to the tooth to be moved, eg. tipping against translation.

Temporary increased mobility will occur and is accepted during tooth movement, but if forces are too extensive the teeth become too mobile. Pain, root resorption due to necrotic PDL and undermining resorption and loss of alveolar bone height are other risks of orthodontic treatment. Pulp vitality may be at risk though very unlikely.

Orthodontic treatment in dogs and cats is classified into three categories: Preventive, Interceptive and Corrective orthodontics. Guiding owners to provide exercises and chew toys to avoid developing malocclusion is classified as preventive treatment. Interceptive treatment is when extraction of deciduous or permanent teeth is performed to prevent malocclusion in permanent dentition. Treatment of malocclusion in permanent dentition using appliances is classified as corrective orthodontics.

Correct occlusion in dogs and cats is a relative concept due to the very different skulls types in the different breeds—especially in dogs.

For a well-illustrated and detailed description of normal and malocclusion, please go to www.avdc.org/nomenclature/Nomen-Occlusion.html#normal

Common malocclusions seen in dogs and cats are rotated maxillary premolars in brachephalics, mandibular mesioclusion in brachycephalic animals, linguoverted mandibular canines, linguo-distoverted mandibular canines, mesioverted maxillary canines (lancet tooth) and anterior or posterior cross bite.

Motorized endodontic systems for use in small animals – a review of the literature

Cedric Tutt DEVDC

Motorised endodontic systems include rotating and reciprocating filing systems and by extension ultrasonic endodontic system shaping techniques will also be reviewed.

The aim of endodontic instrumentation is to debride and shape the endodontic system so that it can be effectively obturated and the access site restored to preserve function of the tooth.

Stainless steel and Nickel Titanium (NiTi) hand files in Hedstrom (H-Files), Kerr (K-Files) and reamer formats have been routinely used. The benefit of NiTi files is that due to their flexibility, they can follow curvature of the canal without gouging and ledging.

Motorized endodontic canal preparation motors were initially based on a table-top device which via a foot pedal and cable to the handpiece, drove the files in a rotary manner. Some newer units retain the wired format but have advanced programmable software to control the action of the file. Recent advancements in endodontic system instrumentation has seen the development of rechargeable, battery-operated handpieces which are ergonomically designed to give comfort and minimal strain on the surgeon’s hand. Some handpieces are preprogrammed with little input required from the operator while others may be used as standalone units or managed by an application on a tablet (iPad). These units are programmable depending on the filing system being used with specific rotation speed and torque adjustments possible.

The modern motorised endodontic filing systems have a range of file lengths, the longest at present being 70mm with ISO sizes #20-#140, adequate for most domestic animals. Specific heat treatment techniques are applied to the files during the manufacturing process which lead to greater strength and resistance to rotational fatigue and separation.
File cross-sectional shapes include: triangular, rectangular and s-shaped. These files have differing cutting ability, some working by rotation only and others by reciprocation. In both systems, if the files engage the dentine, the handpiece will switch to reverse to prevent separation. If torque settings are too high a file will separate – sometimes with very disappointing results, which may include extraction. Separation of NiTi files appears to be more common during rotational instrumentation than reciprocation. In a recently launched motorized veterinary endodontic reciprocating NiTi filing system, fluting length has been dramatically increased to move the mechanically weakened part of the file out of the canal when it is a maximum working length. In combination with ideal torque settings, it is hoped that this advance will dramatically reduce or even eliminate file separation. Using the fracture site as access, these files create a cylindrical-to-conical shape from the coronal access to the apical extent of the canal, facilitating flushing and obturation. As long as the file is eased out of the canal, without dragging it against the canal perimeter, a circular access will result, maximising tooth substance retention and strength.

When compared to hand filing using stainless steel K-files, rotating NiTi files were shown to leave less untouched canal wall and cause less straightening of the canals. Files with a greater taper (4%), were shown to leave less untouched canal wall, than files with a lesser taper.

Obturation techniques have been developed which go hand-in-hand with the filing systems – GP points and obturation devices are of the same size and taper as the files used. Warm obturation techniques also make use of GP delivery systems which are of the same dimensions as the files used – providing highly efficient “single cone” obturation.

This presentation will compare file lengths, cross-sections, rotation vs reciprocating, efficiency of cleaning/shaping and the type of motorized handpieces currently in use. Ultrasonic endodontic debriding systems will also be described.

**Lightspeed files**

P. Theuns

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**Introduction**

Lightspeed instruments were introduced in the eighties, they helped the practitioner to not only work faster but also more accurate whilst cleaning the root canal.

Lightspeed files follow the root canal and prevent ledging and or zipping.

We need to take under consideration that we copied the endodontic procedures from human dentistry books. The anatomy of the root differs from the human teeth. The animal tooth root is difficult to properly get cleaned with the traditional files. Lightspeed files will help to overcome part of these difficulties, they will improve the cleaning and shaping of the canal and will also decrease the time needed to complete the root canal treatment.

A recent paper, looking at over 60 studies of human endodontic effectiveness, showed a success rate of only about 85% in the fifty years prior to the turn of the century. Over the last decade, with the advent of nickel-titanium rotary instruments and the crown-down technique the rate actually dropped 6-8%. A survey of dentists attending a recent US endodontic program found that, of those with endodontically treated teeth, about 50% still had varying degrees of tooth sensitivity. Traditional endodontic therapy can hardly be said to provide the desired level of patient care.

The need for shifting the paradigm from small apical preparations to those that actually match the naturally anatomy has been a matter of discussion for over 15 years. If we keep the apical preparation too small, we will not be able to adequately clean the apical part of the canal. Fortunately, we are seeing more and more
research and articles supporting this idea.

**Light Speed instruments**

The new lightspeed (LSX) files have the following features:

1. The round blunt end of the LSX blade that forces the instrument to follow the natural contour of the canal.
2. The blade features a small flat surface, or radial lands, on each end of the blade that keeps the instrument centred in the canal.
3. The short blade provides excellent tactile and aural feedback on a millimetre by millimetre basis as the LSX moves down the canal. If the canal is oval, it vibrates and the increasing resistance to advancement correlates to removal of canal debris.
4. The LSX rotates at 2500 rpm (rounds per minute) and has four sharp edges, one on each edge of the radial lands. The result is a smooth cut and a debris mass that has a soft texture and is easier dissolved and removed by irrigation.
5. The small and flexible shaft supports, but does not control the LSX blade. This avoids apical transportation and maintains the natural contour or anatomy of the canal.
6. The design of the shaft/shank junction is a major safety feature, which allows the instrument to separate at a point just outside the canal, rather than fracture in the canal, this implies that the end of the shaft can still be used to remove the broken instrument.
7. The shank and the handle are colour coded with the size printed on the handle and the five 1 mm markings on the shaft reduce the dependence on rubber rings to measure the distance.
8. The lightspeed instruments are available in four lengths; 21, 25, 31 and 50 mm for veterinary use.

When using the Light Speed system, the files are introduced manually in the canal continually rotating, with a slow continuous apical movement until the blade binds. After a momentary pause, the blade is advanced to the working length with intermittent pecking motions. The number of pecks (up and down movement) required to reach working length increases as the instrument size increases, because more wall dentin is cut. The instrument that requires 12 or more pecks (12-peck rule) to advance from the point of first binding to the working length is the master apical rotary size (MAR). An instrument one size larger than the MAR then is used to instrument to a length 4 mm short of the working length. Before each file is introduced in the canal, the canal is irrigated with EDTA (ethylenediaminetetraacetic acid). Between each file size the canal is flushed with NaOCl. Then the coronal part of the canal is enlarged using the step back method. Using the next size rotary file the canal is instrumented to a 4 mm step back from the working length. Continue with stepping back with sequentially larger full-size instruments until a size is reached that cannot be easily advanced beyond the coronal third. Finally, the MAR is used to recapitulate to the working length. The LightSpeed instruments should be used in a handpiece that rotates at 2500 rpm. LightSpeed instruments are designed with 2 blades that have neutral rake angles. The radial lands keep the instrument centred in the canal while the blunt instrument tip prevents it from cutting or gouching the canal walls. LightSpeed are very flexible which allows them to negotiate and clean curved canals. There is also an option to use them by hand in extreme curves.

**Obturation**

Obturation can be done with traditional gutta percha or with a simply fill plug.

**Sealer**

Different sealers can be used. The LightSpeed manufacturer recommends using AH plus sealer when using gutta-percha plugs. This 2-component sealer is biocompatible and adapts closely to the canal walls. It also provides minimal shrinkage, long-term dimensional stability and outstanding sealing properties. It has a 4-hour working time and sets in eight hours.
However, this will increase the financial investment of the equipment considerably.

A possible new way to use the light speed system is combining it with the gutta flow sealer. The gutta flow sealer does not shrink but expands a little bit. The gutta flow bio seal is an extension of this sealer. GuttaFlow bioseal forms hydroxyapatite crystals on the surface. The crystals significantly improve adhesion and also stimulate natural triggers, especially the regeneration of bone and dentine tissue. Using this catalytic effect combined with the SimpliFill Apical Gutta Percha Obturators could be a way to start using only the Gutta flow carrier and not an extra gutta percha point coronal from the carrier anymore. More evidence is necessary to support this idea.

Conclusion

Veterinarians have to realize that the LightSpeed system allows for the use of longer (50 mm) rotary files for use in the canine teeth. Because rotary files make easier faster and safer access of the canal possible, they are a welcome extension to the dental instruments for the veterinarian practicing endodontics on a regular base.

Literature

3. 19th veterinary dental forum and world veterinary dental congress IX, how to improve the quality and speed of your root canal treatments with LightSpeed rotary instruments, Bob Boyd, pp. 49-51

Composite restorations

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Tooth Anatomy

Teeth are roughly broken up into three layers: enamel, dentin, and pulp.

The innermost layer is the endodontic system (root canal or pulp). It contains the nerves, blood vessels, and connective tissue which supply and nourish the tooth during life. The blood and nervous supply enter the tooth through the very bottom or apex of the root.

The outer layer of the tooth crown is enamel, which is an inorganic substance. It is virtually all (97%) calcium and phosphorus and is the hardest substance in the body. Enamel has no nervous or circulatory system. It is applied in a very thin layer (less than 1 mm thick in veterinary patients) over the tooth surface during development by a cell layer called ameloblasts. Once eruption has occurred, enamel cannot be replaced or repaired.

The central layer, which is the vast majority of the tooth structure in mature patients, is dentin. Dentin has roughly the same mineral content as bone. Dentin is a somewhat living structure which has a nervous supply and can occur can respond to stresses. Running at right angles to the root canal all the way around the tooth from the root canal out to the enamel are dentinal tubules. Each one of these dentinal tubules contains an odontoblastic process, which is basically a nervous supply; however, they are only sensory and can only report
changes as pain. There are approximately 50,000 dentinal tubules per mm² coronal dentin. Therefore, a 1 cm area of enamel loss will expose 3-4 million odontoblasts!

**Response to damage**

Exposure of the dentinal tubules will lead to much quicker dentinal fluid flow out through these dentinal tubules via the capillary effect. This increase in fluid flow deforms the A-delta C-delta fibers and thus will be perceived by the patient as pain. Anything that will change the flow rate will cause the nerves to fire and result in pain (sensitivity). This includes heat, cold, and desiccation. The sensitivity is actually a sign of low-grade pulp inflammation known as **pulpitis**.

In addition to the sensitivity produced by the exposure of the dentinal tubules, there is a possibility of ingress of bacteria into the root canal system. In some cases, this can result in endodontic infection and subsequent abscessation. This occasionally can be seen clinically as a swelling or draining tract but is generally subclinical and therefore undiagnosed. The only way to diagnose this infection is via dental radiographs.

Once exposure has occurred, material will accumulate on the surface which can mineralize and block the tubules (Smear Layer). In addition, the tooth will sense the disruption of its normal protection and will attempt to shield itself from the harmful invaders of the oral environment as well as decrease the patient’s pain. This will take the form of creating either tertiary or sclerotic dentin. Eventually (as long as the causative problem is not allowed to progress), this may result in the end of sensitivity. However, this process is lengthy (likely months) and the patient is painful and susceptible to infection during this time.

**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 abscessation.

*Caries*: True bacterial caries is 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 past 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.

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**Feline dental radiology simplified**

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**Dental radiology techniques**

*Dental radiograph units*

Radiographic exposure is controlled by 3 components: kVp (kilovolt peak), MA (milliamperage), and exposure time. kVp controls the “quality” of the x-ray beam. This is the power of each particular x-ray particle which controls the penetration of the beam through tissues.

The quantity of the exposure is controlled by MA and time of exposure. The higher the MA, the more X-rays produced over the time period. Multiply this number by the exposure time and you will get the total...
number of x-ray units.

Since there is not a significant amount of variation of tissues in oral radiology, the KVP and MA are set constant on dental radiology units. The only variable factor is time. This is measured in seconds or pulses. One pulse is equal to 1/60 of a second. Most standard (human) dental radiology units have a digital control for the exposure and it is set by the operator based on a technique chart. Recently, however, veterinary specific machines have become available which has a computer that sets the exposure based on the size of the patient, the speed of dental film used, and the particular object tooth. This can take a lot of the guesswork out of the exposure setting. However, with a little experience and practice, it is easy to figure out a setting.

Dental radiographic film

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

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

There are several different sizes of dental film available (4, 3, 2, 1, and 0). The most common sizes used in veterinary medicine are 4, 2, and 1. Size 3 are bite wings and are generally not used in veterinary medicine. Size 4 (occlusal) film is the largest available, it is used mostly in large breed dogs or when taking whole mouth radiographs. For small dogs and cats and most any single tooth radiograph, size 2 (standard) is commonly used. For the mandibular first and second premolars, and very small cats and puppies size 1 (or 0) (periapical) are used.

Another consideration in selecting film size is cost. Size 4 film is about 3 times the cost of size 2. Therefore, if you can use a size 2, it is recommended. However, it is much easier to position size 4 films, allowing for much more latitude in positioning. This will result in less retakes. Therefore, the less experienced may consider practicing with size 4 film and graduating to size 2 when a level of skill is obtained.

Digital dental radiology

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

Taking a dental radiograph

Step 1: Patient positioning

Position the patient so that the area of interest is convenient to the radiographic beam. In general this is where the object is “up”. For maxillary teeth, the patient should be in ventral recumbency. For mandibular canines and incisors the pet should be in dorsal recumbency. Finally, for maxillary cheek teeth, the patient should be in lateral recumbency with the affected side up. This being said, in our practice virtually all radiographs are exposed in lateral recumbancy. 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.
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.

New approaches to tooth extractions: the concept of the “atraumatic tooth extraction”

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Introduction

Tooth extraction is arguably the most commonly performed procedure in veterinary dentistry today. It can be a traumatic procedure and can result in the destruction and loss of alveolar bone and damage to surrounding soft tissues during the procedure, as well as causing post-operative pain.

Unfortunately, tooth extraction equipment and techniques have not changed very much over the past 100 years in human dentistry and over the past 40 or so years in veterinary dentistry, where surgical extraction techniques are the norm.

In human dentistry, there are now, various instruments, whose design, can allow the operator to perform “atraumatic” extractions, with minimal or no alveolar bone loss and minimal damage to surrounding periodontal tissues.

These minimally invasive (“atraumatic”) instruments were designed due to the advent of endosseous dental implants. The instruments were manufactured to allow the operator to preserve bone and soft tissue and, today, at least in human dentistry, these instruments have become an important part of the tooth extraction procedure.

Traditionally, tooth extraction has been associated with post-operative pain and loss of alveolar bone, which is thought to occur from both physiological and iatrogenic mechanisms. In human dentistry, the post extraction loss of alveolar bone can compromise the functional and esthetic rehabilitation with removable or fixed prostheses, including dental implants.

A traditional standard surgical approach to tooth extraction includes raising of a mucoperiosteal flap, followed by bone removal to facilitate tooth extraction. The raising of the flap alone and raising of the periosteum, may lead to some bone resorption, but the surgical removal of alveolar bone represents additional alveolar bone loss even before bone remodelling commences post extraction. In addition, clinical research has implicated flap surgery with increased postoperative pain, at least in humans.

Minimally invasive extraction techniques

Hand periotomes/proximators

Manual periotomes have been shown to aid in removing teeth without damaging the osseous housing. These instruments had thinner, more delicate tips intended to be utilized differently than elevators and were designed to be placed into the periodontal ligament space with pressure applied in a vertical direction.
along the root’s long axis.

Proximators™ (Karl Schumacher instruments, USA) are more robust versions of periotomes. Proximators are used to sever the periodontal fibres and create lateral expansion of the alveolus. Using the Proximator™ reduces the amount of iatrogenic damage during the extraction procedure. I see a place for these instruments, when performing more delicate extractions of curved or fine roots of multi-rooted teeth.

Periotomes and Proximators are used in a rocking action and gently advanced along the periodontal ligament space towards the apex of the tooth. They should not be used as a lever. This can lead to fracture of the instrument.

Both periotomes and proximators are placed into the periodontal ligament space to sever the periodontal ligament fibres. A periotome has a thin flexible blade that mostly cuts the fibres but does little to expand the alveolus. The Proximator in addition to severing the ligament attachments, can also expands the alveolus, as well as luxating the root, and displacing the root coronally.

There are only a few studies looking at the benefits of periotomes over conventional tooth extraction methods. One study4, showed that the periotome provided the opportunity to remove teeth without reflection of flap and thus, according to the authors, avoided the need for lifting off peristome and exposure of bone. The periotome was advanced 2/3 the way along the root surface, thus allowing expansion of the alveolus, and the eventual delivery of the tooth with extraction forceps, by applying rotational forces in a coronal direction. The authors concluded that this may be helpful in leaving the shape of extracted socket undisturbed and the alveolus intact. In this study, in the test group where a periotome was used, duration of surgery, the frequency and number of analgesics consumed, pain reduction and gingival laceration, all favoured the use of this periotome instrument for extraction over conventional elevation and forceps extraction. The authors concluded that the use of periotome in single-rooted tooth extractions gives a superior result compared to extractions carried out using the traditional periosteal elevator and flap reflection.

Mechanically driven periotomes

More recently, a new mechanical extraction device (iM3 Vet-Tome®) has been introduced. This instrument has a mechanically driven blade of various sizes that passes along the periodontal ligament space, thus loosening the tooth without the need for buccal or lingual alveolar bone removal (however, sometimes minimal buccal bone is removed to obtain wound closure). The outcome is a less traumatic tooth extraction that will allow for less post-operative pain and quicker healing of the extraction socket. It has been reported in animal studies, that non-surgical extraction sites with four bony walls that are intact, tend to heal faster than sites with less than 4 walls. In one such study5 on Landrace pigs, the authors concluded that an important factor determining the quality of the socket after extraction is the presence of the buccal wall, meaning that these sites have high regenerative potential and show less resorption even following natural spontaneous healing.

iM3 Vet-Tome® is a mechanically driven periotome. It is initially introduced at about 45 degrees to the root surface onto the mesial or distal surfaces of the tooth. In a side sweeping action, the iM3 Vet-Tome® is used in short bursts to cut along the periodontal ligament to close to the apex of the tooth and will eventually cut 360 degrees around the tooth, normally without the need to raise a mucoperiosteal flap, nor usually without the need to remove bone. There are various width blades that come with the iM3 Vet-Tome® and these can be matched to the size of the tooth. Once the tooth has become loose, dental elevators can be used to further loosen the tooth, following the path that the iM3 Vet-Tome® created. Finally, with the use of extraction forceps, the tooth can be extracted. The socket can be sutured, whilst maintaining the four bony walls of the socket.

Directa Dental (Sweden) also make a mechanical periotome handpiece that attaches, ideally, to an electric slow speed motor. The Luxator LX™ (Directa Dental) fits a standard “E” coupling motor and this provides activation of the tip. This self-directing tip allows the operator to place the tip into the periodontal ligament space and, when activated, walk the tip around the tooth without the need to remove it for repositioning. When activated, the tip moves vertically in a reciprocating motion. These tips are not intended for use as elevators. If they are used as elevators, the elevation forces that can be applied, will damage, not only the Luxator LX periotome tips but may also damage the alveolar bone at the buccal or lingual crest.

The Luxator LX periotome tips have a concave inner and convex outer surface in cross-section. The recommended speed when operating the Luxator LX is 4,000 rpm, and it is recommended to start at a low speed and increasing the speed, if the tip is not advancing into the PDL with light apical pressure.
Therefore, it is preferable to have an electric driven motor rather than an air driven motor, so that the speed of the tip can be more accurately controlled. Speeds faster than 4,000 rpm will not make extractions easier or faster, and higher speeds may also damage the Luxator LX contra-angle handpiece.

Another mechanical periotome that has just become available is the Exo-safe™ hand-piece and motor (Anthogyr, France). It is composed of various RA periotome blades, that attach and lock into an automatic impactor (hand-piece) which is directly connected to a micro motor.

The advantages of mechanical periotomes include less trauma to hard and soft tissues during the extraction procedure, no heat production from the instruments, hence no thermal necrosis of bone, little or no bone removal required to perform the extraction and less post-operative pain and potentially faster healing.

The main disadvantages with any mechanical periotomes, apart from initial cost of the equipment, is that they will not cut through ankylosed or fibrosed periodontal ligaments, overzealous use of the blade can lead to blade fracture and the blades need to be replaced on a regular basis. Also marked root dilaceration may prevent the blade from following the PDL space. A pre-operative periapical radiograph is essential to assess root curvature, the PDL space and any other pathology, such as root resorption, that may interfere with the correct use of the periotome.

Peizosurgery

Peizosurgical units are starting to become available for extraction procedures, at least in human dental field.

The principle of piezosurgery is ultrasonic transduction, obtained by piezoelectric ceramic contraction and expansion. The vibrations thus obtained, are amplified and transferred onto the insert of a drill which, when rapidly applied, with slight pressure, upon the bony tissue, results, in the presence of irrigation with physiological solution, in the cavitation phenomenon, with a mechanical cutting effect, exclusively on mineralized tissues. These units have been adapted to cut along the periodontal ligament fibres.

Ultrasonic vibrating specialised ‘Syndesmotomes’ sharp tips have been recently developed for tooth and root extraction. The tip is inserted into the gingival sulcus and tracks along the periodontal ligament between the root and the alveolar bone. The periodontal ligament fibres are severed, and, in this way, a nearly atraumatic extraction can be achieved.

The main problems with Peizosurgical units are that they are very slow to cut, thus lengthening the procedure time and they may inadvertently cut their own channel into alveolar bone, whilst trying to follow the periodontal ligament.

Summary

Although surgery, involving mucoperiosteal flaps and alveolar bone removal, is still the commonest approach to tooth extraction in dogs and cats. Other techniques, that may prove to be less invasive, leading to less post-operative pain and a quicker return to function could be and should be considered as an alternative treatment option, as it already is in the field of human dentistry.

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**Tips and tricks of tooth extraction**

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**Abstract**

Tooth extraction is one of the most frequently performed procedures in small animal practice. Utilizing good instrumentation and applying proper techniques (closed or open extraction) will facilitate complete tooth removal and will avoid the occurrence of complications.

**Basics of tooth extraction**

Tooth extraction is one of the most frequently performed surgical procedures in small animal practice. The most common indications for tooth extraction in dogs are periodontal disease and tooth fracture, and in cats tooth resorption and stomatitis. If the disease process is too advanced for the teeth to be saved, extraction is necessary. Financial and other considerations may lead the client to request extraction. Tooth extraction is contraindicated in patients (1) that cannot be anesthetized due to health concerns; (2) that have had radiation therapy involving the jaws that would inhibit healing; (3) with bleeding disorders that cannot be controlled; or (4) are on medications that cause prolonged bleeding times or prevent healing. Teeth are anchored to the alveolar bone of the mandible, incisive bone and maxilla by soft tissue components of the periodontium, the gingiva and periodontal ligament. During the extraction process, these tissues must be severed (junctional epithelium and gingival connective tissue) or stretched and torn (periodontal ligament) to allow delivery of the tooth to be extracted. Gentle tissue handling is important to minimize trauma and to allow rapid healing of both soft and hard tissues. In the dog the incisors, canines, first premolars, and lower third molars are single-rooted teeth; in the cat, the incisors, canines, and commonly the upper second premolars are single-rooted. The cat’s upper first molars may be treated as single-rooted teeth even though they have more than one root (the roots are usually fused together). The upper fourth premolar in the cat and dog and the upper first and second molars in the dog are three-rooted. All other teeth are two-rooted.

**Equipment, instruments and materials for tooth extraction**

The basic equipment, instrument and material needs for tooth extraction include:

- High-speed dental unit with water irrigation and 3-way syringe
- Non-surgical- and surgical-length friction-grip (FG) burs such as round (¼, ½, 1, 2, 4; to remove alveolar bone), cross-cut fissure (700, 701, 702; to section multi-rooted teeth) and round diamond burs (9, 14, 23; to smooth alveolar bone)
- Number 3 or 5 scalpel handle with blades 11, 15 or 15C
- Sharp and narrow-tipped (2-6 mm) periosteal elevators (such as Mead #3 or Periosteal #EX-9M for mid-sized and larger dogs, Glickman #24G or Periosteal #EX-9 for small dogs and cats)
- Adson 1 x 2 thumb forceps (smaller version)
- Dental elevators (1, 2, 3, 4 and 6)
- Dental luxators
- Small extraction forceps
• Root tip elevators
• Root tip forceps
• Small spoon curettes
• Irrigation solutions (0.12% chlorhexidine, lactated Ringer’s)
• Gauze sponges
• Small Metzenbaum scissors
• Needle holders
• Synthetic, absorbable monofilament suture material (4.0, 5.0) with swaged on, taper-point round, 1/2-circle, non-cutting needle
• Suture scissors (or designated pair of Mayo scissors)

Proper holding of instruments

Blades of dental luxators are designed to penetrate into the periodontal space and cut periodontal ligament fibers. Blades of dental elevators are worked into the space between the tooth and the alveolar bone and carefully rotated to create a slow, gentle and steady pressure on the tooth. Both instruments are grasped with the butt of the handle seated in the palm and the index finger extended along the blade of the instrument to act as a stop should the instrument slip and to prevent iatrogenic damage. The blades of extraction forceps should be applied as far apically on the tooth as possible to reduce the chances of root fracture.

Closed extraction of teeth

Extractions can be performed using the closed technique (without raising a mucoperiosteal flap) or open technique (raising a mucoperiosteal flap to expose alveolar bone). The closed technique should always start with cutting the gingival attachment around the tooth. A luxator or elevator is then inserted between the gingival margin or alveolar bone and the tooth. Pressure is applied while slowly rotating the elevator through a small arc and holding the instrument firmly against the tissues for at least 10 seconds. As the periodontal space widens, it is helpful to change from smaller to larger instruments. When the tooth is sufficiently loose, forceps are placed as far apically on the tooth as possible, and the tooth is rotated slightly on its long axis with a steady pull and removed from its socket. Granulation tissue, debris, pus, and bony fragments are removed from the extraction site, which is rinsed with chlorhexidine digluconate prior to closure. Leaving a blood clot in the alveolus is an essential part of healing. Packing the alveolus with osteogenetic, osteoinductive or osteoconductive materials may be done in selected cases. Multi-rooted teeth require sectioning into crown-root segments, which are extracted using the same principles as for single-rooted teeth. Sectioning is performed with a cutting bur in a high-speed handpiece and water irrigation, starting from the furcation through the tooth crown.

Open extraction of teeth

An open extraction technique is employed when a tooth resists appropriate elevation due to its size and root anatomy/pathology, or if the operator is unable to retrieve a fractured or retained root through the alveolar socket. A mucoperiosteal flap with one or two releasing incisions extending beyond the mucogingival line into alveolar mucosa is made over the tooth/teeth to be extracted. Using a periosteal elevator the flap is elevated apical to the end of the bony prominences (alveolar juga) covering the roots. Multi-rooted teeth are sectioned. Alveolar bone overlying the roots is then removed with a round bur and water irrigation by as much as 1/3 to 2/3 of the length of the root(s). The tooth or crown-root segments are then luxated, elevated and extracted. The extraction site is debrided prior to replacing the mucoperiosteal flap. To avoid tension on the closed flap, the peristeme should be incised in across the entire base of the flap. The flap is then apposed to the palatal/lingual gingiva by means of simple interrupted sutures.

Crown amputation with intentional retention of resorbing roots

An alternative to complete extraction of teeth with dentoalveolar ankylosis and root replacement resorption (as seen in cats) is crown amputation with intentional retention of resorbing roots. The gingival attach-
ment is incised, creating a small envelope flap or after making one or two releasing incisions a mucoperiosteal flap. The tooth crown is amputated from the root with a cutting bur and water irrigation. The resorbing root is further reduced with a round diamond bur to about 1-2 mm below the alveolar margin. The gingiva must be sutured tension-free over the defect, and a postoperative radiograph is obtained. This technique is contraindicated for teeth with periodontitis, endodontic disease and periapical pathology, and in patients with stomatitis or osteomyelitis.

Bibliography


Management of tooth extraction complications

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Abstract

Reported complications arising from tooth extraction in dogs and cats include fractured roots, hemorrhage, trauma to adjacent structures, sublingual edema and sialocele, orbital and brain trauma, fracture of the alveolus or jaw, oronasal communication, trauma from opposing teeth, tongue hanging out of the mouth, emphysema and air embolism, and local and systemic infection.

Fractured roots

The entire tooth should be removed to prevent infection and inflammation of the extraction site. Dental radiography is invaluable in determining the position and size of a root fragment. Special root tip elevators, picks and extraction forceps are available. Creation of a mucoperiosteal flap and partial alveolectomy will facilitate removal of a root fragment. If a root fragment cannot be retrieved, the surgical site should be evaluated periodically by means of clinical and radiographic follow-up examination. Retrieval of root fragments from the nasal cavity, infraorbital or mandibular canal after accidental repulsion of a root fragment into these spaces may be made through soft tissue and bone away from the extraction site.

Hemorrhage

Digital pressure with gauze is usually sufficient to stop bleeding. Cold compresses also can reduce blood flow sufficiently to allow a clot to form and reduce postoperative swelling following flap surgery. Excessive alveolar hemorrhage is rare. The alveolus may be irrigated packed with specific materials aiding in hemostasis, and the gingiva is sutured over the packs without tension. Vasoconstrictors are not recommended.

Trauma to adjacent structures

The operator should not leverage against adjacent teeth to prevent unwanted elevation and crown fractures of teeth not to be extracted. When deciduous teeth are extracted, care should be taken not to elevate or damage the underlying tooth buds of permanent successors. Instruments must not be inserted between a deciduous canine tooth and its developing permanent successor. Gingival lacerations commonly occur du-
ring the extraction process. More severe soft tissue lacerations may result from slippage of sharp instruments or trauma from rotating burs and should be sutured closed.

**Sublingual edema and sialocele**

Tongue manipulation, excessive alveolar mucosa elevation at the lingual aspect of the mandible, and iatrogenic trauma can result in sublingual edema. If airway and breathing are compromised, intravenous dexamethasone is administered. Instrument slippage may also cause injury to the ducts of the sublingual and mandibular salivary glands, causing formation of a sublingual sialocele (ranula). If breathing and masticatory function are not compromised, postponing marsupialization or resection of the sublingual and mandibular gland-duct complexes should be considered because the ranula often resolves spontaneously within weeks or months.

**Orbital and brain trauma**

Iatrogenic orbital trauma with panophthalmitis can occur after extraction of caudal maxillary teeth. Orbital and brain structures may be perforated by a pointed instrument particularly in patients with severe periodontitis of the caudal maxillary teeth. If antimicrobial and anti-inflammatory treatment fails, enucleation and other measures may need to be performed.

**Fracture of the alveolus or jaw**

Excessive force can cause fracture of the alveolus or jaw. Owners of animals with severe periodontitis should be warned about an increased possibility of jaw fracture, in particular when mandibular first molar or canine teeth need to be extracted. Preoperative dental radiography is imperative. If a jaw fracture occurs, diseased teeth in the fracture line should be extracted, the extraction sites debrided, orthopedic repair performed, and soft tissues sutured. An adhesive tape muzzle can be fabricated to support the jaw while a fibrous union is formed. Partial mandibulectomy is performed in the case of pathologic jaw fracture if jaw salvaging techniques are not available or successful.

**Oronasal communication**

An acute oronasal fistula is present when the nasal cavity is penetrated during extraction of maxillary teeth. This can effectively be treated by raising a buccal-based mucoperiosteal flap to close the extraction site. A chronic oronasal fistula (typically in the area of a lost or extracted maxillary canine tooth) is treated in similar fashion, with epithelium lining the fistula on the palatal side being removed to allow for proper healing of the flap.

**Trauma from opposing teeth**

When a maxillary canine tooth is extracted in cats, the upper lip may no longer be held out of the path of the opposing mandibular canine tooth which may pinched, puncture or lacerate the upper lip upon closing the mouth. This can be solved by coronal reduction, orthodontic movement or extraction of the mandibular canine.

**Tongue hanging out of the mouth**

It has been reported that the tongue may not be held in the mouth at all times when mandibular canine teeth are extracted in dogs. In the author’s opinion, this is rarely the case and more likely associated after partial or complete mandibulectomy procedures.

**Emphysema and air embolism**

Emphysema may occur after tooth sectioning or alveolectomy with air-driven high-speed equipment or
when air or air/water spray is blown into submucosal tissues. Gentle digital pressure applied to the sutured flap will help evacuate air bubbles. Blowing air or air/water spray into alveolar sockets or onto bleeding tissue surfaces is risks the development of air emboli.

**Local and systemic infection**

Tension on suture lines can lead to wound deshiscence which can be treated by means of resuturing, or the wound is left to granulate and epithelialize. Excessive trauma during the extraction procedure can result in loss of blood supply to the alveolar bone. Alveolar osteitis is rare in cats and dogs, but it may also develop when the blood clot in the alveolus dislodges and the bone becomes exposed to the oral environment in non-sutured extraction sites. Sequestered bone is then removed, and the alveolus is curetted until healthy bleeding bone is reached. The wound is sutured closed over a newly-formed blood clot with a healthy soft tissue flap. If an extraction site is not healing for longer than one week, a biopsy should be performed to rule out the presence of neoplasia. Bacteremia has been reported during and after ultrasonic teeth cleaning and tooth extraction. However, perioperative use of systemic antibiotics is only warranted in selected cases (e.g., debilitated and immunocompromised patients; patients with organ disease, endocrine disorders, cardiovascular disease, severely contaminated wounds and systemic infections; and patients having permanent implants and transplants). Tooth extraction causing systemic infection is rarely reported.

**Bibliography**


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**Periodontal flap surgery**

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**Introduction**

Any pocket with depths greater than normal (for the species) are pathologic and in need of therapy. These are present in the vast majority of patients and represent not only an opportunity to improve patient health, but also to increase practice income. A thorough oral exam will elucidate these pockets and allow for proper therapy.

Periodontal therapy/surgery involves removing the infection from the root surface (i.e. plaque, calculus, and granulation tissue), as well as smoothing the diseased root surface. These steps allow for gingival reattachment leading to a decrease in pocket depth.

In dogs, pockets between 3 and 6 mm which are not associated with tooth mobility or other pathology (furcation, root caries) are best treated with closed root planing and subgingival curettage. This step is performed with a combination of mechanical and hand scaling. This should be meticulously performed in order to achieve as clean a tooth as possible to promote healing. Following this, periocuetic can be administered to improve attachment gain.

Pockets greater than 5 to 6-mm require advanced procedures for effective cleaning, owing to the fact that residual calculus is seen with regularity in pockets greater than 6-mm. In humans this is known as the 5-mm standard. In addition, periodontal surgery is indicated for teeth with even moderate alveolar bone loss, furcation level II and III, and inaccessible areas. Visualization is best accomplished via periodontal flap
procedures, which should be offered if the clients are interested in salvaging the teeth. These are advanced procedures but can be learned by general practitioners.

Periodontal surgery is very effective for treating regaining attachment and salvaging teeth. However, without a commitment to regular periodontal care (consistent homecare and professional cleanings), these surgeries will ultimately fail. This should be communicated to the client prior to performing surgery.

Since these are involved procedures and are generally performed on older patients, a complete work-up prior to surgery is strongly recommended. In addition, proper pain management, including regional anesthesia is mandated for proper patient care.

**Equipment needs**

All incisions for periodontal surgery are best accomplished with a number 15 or 11 scalpel blade. Other equipment should include a selection of periodontal elevators, several sharp curettes, 7 x 7 tissue forceps, and small needle holders. It is recommended to have all of this as well as a sharpening stone in a sterile pack. Suture should be swedged on a reverse cutting needle and should be absorbable and fine (6-0 to 4-0).

In those cases where bone augmentation is desired/indicated, materials for guided tissue regeneration is necessary. This should include at minimum an absorbable barrier membrane. In addition, bone grafting/augmentation products are recommended. At this point, the highest rated material is a demineralized freeze-dried bone allograft, but many other options exist.

**Surgical preparation**

All surgery should initiate with a complete dental prophylaxis to decrease oral contamination. Ideally, this is performed a few weeks prior to the surgical procedure. Following this, a complete oral exam is performed. This should include the visual as well as tactile senses. Tactile evaluation consists of a combination of periodontal probing and sounding. Finally, dental radiographs should be exposed of the surgical area to document attachment levels.

**The sulcal incision**

This is a procedure that is typical for human periodontal surgery. The theory is that it will remove the infected pocket epithelium as well as create thinner gingival margin to decrease plaque and calculus retention. The sulcal incision is created reverse bevel. This means that the blade is angled AWAY from the tooth on approximately a 45 degree angle. However, in veterinary patients, there is generally not the amount of gingival thickening seen in humans and the depth of the pocket would require significant sacrifice of attached gingiva. Therefore, this author rarely performs this technique, preferring to debride the pocket epithelium following flap creation. If a reverse bevel incision is made, it is generally at a steeper angle (about 70 degrees). This remove the epithelium and thins the margin without sacrificing significant AG. It is a more difficult incision to create but will make the cleaning as well as suturing easier. Once the reverse bevel incision is performed, the rest of the flap is created.

**Flap types**

There are numerous options for flaps, depending on the presentation. The most common flap used in periodontal surgery is a full flap, or one with vertical releasing incisions. This allows for increased exposure, however is somewhat more invasive. The other common flap for periodontal surgery is the envelope flap. This is created along the arcade, without vertical incisions.

**Envelope (horizontal) flap**

The advantage of this flap is that there is less chance for dehiscence and there is less suturing than for a full flap. The only disadvantages are that there may not be as much exposure for cleaning the surface of the root. Also, repositioning is not possible without vertical releasing incisions. An envelope flap is created by incising the gingiva between the target teeth. The incision should be made in one motion all the way down to the
alveolar bone. This will create a full thickness flap. The incision can be carried to adjacent healthy teeth, if necessary for sufficient exposure. Make sure when you are performing this flap to not damage the gingiva.

After the extent of the horizontal flap is created, the flap is elevated from the alveolar bone. It is important to ensure that the entire flap is fully cut prior to attempting release. If there is a small area of attachment, it could result in tearing. Start elevation slowly and if significant resistance is felt, re-incise the area. This is best performed with a sharp periosteal elevator. Carefully release the full thickness flap to expose the root surface and alveolar bone for cleaning and contouring. Following therapy (see below), the flap is replaced (without tension) and sutured interdentally.

**Full flap**

The full flap is once again initiated by performing releasing incisions mesial and distal to the area or cleaning. These incisions should be made very slightly divergent (so that the base is slightly wider than the gingival area) to maintain blood supply. Additionally, the incisions are typically made on line angles of the target teeth or one mesial and distal to the target tooth (teeth). Line angles are theoretic lines where two edges of a tooth meet. In general, the incisions are made on medial and distal line angles. If there is a diastema between the teeth (most notable distal to the canine teeth) an interdental incision may be made. Incisions should never be made mid root as this will damage the periodontal attachment.

After the extent of the flap is created, it is elevated from the alveolar bone. This is best performed with a sharp periosteal elevator. Carefully release the full thickness flap to expose the root surface and alveolar bone for cleaning and contouring. Following therapy (see below), the flap is replaced (without tension) and sutured interdentally. The vertical incisions are closed with simple interrupted sutures placed 2-3 mm apart.

Full flaps can also be sutured at different levels on the tooth. Apical repositioned flaps are utilized to move the gingival height apically, thus decreasing pocket depth. These flaps are most commonly used in the mandibular incisor area. Coronal repositioning flaps are used to move the gingival attachment up the tooth. This is used to move the attachment up the tooth to gain attachment levels. This results in increased attachment, but may also result in increased pocket depth.

**Treating the exposed root/bone surface**

The goal of periodontal surgery is to create a smooth and clean tooth surface for reattachment. This is comprised of several steps.

The first and most important step is thorough root planing. This is best performed with a combination of ultrasonic and hand scaling. This author prefers utilizing the ultrasonic scaler on the root surface to remove the vast majority of the plaque and calculus. Following this, a sharp curette is used to plane the exposed root surface to as smooth as possible a finish.

Following the root planing, the remaining alveolar bone is smoothed to a knife sharp edge. Additionally, the bone should scalloped around the tooth. This can be performed with a bone chisel or a finishing bur.

Next, root conditioning may be performed. This step is designed to clean the root surface as well as slightly demineralise it to improve reattachment. There are many products that have been or can be used for this step. Classically it was performed with citric acid, but recently EDTA has been promoted as the best product. Following manufacturers recommendations, it is placed on the exposed root surface and left for the prescribed time. After that, it is rinsed from the surface.

**Guided tissue regeneration**

If bone augmentation is indicated, it is mixed according to manufacturer’s directions and placed in the defect. There are numerous products available; the practitioner must make their own decision based on cost. However, currently, the product with the best track record for regrowth is freeze dried, demineralized cancellous cadaver bone.

A barrier membrane should be placed over the surgical site if bone regrowth is desired. In veterinary medicine, absorbable membranes should be utilized. There are several types and manufacturers; this author finds that the lamellar bone membrane works well. Another option for the barrier membrane is to create one out of a periocutic. This has the added advantage of the antibiotic and anti-inflammatory properties of the
product. To perform this, place a small amount of properly mixed Doxirobe on a glass slab. Thin the product with air and then wet it. Once set, use a scalpel blade to cut out the correctly sized and shaped membrane. Then carefully lift the membrane and suture in place.

**Follow-up**

The patient should be prescribed antibiotics and pain management and fed soft food for 2 weeks. At the end of 2 weeks, the patient should be rechecked to ensure that the flap has healed. The owner should be counselled on home care and recheck needs. The patient should be rechecked in six months to determine success or failure of the procedure. This recheck should be performed under general anesthesia and include probing and radiographic monitoring of the surgical site.

**Conclusion**

Periodontal disease is the number one diagnosed problem in small animal dentistry. More clients are interested in salvaging these teeth, and periodontal surgery can provide this benefit. By learning these procedures, general practitioners can provide this service under one anesthetic.

**Diagnostic imaging of the canine temporomandibular joint with standard extraoral radiography, CBCT and arthroscopy**

**Jerzy Gawor, Igor Bissenik and Emilia Klim**

**Introduction**

Proper management of TMJ problems depends on an accurate diagnosis. Actions based on assumption only can lead to severe complications, such as further damage of injured joint structures, its ankylosis, or another malfunction. Diagnosis is based on a series of well positioned radiographs or, ideally, 3D imaging. CT is superior for TMJ evaluation than standard radiography, whereas MRI provides more accurate evaluation of the soft tissues. CT is the preferred diagnostic imaging modality for bony lesions. Attempts to obtain diagnostic quality 3D TMJ imaging in dogs using ultrasound technology have not yet provided satisfactory results and will require further refinement before this technique is clinically relevant. Regarding arthroscopy the successful in vivo attempts to TMJ arthroscopy in beagle dogs was described and published.

Objective of the study was to compare diagnostic value of 3 different diagnostic modalities of canine TMJ with particular interest to arthroscopy and its practical application.

**Materials and methods**

There were 4 canine heads used for the studies representing following breeds: German shepherd, Bernese mountain dog, Boxer and Labrador retriever. All of them were obtained from the matured dogs euthanised because of healthy reasons and with release of rights of their bodies.

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3 Engelke W Ruttiman UE, Tsuchimochi M, Bacher JD. An experimental study of new diagnostic methods for the examination of osseous lesions in the temporomandibular joint.
Three different diagnostic procedures were performed: Standard extra oral radiography, followed by CBCT and finally arthroscopy was performed in both TMJs. After arthroscopy another CBCT was done.

1. Standard extraoral radiography were conducted with 2 classic projections were exposed. *Lateral oblique view.* The head was positioned in lateral recumbency with the palate angulated approximately 80° to the table plane and the nose elevated from horizontal in 10° for German Shepherd, 15° for Labrador and Bernese and 25° for Boxer. This projection was exposed on left and right side with the same conditions. At each projection the x-ray beam was directed perpendicularly to sensor. *Dorsoventral view.* The head was positioned in sternal recumbency and the x-ray beam was directed perpendicular to the film. All the above radiographic projections were exposed in two options: with wide opened jaws after placement mouth prop 90mm and without tension with slightly opened jaws for about 20-30 mm. Finally, from each specimen 6 radiographs were obtained. Radiographs were evaluated by board certified veterinary dentist with particular attention to TMJ structures.

2. CBCT scan with the use of NewTom5G vet 0,3mm of each head one with open jaws, second with closed. Then separate study with 0,15mm of the TMJ area was performed. The same CBCT scan with high (0,15mm) resolution was done after arthroscopy to assess potential damages of the structures during arthroscopy. Scan was evaluated by board certified dentist with particular attention to TMJ area.

3. Arthroscopy. Two approaches were made for arthroscopy: with and without surgical access. The first option started with skin incision and exposure of the TMJ capsule from the lateral aspect and mini-arthrotomy. Regardless of technique, just before insertion of the arthroscope, the joint cavity was distended with few millilitres of saline using 18G hypodermic needle then access was made with blunt trocar followed by insertion of 1,9 mm diameter short 30-degree oblique arthroscope through lateral port.

**Results**

Each diagnostic method delivered different range of information. The most limited diagnostic value provided was standard extra oral radiography however the shape of the articular surface of the temporal bone as well as condylar process were visible. Additionally, rough assessment of the relations between condylar and temporal articular surfaces was possible. CBCT assessment obtained exact size, shape, regularity, topography of the TMJ both in individual and comparative (left to the right side) way. Additionally, condylar and temporal bone condition assessment was available. The final CBCT test after arthroscopy provided information about damages of the bony structures during arthroscopy. In presented studies CBCT revealed 2 damages of the TMJ both were found in lateral aspect of mandibular condyles. No other damages were found. During arthroscopy the examiner could evaluate soft tissue like articular disc, joint capsule, articular cartilage surface and content of both compartments in articular space.

**Discussion**

As none of assessed specimen did not show any clinical features of TMJ pathology in terms of mobility, shape and symmetry, the diagnostic imaging was focused on anatomical aspect.

In the lateral oblique projection, it is possible to evaluate the shape of the articular surface of the temporal bone and the condylar process shape. The vertical projections (DV and ventrodorsal [VD]) provide visibility of the relationships between the condylar process and the articular surface of the temporal bone. CBCT provided accurate information about TMJ with particular role of measurement of the TMJ space which was important for the use of arthroscopy. This imaging modality allowed for comparison its features in different types of the head. Software allowed for additional multiplanar reformation i.e., 2D images in axial, coronal, sagittal and even oblique or curved image planes.5

An important advantage of CBCT imaging of TMJ is that it allows accurate measurements of the volume.

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and surface of the condyle. However, it should be emphasized that the diagnostic information obtained from CBCT modality is limited to the morphology of the osseous joint components, cortical bone integrity and subcortical bone destruction/production.

Described arthroscopy was performed with arthroscope 1.9mm diameter. Having surgical access and mini-arthrotomy evaluation of the upper and lower joint cavity took less time than in pure arthroscopy non-surgical approach, however, in both options visualization of both cavities was possible. Arthroscopy provided detailed qualitative information about intracapsular soft tissue structures of the TMJ as: articular cartilage surfaces and separate evaluation of both joint compartments.

Revealed damages of the condyles the most likely were associated with inaccurate introduction of the arthroscope. Despite these findings arthroscopy remains the minimal invasive technique of diagnostic imaging of the joint.

Conclusion

TMJ diagnostics process can benefit from CBCT and arthroscopy and these two diagnostic modalities are complementary delivering different kind of information. Arthroscopy must be performed with caution not to damage TMJ structures. Standard radiography can play a role as an orientation method only being significantly inferior to two other discussed methods.


**Temporomandibular joint pathology in wild carnivores in the Western United States**

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The skulls of large numbers of pinnipeds, mustelids, ursids, felids and canids occurring in the western United States, were examined for the presence of bony changes associated with osteoarthritis of the temporomandibular joint (TMJ-OA). The museum specimens were sourced from wild populations.

The occurrence of TMJ-OA ranged from 0-63.5%. The most commonly affected species included the California sea lion (63.5%), walrus (60.5%) and American black bear (50.0%). Conversely no TMJ-OA was found in the California bobcat and gray fox. Severe TMJ-OA, likely to have been associated with impaired function, was found in the southern sea otter (4.1%). In addition, osteochondritis dissecans-like lesions of the TMJ were also found among the species.

While the etiology and pathophysiology of TMJ-OA in wildlife remains unknown, it was concluded that is some species TMJ-OA may contribute to morbidity and mortality.
Masticatory myositis is an autoimmune disease reported in dogs and recently in cats, characterized by inflammation, necrosis and atrophy of all masticatory muscles but digastricus.

Clinical presentation can be variable depending on the phase of the disease. Acute phase manifests with swelling and pain. Other unspecific signs such as fever, lethargy, anorexia can be present. Chronic phase characterizes by muscle atrophy with or without pain. The main common sign to both phases is inability to open the mouth in the conscious patient. The inability can be only due to pain or due to mechanical impediment. Tracheostomy might be necessary if the patient is placed under anesthesia.

The disease affects mainly young adult dog (about 3 years of age) although any dog at any age can be affected.

Differential diagnoses include immune-mediated disease (extraocular myositis, polymyositis, dermatomyositis), bacterial and parasitic diseases (neosporosis, toxoplasmosis, hepatozoonosis), skull fracture, TMJ luxation, TMJ ankylosis, neoplasia and paraneoplastic syndrome, foreign body, abscess, ear disease, and tetanus.

2M antibody titer with or without detection of immune complexes in the masticatory muscles (immunohistochemistry) provide the diagnosis. Diagnostic imaging (CT and MRI) is used to rule out other conditions (TMJ diseases, ear disease...) and select the area where the biopsy is taken from. The samples should be taken from areas with inflammation (active disease) and not from areas with severe atrophy and necrosis.

Immune-suppressive treatment usually with glucocorticoids is able to control the disease, however azathioprine can be added in order to decrease side effects of the prednisone. Pain management might be necessary, mainly during the first weeks of treatment.

Prognosis is better if the treatment is initiated during the acute phase and early after the onset. Dogs in acute phase improve quickly while if the atrophy is severe it can take months for full recovery or they might not fully recover.

Relapses are relatively frequent, usually if the treatment is discontinued too early. Our recommendation is to continue with prednisone for 10-12 before discontinuing completely its administration. Younger animals appear to be at higher risk for relapses than older dogs. 2M-fiber antibody titer, evaluation of the range of mandibular motion, pain, and changes in behavior (ability to pick up food or regular toy and activity level) are the parameters that are evaluated at each recheck to detect relapses.

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

This case report reviews an unusual case of necrotising stomatitis and successful long-term management in a 2-year-old, female, English Springer Spaniel dog.
Episodic, antibiotic responsive necrotising stomatitis was reported in a two-year-old, female, English Springer Spaniel dog. Multiple management strategies had been undertaken by the primary clinicians and secondary centre without definitive diagnosis or resolution.

A review of the diagnostic approach and subsequent findings will be presented. Definitive diagnosis of vasculitis, presumed to be immune mediated, with a secondary infection with methicillin resistant Staphylococcus intermedius was made. Subsequent treatment will be described.

The subgingival microbiome of domestic cats with periodontitis varies according to the clinical form of the disease

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Periodontitis is an inflammatory disease highly prevalent in domestic cats, characterized by destruction of periodontal tissues. Pathogenesis involves the presence of a bacterial community (i.e. microbiome) within the subgingival area that elicits a local inflammatory response. Aggressive (AP) and chronic periodontitis (CP) represent two clinical forms of the disease. Moreover, cats with chronic gingivostomatitis (FCGS) develop more severe and extensive forms of periodontitis compared to cats without this disease. The purpose of this study was to compare the subgingival microbiome of periodontally healthy cats and cats with AP, CP and FCGS. For this, 139 subgingival samples were collected from 45 client-owned cats. Bacterial DNA was extracted and amplified, and sequencing of a hypervariable region of the 16S rRNA gene was performed using a MiSeq platform. Standard clinical and radiographic data was used for disease staging and classification of sampled sites and animals. Analyses show that the subgingival microbiome of healthy cats is less rich and diverse compared to diseased cats, and that its composition varies significantly compared to healthy animals and across disease categories. Specifically at the genus level, the relative abundance of Treponema, Snowella, Filifactor, Desulfomicrobium, Dysgonomonas, Peptostreptococcus, Alkaliphilus, Syntrophomonas, Methylobacillus, Candidatus Tammella, Odoribacter, Peptoniphilus, and Rhodotermus was significantly increased in diseased cats. Additionally, Syntrophomonas and Snowella were significantly more abundant in AP compared to other disease categories. These preliminary results suggest that the different clinical presentations of periodontitis in cats could be driven by differences in the subgingival microbiome composition. Functional studies are required to validate this hypothesis.

Feline chronic gingivostomatitis in single- vs. multi-cat households

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Feline chronic gingivostomatitis (FCGS) is a common disease of major clinical significance but unknown etiology. Several infectious agents have been associated with FCGS, but causality has not been demonstrated. Multiple independent studies have shown that the prevalence of feline calicivirus (FCV) in cats with FCGS is higher compared to unaffected cats, and an etiologic role is suspected. The prevalence of FCV infection has
been shown to be particularly high in multi-cat environments. If FCV plays an etiologic role, it is likely that FCGS is more common in multi-cat environments compared to single-cat, and that the risk of FCGS correlates with the number of cohabiting cats. The purpose of this case-control study was to determine whether FCGS is more common in multi-cat compared to single-cat households, whether the number of cats sharing a household correlates with the risk of FCGS, and whether the number of cats sharing a household impacts standard surgical intervention for the treatment of FCGS. Seventy-six cats met the criteria for inclusion, of which 36 (47%) were FCGS cases and 40 (53%) were periodontitis controls. Bivariate analysis showed that FCGS cats were significantly more likely to come from multi-cat households and had significantly more total cats per household. Multivariate analysis also showed that cats cohabiting with other cats had a significantly increased odds of FCGS compared to cats with stomatitis. The number of cohabiting cats was not associated with surgical outcome. The results of this study support the notion that the etiopathogenesis of FCGS involves an infectious agent(s).

**Summary**

Digital dental radiography remains the mainstay of imaging in dentistry. Systems based on photo-stimulated phosphor (PSP) technology, are preferred. The routine use of full-mouth radiographic series is the standard of care. Computed tomography is indicated for oral and maxillofacial trauma, tumors and soft tissue conditions. Cone-beam computed tomography is indicated for dental conditions and maxillofacial trauma. Computed tomography with tridimensional (3D) imaging and 3D printing is very useful prior to advanced mandibular and maxillofacial surgery. Tridimensional imaging is especially useful for mandibular and maxillofacial fracture repair and palatal defect repair. Tridimensional printing is especially useful for surgical planning for mandibular reconstructions, complex oncologic excisions and correction of temporomandibular (TMJ) ankylosis.

**Dental Radiography**

Dental radiographs form an essential part of a comprehensive oral examination and radiological findings are a key element in dental decision-making. A commonly used approach is to radiograph those areas where one expects to find pathology, based on the visual oral examination and periodontal probing. The indications for dental radiography can be summarized as follows: (1) clinical signs of periodontal or endodontic disease; (2) prior to extraction, and post-extraction, if there is any suspicion of root fracture; (3) before, during and after endodontic procedures; (4) clinical staging of oral tumors; (5) dental trauma; and (6) diagnosis of missing teeth.

A “full-mouth survey” is defined as a series of radiographs depicting not only the teeth present, but also edentulous parts of the jaw bones that are normally tooth-bearing. It is common practice for a full-mouth radiographic survey to be obtained during a patient’s first visit to a dentist. This is done for two main reasons: to determine the condition of the teeth and bones, and to establish a baseline for future changes. The routine use of full-mouth radiography is well established in human dentistry, although there is also some concern about the radiation safety aspects. However, for the adult, dentulous, new patient with clinical evidence of generalized dental disease, a full-mouth radiographic examination is considered appropriate.

Full-mouth radiography of small animal patients referred for dental treatment is not routinely done in
practice, presumably because it is considered cost-prohibitive, and because it is not established practice to do so. With the increasing sophistication of veterinary dentistry and increased availability of suitable dental radiographic equipment, it is conceivable that the current standard of care should be upgraded to include full-mouth radiography when an animal is first presented for dental treatment.

A study of the clinical value of radiographs showed that the diagnostic yield of full-mouth radiography in dogs and cats is high. In 72.6% of the dogs and 86.1% of cats, radiography of teeth or areas with clinically evident dental disease provided additional, clinically useful, or essential information. Radiography of teeth or areas without clinically evident dental disease revealed incidental findings in 41.7% of the dogs and 4.8% of cats, and clinically important lesions in 27.8% of dogs and 41.7% of cats. Further inspection indicated that older patients clearly derive more benefit from full-mouth radiography than do younger patients. The routine use of full-mouth radiography is therefore justifiable for new canine and feline dental patients.

Direct digital imaging systems are becoming increasingly common in dental radiography. The majority of these systems are based on charge-coupled device (CCD) technology. The disadvantages of CCD systems include the restrictions associated with the bulky sensor, connecting wire, limited sensor size (no size #4), and high sensor cost. Systems based on photo-stimulated phosphor (PSP) technology are preferred. Digital imaging based on PSP technology uses reusable imaging plates (including size #4) without cables or sensors, in combination with a conventional dental x-ray unit.

**Computed Tomography (CT)**

Computed tomography (CT) is becoming more readily available and affordable in veterinary medicine. It is indicated in dentistry and maxillofacial surgery in trauma cases to visualize the maxillofacial structures and temporomandibular joints. The use of CT with contrast medium is indicated for tumor cases and soft tissue conditions, such as masticatory muscle myositis. The CT scan should be acquired with a slice thickness as thin as possible.

**Cone-Beam Computer Tomography (CBCT)**

A recent advance in dental and maxillofacial imaging the cone-beam computed tomography (CBCT). With this imaging modality images are obtained with very high resolution. These can then be imported into special imaging software to evaluate the teeth and maxillofacial structures in great detail. It can be used as a substitute for dental radiographs, especially when the skull morphology makes the interpretation of radiographs difficult, such as in brachycephalic dogs. It is an excellent modality for the evaluation of craniofacial trauma and the TMJ. It is not indicated for the evaluation of soft tissue conditions and oral tumors, as intravenous contrast cannot be used.

**Tridimensional Imaging and Printing**

Advanced mandibular and maxillofacial reconstruction surgery in veterinary medicine is becoming more common and receiving wider acceptance. However, these difficult cases require special preoperative planning due to the region’s complex anatomy. The use of tridimensional (3D) imaging and, more recently, 3D printing as surgical planning modalities for mandibular and maxillofacial surgery in dogs and cats were recently introduced.

The use of 3D imaging following CT or CBCT is the standard of care at our institution and is performed by the attending surgeon. Several software programs are available for manipulation of DICOM files created by CT or CBCT for volume rendering and 3D imaging. This is routinely indicated for maxillofacial trauma cases as well as for oral tumor cases with bony involvement. It is also indicated for palatal defects, to compare the size and shape of the osseous defect with the soft tissue defect.

Having a 3D model provides the surgeon with the ability to perform precise preoperative planning and practice a virtual osteotomy and design a patient-specific implant preoperatively. The 3D printing of the affected skull overcomes this limitation and allows for a tangible understanding of the disorder and the precise surgical treatment. This may be further justified as precise presurgical planning may reduce the surgery time and allow for a reduction in overall surgical costs.

Oral and maxillofacial tumors with bone involvement in difficult locations are indications for 3D printing.
The 3D printed skulls allow for precise presurgical planning of the ostectomy sites. They are also excellent tools for client and student education.

Patients with complex mandibular and maxillofacial fractures may also benefit from 3D printing. The 3D printed skulls can be used for presurgical planning, plate selection and pre-bending of the plates, which saves on anesthetic time. For defect non-union mandibular fractures, the intact mandible can be mirrored for highly accurate pre-bending of the plate destined for the affected side.

We routinely use 3D printing of skulls prior to mandibulectomy and reconstruction. The 3D model of the intact mandibles, prior to mandibulectomy, can be used for ostectomy planning and for pre-bending the plate for the reconstruction.

Corrective ostectomies for ankylosis and pseudoankylosis of the temporomandibular joint can be very complex and not only involve the condylar process but also the coronoid process, zygomatic arch, and temporal bone. Precise preoperative planning and practicing a virtual osteotomy is possible with 3D printed models.

References


Case report: Rhabdomyosarcoma on maxillary region in a cat

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Rhabdomyosarcomas are tumors that are often found in the larynx, tongue, and heart. They arise from striated muscles in adults, and from embryonic stem cells in juveniles. This is a malignant, easily metastasizing and aggressive type of tumor. Aggressive and widespread metastasizing can occur in the lungs, the liver, the spleen, the kidneys, and the adrenal glands. Rhabdomyosarcomas have been reported in relation to vaccine injection-sites in cats.

History: A 5-year-old, male (intact), domestic short haired cat (weight= 4kg) was referred for investigation of ulcer and a mass on the left side of face. The patient displayed decreased appetite, dysphagia, hyper salivation and halitosis.
At the first examination of the mouth a large diffuse extraoral ulceroproliferative growth on buccal gingiva of about 4.5 cm x 2.3 cm size on the maxillary region extending dorsoventrally from zygomatic process to the lower border of the mandible and caraniocaudally from first premolar to retromolar region and the corner of the lips was observed.

Radiographic examination of maxilla and mandible did not show any destructive lesion on the bones. The complete blood panel showed a mild neutrophilia and infection and urinalysis was normal.

The submandibular lymph nodes were bilaterally enlarged and easily palpable.

Surgical biopsy: Under general anesthesia, surgical Biopsy was obtained and sent for histopathologic examination.

H&E staining revealed a tumor with small, stellate and round cells with eosinophilic cytoplasm and eccentric small nucleoli. The tumor was moderately cellular with hypo- and hyper-cellular areas with a loose stroma. Cytoplasm was either granular and fibrillar resembling myofibriles of the muscle cells. The nucleus was elongated and hyperchromatic.

Immunohistochemistry (IHC) studies with myosin, desmin and EMA for confirmation our diagnosis was done and showed that: myosin, strongly positive in tumoral cells, desmin: moderately positive in tumoral cells, EMA: negative in tumoral cells and Rhabdomyosarcoma was confirmed.

Complete Surgical resection of the tumor was done, and Chemotherapy obtained. The case was Followed up monthly for first three month and then every three month and there was not any recurrence of tumor after two years.

Hera, a 10 months old female Cane Corso, was presented on the 15th of October 2018 for a dental consultation. She had pink teeth, a strong halitosis, “wasn’t eating like she used to” and showed signs of pain (didn’t let anyone touch her mouth or look at her teeth).

X-rays showed a very large pulp cavity in all teeth, very thin dentin and enamel, crown fracture with pulp exposure in 304 and 404 (Figure 2), but also an abnomal density of the cortical bone in the mandible (Figure 1). The owner reported that the deciduous teeth were pink too.

The dog previously had 2 surgeries in both elbows in another clinic (bilateral elbow dysplasia). Hera is also blind with both eyes (there is no vascularization in the eyes).

Antibiotics (amoxicillin with clavulanic acid 20 mg/kg/12 h) and analgesia (meloxicam 0.1 mg/kg/day) were immediately started and the patient was scheduled for a dental procedure a week later. CBC and routine biochemistry were normal.

The dental examionation under anvhesia revealed 6 crown fractures with pulp exposure (109, 110, 209, 210, 304, 404). We extracted these teeth and tried to seal the remaining ones. The dental extractions were very difficult, but the healing was good.

At this first dental procedure, we took a blood sample to see what were the vitamine D3, calcium and parathormone levels. When results came, we found out that Hera had hypoparathyroidism (Parathormone level was 1.2 pg/ml, almost 16 times lower then the physiologic range) and recomanded a thyroid ultrasound, which is not available unfortunately.

Also Vitamine B12 was low, so the patient received treatment for that too.

After the first procedure, the recovery was fast, the dog started to eat the next day, but only very soft food.

The second dental procedure together with the ovariohysterectomy took place on the 23rd of February 2019, when we performed extractions of 208 and 209 retained roots and full 405 was extracted for histopathological examination. The recovery was even better than the first one. Hera received clindamycin 11 mg/
kg/day, 7 days and meloxicam 0.1 mg/kg/day, 4 days.

The dental pathology of this patient might be a very rare congenital dental condition called „shell teeth”, in which teeth have large pulp chambers and insufficient coronal dentin. The treatment of this dental disease is full mouth extractions, but given the very high level of difficulty of the extractions, we chose to extract only the fractured teeth. It may be a consequence of a congenital hypoparathyroidism, which would also explain the other pathological signs (blindness, bilateral elbow dysplasia).

Hera is a very interesting case with high didactic value. She remains supervised for evaluation of her clinical evolution.

Fig.1 Abnormal density of the cortical bone.

Fig.2 Crown fracture with pulp exposure 304 and 404.

Fig.3 Complicated crown fracture 304.

Fig.4 404 pulpar granuloma and 404 extraction.

Diagnosis and outcome of a unilateral cranial mandibular swelling in a 1/2-year old Golden Retriever

C. Heinichen

The case report deals with a six month old female Golden Retriever which was presented to us with a unilateral swelling of the left cranial mandible. The dog is owned by its family since the age of 8 weeks. A trauma which could have been caused the bulge was unknown to the dog’s owners.

The clinical examination showed a lacking of the permanent lower left canine (304) and the first premolar (305). Furthermore the 308 was rotated. The cutting of teeth in all other quadrants had been taken place already. The gingiva and the sub lying bone in the area of the missing teeth seemed to be thickened. The swelling was painless.

The most common reason for a swollen jaw in a young dog is the disruption of the permanent tooth. Most
often the first premolars are occurred. To diagnose a missing tooth it is important to be aware of the expected number of teeth which is in dogs 42 in the permanent dentition. To decide, if a tooth is missing, it is often helpful to check the dentition at the contralateral side and to be aware of the time of dentition depending on the breed. If a tooth is lacking one has to differentiate between a real and a false hypodontia. In real hypodontia, which often occurs in brachycephalic dogs, the tooth is missing. Where else in false hypodontia the tooth has not erupted. The retention of a tooth is often followed by the development of a dentigerous cyst. As a result of the cyst the adjacent bone and the roots are getting resorbed. Other differential diagnosis are hamartomas, abscesses or neoplasias. To distinguish between a cyst and other odontogenic disorders the radiology is the gold standard. While the cyst shows a characteristic increased radiolucency in the affected area, the odontoma, as an odontogenic malformation, has granular, radiopaque structures.

For further diagnosis and the planning of the surgery a CT was performed. In this the dislocated lower left canine surrounded by multiple hyperdense structures with a clear defined border was visible. The missing first premolar could not be identified.

At the 3-D reconstruction underlined the big dimension of the bone defect.

Before surgery the patient received an intravenous antibiotic (Lincomycinhydrochlorid-Monohydrate 20 mg/kg bw intravenously. Butorphanol in a dosage of 0.2 mg/kg bw was administered intravenously preemptive. The patient was placed on its right side and the surgical field was prepared carefully. After the preparation of the lingual and buccal mucosa the corticalis of the mandible was removed with a bone drill with permanent cooling with 0.9% saline. After that the displaced canine was removed with luxators and elevators. Then the multiple loose tooth-like structures were removed with an abrason. After rinsing the wound cavity with sterile 0.9% saline a gentamicin drained sterile gelatin sponge was left in there for three reasons: First, to stop the bleeding caused by the abrasion, furthermore to stabilize the coagulum and finally to enhance the ossification. Alternatively we discussed the use of autologous spongiosa gained from the iliac crest. The owners refused this due to the fact of a prolonged anesthesia and possible complications. The advantage of autologous bone material would have been its high biocompatibility. Furthermore it is not allergenic, not infectious and is containing multiple factors for a physiological fracture healing. Another possibility would have been the use of synthetic bone substitute.

To decide, if the use of bone substitute material is essential or not the size of the defect can be a helpful criteria. In an experimental study it has been shown that bone defects which lacks more than 15 mm of perist in dogs reaches the “critical size”. This means, that defects of this dimension bear a high risk that the defect is regenerated by connective tissue instead of bone material.

In our case the wound was finally sutured in two stressless layers with a resorbable 3-0 monofile suture with single stiches. The dog obtained Clinacin in a dosage of 5.5 mg/kg bw twice per day over a period of five days and an NSDAID for three days (Meloxicam 0.2 mg/kg bw sid).

The owners were instructed to feed soft food and the dog has to wear a collar for two weeks. The heeling of the gum was without any complications.

In the histopathological examination the material came out as an odontoma. They are rather malformations (hamartomas) instead of true neoplasias. Hamartomas are hyperplastic masses of differentiated dental tissue caused by a developmental defect. Their ranking is based on their inductive potential. This means, that an interaction between epithelial and mesodermal tissue takes place, comparable to the processes during odontogenesis. The odontoma belongs to the inductive neoplasias. Odontomas are classified as complex and compound odontomas. In compound odontomas tooth-like structures (denticles) are present but their arrangement differs from that in normal teeth. In complex odontomas the arrangement of the tooth components is disorganized. The incidence of odontomas in dogs is rare. They are usually located in the mandibulary arch. Odontomas are benign tumors. Because of their space-occupying character they can have a negative influence on the integrity of the jawbone. The prognosis is very good if the odontoma had been completely eliminated. If not, relapses can occur.

A computer-tomography was taken three weeks after surgery. The chosen option with the gelatin sponge and the blood as a supplier of angiogenetic factors and stemcells had performed well.

In the monitoring 15 months after surgery the dog shows an unrestricted load bearing capacity and functionality of the jaw proven by the race specific carrying of sticks.
Periodontal disease including gingivitis and periodontitis is a common disease in small animal practice. It produces pain, inflammation, weight loss and oral hemorrhage. This condition requires dental treatment and often aggressive, multiple dental extractions. One of the biggest challenges is the assessment of dental pain in small animal patients. Specific signs of pain are not well recognized until pain is severe with an ultimate impact in quality of life (QoL). In this presentation, a multidisciplinary perspective including pain assessment and treatment, food intake and specific pain behaviors in cats with periodontal disease will be presented.

Pain is a serious welfare issue that produces long-term distress with significant deleterious effects affecting QoL. Two pain scales (e.g. Glasgow composite pain scale-Feline (CMPS-F) and UNESP-Botucatu multidimensional composite pain scale) have been validated and commonly used for acute pain assessment in cats. According to a clinical trial performed at the Université de Montréal, cats with severe oral disease that underwent multiple teeth extractions had significantly higher CMPS-F scores throughout the post-operative period and higher prevalence of rescue analgesia (up to 2 days postoperatively) when compared with cats with minimal oral disease. From these results, CMPS-F could be a useful tool to evaluate the post-operative pain even there is no validated pain scale for oral pain in cats, yet. Additionally, intraoperative dental assessment has the potential to predict post-operative pain and rescue analgesia requirements in cats. We found that gingival and calculus index, the number of missing teeth and teeth extractions were correlated with CMPS-F scores, frequency and prevalence of rescue analgesia in our study. Multimodal analgesic intervention including opioids, local anesthetic blocks and/or non-steroidal anti-inflammatory drugs should be considered for pain relief.

Food intake could also provide a possible outcome for pain assessment. Difficulty to grasp the food is one of the well-known clinical signs in small animals with oral disease. In addition to this sign during food take,
the total amount and the speed of food intake should be considered. Our study revealed that the amount of dry food intake in cats with severe oral disease was significantly lower compared with those with minimal oral disease throughout their hospitalization. Cats with severe oral disease take longer time to eat soft and dry food than those with minimal oral disease.

Behavioral changes provide useful information on dental pain assessment. Our study revealed that body position, position in the cage, attention to the surroundings and the tail position and movement are useful indicators to differentiate whether cats have oral pain. In addition to these general behaviors, behaviors during feeding and playing with the toy may also give an overall idea of comfort and pain status. Specific examples will be shown using practical videos.

References


Prosthodontics and Endodontics: A zirconia crown reconstruction for an upper canine with pulpitis aperta in a cat

Ralucia Ioana Nedela

A 4-year-old, neutered, female, domestic, short haired cat was presented to our department with a fractured upper right canine with exposed dental pulp. All specialists previously consulted recommended tooth extraction.

Our patient refused wet food, eating only solid food, as the solids had no significant temperature difference from the environment.

The cat did not allow any conscious oral examination showing signs of anxiety and aggression when approached. Oral examination under general anesthesia revealed a complicated crown fracture at 104, with pulpitis aperta. The fracture was localized in the cervical part of the crown, leaving the root undamaged. No signs of other root fractures were detected.

The differential diagnosis was made with the gingival polip, that usually accompanies pulpitis aperta. After removing the gingival polip, we have found an exuberant pulp tissue coming out of the root.
Pulpitis aperta is a chronic pulpitis with opened pulp chamber. It can be found in patients of a young age, when the healing power is strong. Our patient was adopted at the age of two, with the coronal fracture present. Pulpitis aperta occurs because of the conjunction of these 3 factors:

- Extensive loss of dental structures
- Ample vascularity of the young pulp, leading to tissue proliferation
- Adequate exposure for drainage.

The exposed pulp grows towards the occlusal surfaces resulting in a cauliflower-like outgrowth. With every meal, the patient experiences pain, when food touches the exuberant proliferation. Various temperatures may cause severe pain in the affected tooth. Hyperplastic pulpitis is a sign of good healing power, thus there is a limiting tendency towards the infection of the periapical region. Usually pulpitis aperta is associated with NO periapical lesions.

We performed a standard root canal therapy and a root canal filling was made with gutta-percha and MTA. After getting our X-ray confirmation for the endodontic treatment, we decided to reconstruct the coronal part with a Richmond type crown that is a post retained full crown. We had to choose between the two main dental materials: metal alloy or zirconia stabilized with yttrium. According to the material’s mechanical properties as stated by the producers, by far zirconia stabilized with yttrium was the most suited material, yielding mechanical and aesthetic properties for the reconstruction.

The patient started to eat wet food from the second day, after endodontic treatment. Her behavior changed from aggressive to a normal one.

Prognosis for this case is excellent. However, the cat will require professional follow up and dental care at home.

The 6 months checkup shows us an excellent marginal closure, no periapical reaction, no mobility, so well integrated that we have small amounts of dental deposits on our zirconia crown.

**Comments**

- Clinical signs of dental pain are hard to be noticed by the owners and even by specialists. As a human dentist I am used to ask different, alternative, helping questions to find out all the existing symptoms to find out the correct diagnosis.
- Proper treatment is impossible without the right diagnosis, so it is imperative not to rush into treatment before gathering all relevant data and establishing the right diagnosis.
- Choosing the right endodontic sealant is one of the keys to success. During these 15 years of dental practice, I have tried different sealants, each of them with their pros and cons. My best results were obtained with MTA and bioceramics based on MTA.
- Coronal restorations may vary from conservative ones, made with light curing filling materials, most of them to prosthodontical ones, like ours. Creativity, personal experience, the possibility of interdisciplinary teamwork can provide a better quality of life for the animal welfare.
A guide to brushing your dog’s teeth

Brushing your dog’s teeth regularly is a great way to keep his gums and teeth healthier and fight gum disease. Introducing tooth brushing gradually will mean he will learn to enjoy the experience.

What you will need:
- A tooth brush with medium bristles and the correct size
- Medium and large dogs – adult (people) size
- Small dogs – child’s size brush
- Toy or miniature dogs – small special pet tooth brush
- Pet Toothpaste (do not use human tooth paste)
- A quiet place without distractions
- A little time and patience

Some important tips before you get started:
- Keep each session short – from a few seconds to a maximum of a couple of minutes
- Pick a time which suits your daily routine and try to keep it as your usual time to brush. It doesn’t matter when in the day you do the brushing.
- Repeat each stage daily until your dog is comfortable with it and then for a few more days beyond. Then you can move on to the next stage. You may do the established stage first and then continue into the new stage when introducing a new stage.
- Every dog is different – so train at a pace which suits your dog. You can always go back a stage.
- Give lots of praise and a reward but only for good behaviour.

Take care when putting your fingers into your dog’s mouth. We don’t recommend doing so if your dog is likely to bite or become aggressive.
A step by step guide

STAGE 1
Introducing the pet toothpaste
- Smear a small amount of toothpaste on your finger tip.
- Allow your dog to lick the toothpaste. He should like the taste and be keen to eat it.

STAGE 2
Getting used to something in his mouth
- Place some toothpaste on your finger tip.
- With your other hand gently hold his muzzle to keep the mouth mostly closed.
- Insert your finger under the top lip on the side of the face.
- Rub your finger tip on the teeth.
- Don’t allow the mouth to open or you may get your finger chewed.
- Slide your finger further back inside the cheeks (Do not do this if there is any risk that you could be bitten). If your dog won’t sit still when you hold his muzzle, you should seek some behavioural advice.

STAGE 3
Introducing the toothbrush – canine teeth to begin with
- Wet the toothbrush with water and add some toothpaste then push it down into the bristles.
- Hold his muzzle to keep the mouth gently closed. This is to stop chewing when the brush is introduced.
- Lift the top lip on one side of the mouth (with a finger tip or thumb of the hand holding the muzzle).

STAGE 4
Brushing the teeth further back
- After brushing the canine teeth, continue on to brush the teeth further back in the mouth.
- To get to the molar teeth you will need to slip the brush past the corner of the lips inside the cheeks. Tip: Try a smaller brush if you struggle to get inside the cheek.
- Brush the upper teeth first and then allow the mouth to open slightly to be able to brush just along the gum line of the lower teeth.
- Remember; Increase the brushing gradually and stop if your dog is reacting more than a little bit.

STAGE 5
Brushing all the teeth
- Brush the canine and back teeth on both sides (as before).
- Now lift the top lip at the front of the mouth (still holding the mouth closed) and brush the incisors.
- You are now brushing the outside of all the teeth. You may want to brush for a little longer to do a more thorough cleaning.
- For the best results brushing should be at least once a day.
Quantitative epithelial cell Ki67-labelling index differentiates canine acanthomatous ameloblastoma from non-tonsillar oral squamous cell carcinoma

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Canine acanthomatous ameloblastoma (CAA) and non-tonsillar oral squamous cell carcinoma (OSCC) are the two most common oral neoplasms of epithelial origin in dogs. Although their biological behavior is clinically different, CAA and OSCC have overlapping histological features that can make differentiation on routinely stained H&E sections challenging. Moreover, previous studies have failed to identify immunohistological markers that can reliably distinguish CAA from OSCC. The epithelial cell proliferation activity of CAA and OSCC has not been investigated in dogs, and it is unknown whether this parameter varies according to patient signalment, anatomical location, degree of local invasion, and tumor type. The purpose of this study was to assess the epithelial cell proliferation index of CAA and OSCC by means of Ki67 immunolabeling and correlate with clinical findings at the time of diagnosis. Quantitative determination of Ki67 immunoreactivity as a marker of cellular proliferation of archived formalin-fixed paraffin-embedded tissue samples obtained from 29 dogs with CAA were compared with those from 13 dogs with OSCC. Preliminary data from this study revealed that patient signalment/anatomical location/degree of local invasion were not associated with epithelial cell proliferation activity of CAA and OSCC; however, the proliferative activity of CAA was significantly different compared to that of OSCC allowing greater diagnostic confidence.

Transcriptome sequencing of canine ameloblastoma confirms odontogenic origin and identifies potential pathways of gene dysregulation leading to oncogenesis

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Canine ameloblastoma (CA) is a benign, but locally invasive and destructive oral neoplasm traditionally assumed to originate from odontogenic epithelium. The histological and clinical features of CA are well characterized; however, the cellular origin and molecular mechanisms of this neoplasm have not been investigated. Treatment of CA usually involves wide surgical excision that frequently results in oral dysfunction. Understanding the cellular origin and molecular mechanisms involved in tumorigenesis are essential in order to develop less invasive chemotherapeutic approaches for CA. Moreover, if the molecular mechanisms of CA are comparable to those previously shown in human ameloblastoma, the dog could serve as an animal model for translational research including small molecule-based pre-clinical trials. The purpose of this study was to investigate the cellular origin of CA and identify dysregulated biologic pathways using transcriptome sequencing. Archived RNAlater-preserved CA samples obtained from 12 client-owned dogs were sequenced using a NextSeq Illumina platform. Control samples for assessment of differential gene expression and gene-set enrichment analyses consisted of healthy gingiva obtained from 4 dogs and non-tonsillar oral squamous cell carcinoma tumoral tissue taken from 9 client-owned dogs. Preliminary results confirm the odontogenic
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origin of CA, while overexpression of ODAM by CA further suggested junctional epithelium origin. Additionally, several biologic pathways were upregulated in CA including signatures of KRAS signaling. Further validation assays including gene-specific qRT-PCR and in-situ hybridization, antigen detection using immunohistochemical staining and Western blot are pending to confirm these preliminary findings.

Periodontal disease is one of the most commonly observed diseases in first opinion practice with prevalence estimates between 9% and 20% [1, 2]. However, more in-depth studies of the disease have reported higher prevalence levels between 44% and 100% [3-6]. This indicates that the disease is under-diagnosed in general veterinary practice where the majority of examinations are performed on conscious dogs. To fully determine the true extent of disease the level of clinical attachment loss and bone loss needs to be determined whilst the dog is under general anaesthesia. Clinically, periodontitis is associated with pain, abscesses, tooth loss and has been linked with systemic disease [7-10].

Periodontal disease is initiated by the build-up of bacterial biofilms on the tooth surface. A number of studies have therefore been undertaken to elucidate the bacterial species associated with periodontal health and disease in dogs [11-13]. Statistical modelling of next generation sequencing data, from a UK cross sectional study of over 200 dogs, identified bacterial species that are potentially diagnostic of health and disease. We have developed quantitative polymerase chain reaction (qPCR) assays for the detection and quantification of specific bacterial species. We have shown that data generated by qPCR and next generation sequencing are correlated, with 72% of the bacterial species having a Pearson’s correlation >80%.

In conclusion, qPCR offers a high throughput and relatively inexpensive method for profiling bacterial species of interest. Screening dental plaque for bacterial signatures of periodontal health and disease has the potential to improve disease detection in conscious dogs.

References

This case report describes the use of autologous clotted blood mixed with biphasic calcium phosphate microparticles to fill a defect non-union fracture and promote bone regeneration in a dog in a two-stage surgical approach.

This new method was designed and tried in a dog with a chronic, unstable mandibular fracture associated with a large sequestrum. Initial treatment involved debridement of the lesion, then the oral wound and oral vestibule were reconstructed in two layers. Four weeks later a second stage surgery allowed placement of a pre-contoured maxillofacial plate to bridge the defect, which was filled with a blood/ biphasic calcium phosphate compound implant.

Cone-beam computed tomography was used prior to the initial surgery for pre-operative planning and 3-D printing of a mandibular template for plate contouring. CBCT was subsequently used to document the healing process, using a bone-density measurement tool to assess bone regeneration.

Radiographic evidence suggestive of osteointegration was observed within 6 months with effective filling of the defect and restoration of alveolar ridge continuity. A return to normal and atraumatic occlusion was considered excellent. Cone beam Computed Tomography was found useful to document radiographic evidence of osteointegration, bone regrowth and remodeling.

The method presented here is, to the authors’ knowledge, the first report showing the successful use of combined autologous blood and BCP microparticles without the addition of exogenous growth factors to repair a large mandibular defect in a clinical case in a dog.

The objectives of bone substitute are to serve as a substrate for the migration, proliferation and differentiation of cells originating from surrounding tissues, followed by bone tissue ingrowth. Calcium phosphate is particularly attractive for use as a bone substitute. It can induce de novo bone formation without need of additional exogenous stem cells or growth factors.

Although macroscopic CaP granules are most commonly used, this method opted for microscopic sized BCP for this work. In recent years, several studies have evaluated the relationship between the sub-micrometric structure of the surface of these materials (HA, β-TCP, BCP) and their ability to induce new bone formation.

The physicochemical properties of CaP materials probably play a role in the stimulation of neo-osteogenesis through the formation of a crystalline carbonate apatite surface layer after implantation. Osteoclast differentiation and activity appears to be influenced by multiple substrate parameters, including surface nano-/microroughness, solubility, and the release of nano-/microparticulate crystals.

The small physical dimensions of surface microstructures (grains and ridges) on calcium phosphate crystals (submicron scale vs. micrometric scale) therefore appear to be essential for the osteoinductive properties of the material.

The biomaterial tested is part of the more recent published research on BCP. The micrometer size of the granules gives the biomaterial its osteoinductive properties. The combined use of autologous blood and
microparticles has only recently been suggested as a means to increase the osteo-inductive potential of the implant, but also to improve the handling characteristics of the composite, micronized BCP which is difficult to use in its basic, dry form. A strong ability of the composite material to induce de novo bone regrowth in bone defects has been showed in experimental models.\textsuperscript{11,12} This combination brings several handling and biological advantages.

Mechanically, the blood clot results in a natural protein hydrogel that helps to gather the particles together. Both the BCP particles and the autologous blood clot contribute to the biological regenerative properties of the biomaterial we used. The blood clot brings the regenerative potential of blood cells such as monocytes and platelets. And such a BCP microparticle size has been proven to induce monocyte proliferation and activation.\textsuperscript{12}

HU measurements derived from the CBCT gray-scale values at 0, 1 and 6 months illustrated the evolution of the implant in terms of restoration of normal bone density, as a radiographic evidence of osseointegration.

At six months, CBCT demonstrated effective bridging of the defect, with radiological evidence of good restoration of bone continuity, differentiation into a cortex-like denser periphery and a more trabecular pattern central part of the filled defect.

Higher HU values at 6 months were very similar to those measured in the immediate postoperative CBCT examination (2146 vs. 2140), and corresponded to the higher values of the contralateral cortical plate. Lower HU values at 6 months were slightly lower than in the immediate postoperative CBCT examination (1459 vs. 1850). However, they were close to those of the contralateral cortical bone plate and they were markedly increased compared to those of the one month examination (1459 vs. 488).

These CBCT derived density values were consistent with previously published results of micro CT analysis, which showed restoration of dense bone at the periphery and trabecular-like bone in the center of experimentally created bone defects.\textsuperscript{13}

Clinical and radiological results obtained in this case are very promising. This technique appeared to be simple to implement, the materials were readily available, simple to prepare and place in situ and they were well tolerated by the animal.

The hydrogel network provided by the blood clot may not be strong enough in the maxillofacial environment to avoid the need for a membrane, either a physiological (e.g. healed mucosa in the present case) or a synthetic one which explains our two-step procedure.

We present this technique as a starting point for a new series of tests (study currently being performed by the author).

References


**Case series of 140 prosthodontic crowns in dogs and cats (2014-2018)**

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**Objective:** To document the success and complications associated with a currently unpublished technique for tooth and crown preparation with follow up after the cementation of 140 metal crowns. The most recent reported failure rate for full veneer crowns in veterinary dentistry is nearly 20% for the canine teeth in dogs.¹

**Material and Methods:** 103 cats and dogs that presented with teeth affected by abrasion, complicated crown fracture, uncomplicated crown fracture, enamel hypoplasia that were treated with prosthodontic crowns. After minimal crown preparation a detailed crown impression of the treated tooth is performed. These detailed vinyl poly-siloxane impressions are sent to a dental laboratory for manufacture of a full metal jacket crown. These crowns utilize a Beryllium free, non-precious white metal alloy (62Ni, 25Cr, 9.5Mo, 3.3Si).

**Results:** Follow-up information was obtained by a combination of physical examination, and owner completed questionnaire sent by mail, by electronic mail and by telephone.

The mean follow-up day was 910 days. We evaluated the owner’s satisfaction and the success rate of the treatment. The treatment was considered unsuccessful in cases of cohesive adhesive failure between the cement, the tooth and the prosthodontic crown and in case of fracture of the prosthodontically treated tooth. The detailed results of the study will be reviewed in the presentation.

**Clinical Significance:** Acute trauma or continuous micro-trauma to a tooth can affect the integrity of the dentinal wall and the enamel. Coronal micro leakage is also considered to be a major cause of endodontic failure. Prosthodontic crowns can be a valuable option in strengthening an endodontically treated tooth and preventing bacterial contamination of a root filling.

**References**

Surgical solutions for acquired palate defects

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Abstract

Causes of palate defects acquired after birth include chronic infection/inflammation (e.g., severe periodontal disease, osteomyelitis/osteonecrosis, eosinophilic granuloma), trauma (e.g., high-rise syndrome, motor vehicle trauma, electric cord injury, gunshot trauma, animal bites, foreign body penetration, pressure wounds secondary to malocclusion), neoplasms, and surgical and radiation therapy. This presentation will discuss diagnosis and treatment of these conditions with cases shown in dogs and cats.

Oronasal fistula along the dental arch

An oronasal fistula is caused by loss of incisive or maxillary bone typically associated with severe periodontal disease or tooth extraction. An acute oronasal fistula after tooth extraction may be diagnosed by direct visualization of the nasal cavity and epistaxis at the ipsilateral nostril. Sneezing and ipsilateral nasal discharge are common clinical signs of a chronic oronasal fistula. A defect in the area of a missing tooth (often in the maxillary canine tooth region) that communicates with the nasal cavity may be noted on oral examination. A diagnosis of oronasal fistula may be made even in the presence of an affected maxillary tooth when the periodontal pocket measurements are so deep that communication with the nasal cavity is likely. An oronasal fistula in the canine tooth region is typically repaired by creation, apposition and suturing of a labial-based mucoperiosteal flap over the defect (or extraction site in the case of an acute oronasal fistula following tooth extraction). Granulation tissue and the epithelial lining at the oral side of the oronasal fistula are removed, and diverting releasing incisions are made rostral and caudal to the defect, extending from the gingiva into alveolar and labial mucosa. The flap is elevated using a periosteal elevator, and the periosteal attachment at its base is incised with a scalpel blade followed by blunt submucosal dissection with small Metzenbaum scissors. The mobilized flap should cover the defect without tension before suturing. The flap is sutured to hard palate mucosa and adjoining alveolar and labial mucosa in a simple interrupted pattern. A two-layer flap technique is rarely needed for repair, but it may be utilized when the vascular supply to the tissues is compromised from previous attempts at closing the oronasal fistula. The first flap originates from palatal mucoperiosteum and is overlapped to cover the defect, thus providing an epithelial surface for the nasal cavity. The second flap is created from labial mucoperiosteum and advanced or rotated to cover the connective tissue surface of the first flap.

Traumatic cleft palate in the midline

Fresh midline clefts of the hard palate are often seen in cats with a history of falling from a height (as part of high-rise syndrome) or motor vehicle trauma. They usually present with bilateral epistaxis or dried blood at the nostrils, a visible misalignment along the midline of the upper dental arch, and a midline hard palate cleft with torn palatal mucoperiosteum. Traumatic clefts of the hard palate can often be managed by use of the medially positioned flap technique. Although these clefts (when narrow) may sometimes heal spontaneously in 2 to 4 weeks with conservative management, the benefit of initial surgical management outweighs the risk of developing a persistent palate defect. The torn palatal tissues are debrided to provide fresh tissue edges. If the defect is older and the tissue edges have epithelialized, incisions are made at the medial aspects of the hard palate defect. Simple undermining the inelastic palatal mucoperiosteum with a periosteal elevator rarely results in enough tissue mobilization to provide tension-free closure. Therefore, relieving incisions about 1-2 mm away from the maxillary cheek teeth on one or both sides are often necessary so that the flaps can be moved medially into apposition with each other. The exposed bone next to the teeth is left to granu-
late and epithelialize. If the separation is extensive, proper occlusion can be accomplished by approximating the displaced bony structures with digital pressure and placing a twisted orthopedic wire between the two maxillary canines that is covered by self-curing composite. Then the torn palatal soft tissues are sutured in a simple interrupted or mattress pattern.

**Caudal hard palate defect**

The split palatal U-flap technique is useful for closure of large caudal hard palate defects. This technique was originally described as creation of a large U-shaped flap made of palatal mucoperiosteum rostral to the defect. An incision is then made along the midline of the flap to create two flaps of equal size. An alternative is, depending on the size dimensions of the head of the patient, to create one flap of slightly shorter (up to the maxillary first/second/third premolar) and another of slightly longer length (up to the maxillary canine/first/second premolar). The shorter flap is rotated and transposed to cover the defect whose epithelial margins were debrided. The medial aspect of this shorter flap is sutured to the caudal aspect of the palatal defect. The longer flap is rotated and transposed rostrally to the sutured shorter flap. The medial aspect of the longer flap is sutured to the rostral edge of the shorter flap. The denuded rostral aspect of the palate from which the flaps were harvested is left to heal by granulation and epithelialization. Leaving a narrow strip of connective tissue in the midline of the hard palate allows suturing of the connective tissue side of the longer flap to the underlying bone, which will help prevent excessive gaping of the flap.

**Other acquired palate defects**

Palatal defects from dog bites, foreign body penetration, and maloccluding teeth are carefully debrided prior to surgical repair. In all cases, the cause of the defect must be removed prior to repair. Rostral hard palate defects resulting from trauma, osteomyelitis/osteonecrosis or partial maxillectomy are successfully treated with transposition flaps that are harvested from labial and buccal mucoperiosteum and advanced and rotated rostrally. In the case of bilateral flaps, a T-shaped suture line should be accomplished to maintain an oral vestibule and avoid ventral pulling of the nose. Opposing teeth should be evaluated whether they cause trauma to the flaps; if they do, they can be extracted or their crowns reduced. Patients with severe trauma to the hard palate and extensive tissue damage (e.g., after electric cord and gunshot injuries) initially are managed conservatively, and the injured tissues are left to necrose so that the maximum amount of tissue is retained. Once the necrotic tissue is evident, surgical intervention may be initiated. For very large palate defects combinations of labial- or buccal-based overlapping, advancement, rotation or transposition (preferably axial pattern) flaps are utilized 6 to 8 weeks following extraction of teeth to facilitate flap management. Barrier materials (e.g., porcine serosa sheet, flexible bone membrane, auricular cartilage) may be utilized underneath flaps. Local axial pattern flaps may be based on the major palatine and infraorbital arteries. They can also be designed as island axial pattern flaps in which the pedicle consists solely of the supplying blood vessels, thus achieving significant rotation of the flap without excessive tension or risk to vascular supply. Distant axial pattern flaps may be based on the angularis oris, caudal auricular or superficial cervical arteries. An alternative for repair of defects in the rostral to mid-portion of the hard palate is the use of a tongue flap that is later amputated and left attached to the palate. Free tissue transfer (grafting) of auricular cartilage for small round hard palate defects, and myoperitoneal microvascular flaps (utilizing transversus abdominis and rectus abdominis muscles based on the cranial abdominal artery) for very large hard palate defects were also described.

**Bibliography**

Non-surgical solutions for acquired palate defects

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Abstract

Palate surgery is generally performed to repair acquired palate defects and re-establish the normal partition between the nasal and oral cavities. The tissues surrounding a palate defect may sometimes not be healthy enough to allow for surgical repair. A prosthetic device (palatal obturator) could then be considered as a non-surgical solution for the management of an acquired palate defect.

Palatal obturator

An alternative method for management of large round or rectangular hard palate defects or when local tissues are compromised from trauma, radiation and previous attempts at closure is to create a temporary or permanent obturator made of a metal alloy, acrylic, composite or other material such as silicone. Fabrication and placement of a palatal obturator usually requires two anesthetic episodes. First an impression will be obtained from which a cast is made. From this cast the veterinary dentist or a dental laboratory technician will create the prosthesis, which is then trial-fitted, adjusted and secured in place at the second anesthesia episode. Initially, the nose is flushed and the edges of the palatal defect are cleaned and air-dried. Polyvinylsiloxane putty is mixed to become a uniform, malleable mass that is carefully placed into the palatal defect. The impression that should have slight nasal overhangs is removed once the material has set. The patient is recovered from anesthesia. A thin layer of vaseline is applied onto the impression. A suitably-sized tray is created with polyvinylsiloxane putty. Then the overhangs of the impression are covered and the tray is filled with polyvinylsiloxane wash. The impression is gently seated into the tray filled with the polyvinylsiloxane wash and removed once the wash has set. The resulting polyvinylsiloxane cast (an exact replicate of the palatal defect) can for example be filled with methyl methacrylate (by means of the mix-and-pour or salt-and-pepper application methods). The raw obturator is removed once the methyl methacrylate has set. It is trimmed and shaped with acrylic burs on a low-speed handpiece. The patient is re-anesthetized, and its nose is flushed and the edges of the palatal defect are cleaned. The obturator is trial-fitted, and final adjustments are made as necessary. The polished obturator is then placed into the palatal defect, and the patient recovered from anesthesia. Halitosis is a common complication with palatal obturators. Dogs and cats with palatal obturators should be re-examined under general anesthesia every 6 to 12 months in order to remove the obturator, flush the nose, clean the edges of the palatal defect, and scale and polish the obturator before it is placed back into position. If the obturator is loose, a new impression will be obtained from which a better-fitting obturator is fabricated. If nasal overhangs cannot be obtained or are insufficiently large, the obturator may be sutured to surrounding soft tissues or attached to teeth with wire and other devices. Obturators may also be equipped with metal extensions that allow snapping the device onto teeth in case there is insufficient anchorage possible within the defect.

Bibliography

**Summary**

The principles of surgical oncology that are pertinent to oral tumors will be discussed. These include the diagnostic approach, based upon clinical staging and obtaining a biopsy. Advanced diagnostic imaging is essential for clinical staging. Several principles are applicable when obtaining a biopsy. The clinical stage and biopsy result combined knowledge of the biological behavior of the tumor type in turn provide the basis for therapeutic decision-making. If surgery is elected, the objective can be (1) surgery for cure; (2) surgery for debulking (cytoreduction); (3) surgery for palliation; or (4) surgery for local cure. Based upon the surgical objective and the tumor type, the appropriate surgical margin is decided upon, which could be (1) an intra-capular excision; (2) a marginal excision, or most commonly (3) a wide excision. In determining the surgical margin, anatomic features are also taken into account, such as the removal of intact alveoli.

**Clinical staging**

An accurate assessment requires a systematic approach and is achieved by using the Tumor Node Metastasis-system (TNM), which requires that the clinician sequentially evaluates the tumor, the regional lymph node and any possible distant metastases; the patient is then classified into one of four clinical stages. Although the system was primarily designed to standardize tumor documentation, it forces the clinician to evaluate the patient in a methodical and comprehensive fashion. Clinical staging enables the clinician to intelligently estimate the extent of the disease. The assessment should be complemented by obtaining biopsies to determine the histopathological nature of the lesions.

**Diagnostic imaging of oral tumors**

With the patient under general anesthesia, radiographs should be obtained of the affected jaw. Intraoral radiographs are particularly useful in cases of suspected oral neoplasia. Skull computed tomography (CT) with contrast, thoracic CT or radiographs, and abdominal ultrasound examination are routinely indicated.

With few exceptions, the diagnostic imaging findings associated with oral tumors are generally not specific, but it may be possible to associate certain patterns with different tumor types. Bone lysis becomes radiographically evident when more than 40% of the compact bone has been already demineralized; radiographs therefore usually underestimate the tumor extension and do not give an accurate idea of the tumor margins. However, the presence of bone lysis is an indication of advanced bone infiltration, which is an important prognostic factor. The presence and pattern of osteolysis, mineralization and/or new bone formation, adjacent cortical bone reaction, and dental involvement may be suggestive of either a benign or malignant (aggressive) lesion.

**Biopsy**

The precise nature of an oral tumor is determined by the histopathological examination of a biopsy specimen; this is the mainstay of oncological decision-making. Obtaining a biopsy is indicated for all oral masses and for any suspicious lesion. Various techniques are available. A fine-needle aspirate is usually of limited value for oral tumors. An incisional biopsy using a disposable biopsy punch is recommended. For any particularly hard or bony tumor, a Michele trephine or osteotome is indicated. It is important to ensure that a representative specimen is obtained. Macroscopically normal tissue on the margin of the tumor should not be included in the biopsy, as this violates previously unopened tissue planes. The site of the biopsy should
be chosen such that it falls within the boundaries of the tissue to be excised, once the diagnosis is made. In selected cases of very small tumors on the gingival margin, an excisional biopsy by means of gingivectomy may be indicated where the tumor can easily be excised in toto. A fine-needle aspirate or an excisional biopsy should be obtained of any enlarged lymph node.

The biopsy must be obtained as atraumatically as possible to restrict the exfoliation of neoplastic cells. A properly obtained biopsy has not been found to enhance the occurrence of metastasis. The biopsy should be adequately fixed and submitted to a pathologist with experience in oral pathology. The result of the histopathological examination should be compatible with the clinical findings; if not, the matter should be discussed with the pathologist. If any doubt remains, an additional biopsy may be indicated. The biopsy result allows the clinician to scientifically select the most appropriate method of treatment. A biopsy result also advances prognostication beyond the realm of intelligent guessing and the client can be more correctly informed.

Decision-making

The correct patient selection for a particular method of treatment depends on an accurate assessment of the nature and extent of the condition. The expected biologic behavior of an oral tumor depends on the species in which it occurs, the location in the oral cavity, the clinical stage, and the histopathologic nature. Understanding the biologic behavior enables the clinician to inform the client accurately.

The success rate and prognosis depend on the tumor type: as a general rule, the results obtained for squamous cell carcinoma are good, fair for fibrosarcoma and osteosarcoma, and poor for malignant melanoma. Failure occurs either as local recurrence (e.g., fibrosarcoma) or distant metastasis (e.g., malignant melanoma).

The choice of treatment is determined by the stage and histopathological nature of the tumor. Once the type and stage of the oral malignancy have been assessed, the clinician should select the modality that has the most proven clinical success, and which is applicable. Conservative surgical excision invariably results in recurrence of the tumor.

Surgical excision remains the most frequently indicated and most practical method of treatment. If surgical excision is impossible or not elected by the client, there remains the option of radiotherapy for radiosensitive and radiocurative tumors like squamous cell carcinoma. However, the necessary equipment is not readily available to most practitioners. Complications can be expected when major bony involvement is already present.

Surgical principles

When contemplating surgical treatment, it is important to have a clear understanding of the procedure’s objective. In most cases, the ultimate surgical goal is to cure the patient; this is achieved by adequate excision, tumor-free margins and the absence of metastatic disease. If the extent of the disease makes this impossible, palliative surgery can be performed. The objective of palliative surgery is not to cure the patient, but to improve the quality of life and, if fortunate, achieve local control. A good example of this approach is the treatment of malignant melanoma: this tumor is known to spread at an early stage, but good local control can be achieved by radical resection of the primary tumor. Debulking is a third surgical objective: this entails removing most of the tumor prior to the application of other therapeutic modalities such as radiotherapy.

Surgical excisions can be classified according to the width of the surgical margins. It is important for the clinician confronted with an oral tumor to choose the appropriate type of excision. Surrounding the tumor are a pseudocapsule and a reactive zone; the former is a macroscopically visible membrane consisting of normal and neoplastic cells, while the latter consists mainly of inflammatory cells. An intracapsular excision involves removing the tumor from within its pseudocapsule or the piecemeal removal of neoplastic tissue. This is rarely indicated but may be acceptable for a very well differentiated odontoma which can be curetted out of the jaw bone. A marginal excision involves a dissection plane located in the reactive zone around the tumor and its pseudocapsule. This type of excision is indicated for well-differentiated, benign tumor types. However, marginal excision is not indicated for malignant tumor types which are known to be infiltrative: not all the neoplastic tissue can be removed and almost invariably results in local tumor regrowth. These tumor types, require wide excision. This involves the en bloc removal of the tumor, pseudocapsule, reactive zone and a wide margin of normal tissue. This is achieved by performing a partial maxillectomy or mandibulectomy; these procedures are indicated for small malignant tumors without bone infiltration, and with bone
infiltration. The canine acanthomatous ameloblastoma can also be successfully managed using wide excision.

References


Local anesthesia in rabbit dentistry: An important component of perioperative (multimodal) pain management

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Using regional nerve blocks (RNB) in conjunction with other analgesic drugs that act in different ways on the nociceptive fibers (e.g. with opioids, α – 2 agonists and ketamine) results in multimodal analgesia, contributing to an overall decrease in excitatory neurotransmission within the pain pathway both during and after dental surgery. Many of the regional nerve blocks in rabbits are technically relatively simple to master, quick and easy to administer, and have a low incidence of complications. Few materials are needed to perform regional nerve blocks and many practices may already have the necessary supplies. The mental, inferior alveolar, infraorbital, and maxillary nerves can be blocked alone or in combination to provide the desired analgesia to any location in the oral cavity. This approach allows for the lowest effective dose of each drug to be used, which decreases side effects and enhances patient safety. This lecture will present the practical approach of three commonly used local nerve blocks in rabbits for dental surgery (e.g. incisor extraction).

Fig.1 Nociception of painful stimuli in rabbits.

Fig.2 Local Anesthesia of the mandibular nerve.
African hedgehogs are becoming very popular as pet animals in the Czech Republic. In contrast, the European hedgehogs can not be kept as pets due to European and Czech jurisdiction as these species are native to European wildlife. European hedgehogs can be kept only in rescue stations. The lecture will cover comparison of dental disease in the African and European Hedgehogs which were treated at the authors (VJ and KH) clinic (60 animal in total, 30 individuals from each group). In both species, the periodontal disease (PD) was the most commonly encountered oral disorder. However, in European hedgehogs, the clinical signs of PD are similar to those found in dogs, cats and dogs. In African hedgehogs, PD was associated with oedematous gingiva, gingival hyperplasia (based on histopathology) with forming of pseudo-pockets and with severe tooth mobility; no hyperaemia was seen. In European hedgehogs, tumours were present very rarely. In contrast, African hedgehog many tumours were diagnosed (21 %), especially in hedgehogs older 3 years (fibrosarcoma, squamous cell carcinoma, osteosarcoma). In both hedgehog groups, it seems that the aetiology of dental problems is associated with improper diet, so optimal diet should be offered to the particular hed-
gehog. Also, the disease severity was associated with long-term subclinical signs which were not discovered by referring practitioners. For proper oral cavity examination, every hedgehog needs to be anaesthetized.

### Macrodontia in pet guinea pigs

#### Vladimir Jekl, Karel Hauptman, and Václav Trojan

Macrodontia is a type of localized gigantism in which tooth (or teeth) are larger than normal for the particular type(s) of teeth involved. Macrodontia in guinea pigs is, in comparison with other pet herbivorous rodents and with rabbits, relatively common disorder. In guinea pigs, teeth in mandibular arcade are, based on authors experience, the most commonly affected teeth. Diagnostics is based on thorough oral cavity examination, radiography and/or computed tomography. Therapy include treatment of the primary disorder and affected tooth extraction, which can be done intraorally, extraorally or by their combination. Other possible method preferred by the authors is apicoectomy of at least of 70% of the tooth substance using extraoral approach.

### Definition and aetiology

Macrodontia is a type of localized gigantism in which tooth (or teeth) are larger than normal for the particular type(s) of teeth involved. In human medicine, it can be associated with numerous systemic conditions and syndromes, hereditary disorders included (Adamiji et al. 2016, Morel Swols 2017) and can be present in both deciduous and permanent dentition (Pace et al. 2013). It can be generalized of only isolated tooth/teeth is affected. Macrodontia was also describe in dogs, in harbour seals and in guinea pigs and other species as well (Pavlica et al. 2001, Schweda et al. 2014, Aalderink et al. 2015).

### Macrodontia in guinea pigs

Macrodontia in guinea pigs is, in comparison with other pet herbivorous rodents and with rabbits, relatively common disorder (Schweda 2014, Bohmer 2015).

The aetiology is not yet scientifically described but for structural changes of the continuously growing tooth seems to be responsible chronic infection/irritation of the germinative tissue of the affected tooth. The macrodontia is commonly present with other disorders associated with dental disease syndrome such is apical and coronal elongation of the incisors and/or premolars, and or molars; changes in tooth curvature; occlusal surface changes; parodontitis; dental caries and other dental and soft tissue pathologies (Minarikova et al. 2015).

In guinea pigs, teeth in mandibular arcade are, based on authors experience, the most commonly affected teeth.

Diagnostics is based on thorough oral cavity examination, radiography and/or computed tomography. Schweda et al. (2014) stated that macroodont premolars and molars can be identified only by computed tomography. In contrast, based on authors experience, with the use of the radiographic technique described by Minarikova et al. (2015) or by technique described by Bohmer and Crossley (2009), this pathology can be easily recognized also on radiographs.

Therapy include treatment of the primary disorder and affected tooth extraction, which can be done intraorally, extraorally or by their combination. Author preferred method is apicoectomy, where the apical part (at least 70%) is removed using extraoral approach using dental burr. After the tooth substance removal use of antibiotic impregnated beds (Boehmer 2015) or marsupialization (use by the authors) - in case of bacterial infection - or simple skin closure is recommended. The coronal part (the tooth remnant) act as a natural plug and prevent feed impaction into the wound after the extraction. This remnant is then wearing down by
natural chewing and then released into the mouth cavity. In a meanwhile, the wound is healing and prevent further complications.

As the adjunct therapy, analgesia is provided using meloxicam (0.3-0.5 mg/kg q12h subcutaneously or orally), gabapentine (10-100 mg/kg q12h orally) and/or buprenorphine (0.03-0.05 mg/kg subcutaneously or in a form of long acting buprenorphine). In case of infection doxycycline and/or metronidazole is recommended.

References


Presentations at a marine mammals rescue center

Lois Legendre

Abstract not provided
Periodontal disease is the most common disease in dogs, but are the signs recognized by the owners? There is a paucity of studies on dog owners’ opinions about their dog’s dental health. The aim of this study was to investigate dog owners’ perception of their dog’s dental health. A target-group specific questionnaire was developed and validated according to general survey methodology guidelines (EVDF-17). During April 2017, the questionnaire survey was distributed nationwide among Swedish dog owners, with questions about the dog’s general dental health, halitosis, amount of dental calculus and the owners’ ability to inspect their dog’s teeth etc. In total, 66,434 dog owners responded (response rate 32%). An exploratory factor analysis identified the construct “Dog owners’ assessed signs of their dogs’ dental health” (5 factors, $\alpha = 0.78$), which was used for investigating associations with background factors of the dog and its owner (e.g. dog breed and age). Interestingly, owners of larger dogs (body weight $\geq 10$ kg) perceived the dental health of their dog as being better compared to owners of smaller dogs (body weight $< 10$ kg; t-test, $p < 0.0001$), in agreement with the higher occurrence of periodontal disease in small dogs. However, a majority of dog owners, 83%, stated that their dog’s dental health was fairly or very good. This study contributes to important basic knowledge on dog owners’ perception of their dog’s dental health.
Effects of edible treats containing *Ascophyllum nodosum* on the oral health of dogs: a double-blind, randomized, placebo-controlled single-center study

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The objective of this placebo-controlled, double-blind, randomized study (designed according to evidence based medicine standards) was to determine the effect of 90-day administration of edible treats containing the brown algae, *Ascophyllum nodosum*, on plaque and dental calculus accumulation on the teeth of dogs, as well as on other parameters characterizing canine oral health status, including: plaque index (PI), calculus index (CI), oral health index (OHI), gingival bleeding index (GBI), and volatile sulfur compound (VSC) concentration. Sixty client-owned dogs, including Japanese chín, miniature Schnauzer, Chihuahua, Pomeranian, and West Highland White Terrier (WHWT) breeds, underwent professional dental cleaning and were randomly subdivided into two groups receiving daily edible treats containing the brown algae *A. nodosum*, or placebo, adjusted to their bodyweight. After a comprehensive oral health assessment, including a professional dental cleaning, which were both performed under general anesthesia, clinical assessments of PI, CI, OHI, GBI, and VSC concentration were performed under sedation after 30, 60, and 90 days of treatment. Oral administration of edible treats containing *A. nodosum* significantly improved PI, CI, and VSC concentration, compared with the placebo-treated group. The consumption of edible treats containing *A. nodosum* efficiently decreased plaque and calculus accumulation in the investigated dogs. Dogs treated with *A. nodosum* also exhibited significantly lower concentrations of VSC and better oral health status (e.g., OHI and GBI) than those in the placebo-control group. The presentation will also include results of saliva tests of the tested dogs.

Comparison of dog owners compliance to perform dental home care using two different protocols

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Tooth brushing is the gold standard for prevention of periodontal disease. Even though Swedish dog owners consider dental health in their pets to be important, few perform daily tooth brushing today. As a part of a larger study on systemic effects of periodontitis, two different protocols for information concerning dental home care were compared. The aim of the study was to see if a more personalized protocol, including practical demonstrations of tooth brushing technique, could result in better dog owner compliance. Owners to dogs with periodontal disease requiring dental extractions were randomly divided into 2 groups. One group received standardized written information concerning their dog’s required dental home care. Dog owners in the other group received more personalized information including a practical demonstration according to a standardized protocol. All dog owners answered a protocol concerning tooth brushing prior to the dental treatment, 2 and 4 weeks after treatment. Dog owners were interview concerning dental home care of their dog 1 year after treatment. The results will be presented.
Update on activities of the Veterinary Oral Health Council

Colin Harvey, BVSc, FRCVS, DACVS, DEVDC, DA VDC,
Director, Veterinary Oral Health Council

The Veterinary Oral Health Council exists to provide independent objective assessment of the effectiveness of oral hygiene products for dogs and cats.

Data from trials conducted under VOHC Trial Protocol requirements are reviewed to determine whether the VOHC pre-set standard for effectiveness in retarding accumulation of dental plaque and calculus (tartar) have been met.

Products that meet or exceed the VOHC standard are awarded the VOHC Accepted Seal.

Efforts to develop an objective digital image scoring system for plaque and calculus in dogs and cats that can be recommended for use in trials intended for consideration by VOHC will be described.

Although not a regulatory agency, VOHC pays attention to safety issues, and is currently considering whether to add a requirement for digestibility testing or mechanical testing of chewed products.

Other VOHC activities, including announcement of new additions to the VOHC Accepted Product list, will be described.

This presentation will encourage audience discussion, either during the presentation, or at a follow-up informal meeting.
Clinical application of cone beam CT in evaluation of dental rabbit abscess

S. Gault, L. Gatel, and N. Girard

Objective: This study aims to demonstrate the benefit of Cone Beam CT (CBCT) to precisely target the localization of rabbit facial abscesses and their periodontal link with the teeth, thus favoring the establishment of an appropriate surgical treatment plan.

Materials and Methods: This study used client-owned rabbits evaluated by the dentistry and oral surgery service of Azurvet referral center. All rabbits underwent general anesthesia and were scanned in a CBCT (NewTom 5G). All CBCT scans were evaluated (cross reading by a specialist and a resident in veterinary dentistry) twice: one evaluation with a left or right panoramic view, half skull concern and zygomatic arch cropped an equivalent of enhance X-ray, one evaluation with standard multiplanar reconstruction (MPR) mode.

Many radiological criteria were evaluated as supernumerary or tooth abnormality, missing teeth, dental bud, apical elongation, periapical lucency, moth-eaten pattern of apical osteolysis, sclerosis of the alveolar bone, tooth resorption and teeth extrusion.

The statistical analysis was performed with R software*. The comparison between different parameters in Panoramic or MPR view was assessed using a paired test. The correlations between the detection of an abscess and the total dental scoring or the different factors evaluated separately were done calculating a Pearson correlation coefficient (r). A test with a p<0.05 was considered significant.

Results: 226 teeth were evaluated. In the MPR mode, 88 teeth fulfilled the criterion of periodontal abscess pathology against 50 in panoramic reading. This represents a significant statistical difference (P <0.01).

There is a significant difference between results of a panoramic view or a MPR reconstruction for the following parameters: missing teeth, dental resorption, apical elongation, osteosclerosis and apical osteolysis (P<0.05). The scoring system was lower in panoramic view in comparison to the MPR for dental abscess, apical elongation, and apical osteolysis. The scoring system was higher in panoramic view for the missing tooth, dental resorption and osteosclerosis. The suspicion of imaging dental abscess using a panoramic view is significantly positively correlated to the super numerary tooth/anomaly, the dental bud, dental resorption, apical elongation, lucency and apical osteolysis. The suspicion of imaging dental abscess using a MPR reconstruction is significant.

Fig.1 MultiPlanar Reconstruction, left to right: Sagital Plan, Frontal Plan, Transversal Plan.
significantly positively correlated to the super numerary tooth/anomaly, dental resorption, apical elongation, lucency, apical osteolysis, osteosclerosis and fractured tooth.

We obtain a very important correlation with these radiologic factors and the presence of abscess for the panoramic (R=0.53) and for MPR (R=0.58).

Conclusions and Clinical Relevance: The panoramic reconstruction is a useful method to target the abceded area; The MPR method is needed to evaluate each tooth individually and determine the exact origin of the abscess.

Fig.2 Right and left panoramic view, half skull concern with zygomatic arch crop.
Diagnostic yield of dental radiography and cone-beam computed tomography for the identification of anatomic structures in cats

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The objective of this study was to evaluate the diagnostic yield of dental radiography (DR) and 3 cone-beam computed tomography (CBCT) methods for the identification of predefined anatomic structures in cats. For 5 feline cadaver heads and 22 client-owned cats admitted for evaluation and treatment of dental disease, a total of 22 predefined anatomic structures were evaluated separately by use of the DR method and 3 CBCT software modules [multiplanar reconstructions (MPR), tridimensional (3-D) rendering, and reconstructed panoramic views (Pano)]. A semiquantitative scoring system was used, and mean scores were calculated for each anatomic structure and imaging method. The Friedman test was used to evaluate values for significant differences in diagnostic yield. For values that were significant the Wilcoxon signed rank test was used with the Bonferroni-Holm multiple comparison adjustment to determine significant differences among each of the possible pairs of diagnostic methods. Differences of diagnostic yield among the DR and 3 CBCT methods were significant for 17 of 22 anatomic structures. For these structures, DR scores were significantly higher than scores for Pano views for 2 of 17 structures, but DR scores were significantly lower than scores for Pano views for 6 anatomic structures, tridimensional rendering for 10 anatomic structures, and MPR for 17 anatomic structures. In conclusion, it was found that CBCT methods were better suited than DR for the identification of anatomic structures in cats. Results of this study can serve as a basis for CBCT evaluation of dentoalveolar and other maxillofacial bony lesions in cats.

The diagnostic yield of dental radiography and cone-beam computed tomography for the identification of dentoalveolar lesions in cats

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The objective of this study was to evaluate the diagnostic yield of dental radiography (DR) and 3 cone-beam computed tomography (CBCT) software modules for the identification of 32 pre-defined dentoalveolar lesions in cats. For 5 feline cadaver heads and 22 client-owned cats admitted for evaluation and treatment of dental disease, 32 predefined dentoalveolar lesions were evaluated separately by use of dental radiography and 3 CBCT software modules [multiplanar reconstructions (MPR), tridimensional (3-D) rendering, and reconstructed panoramic views]. A qualitative scoring system was used. Dentoalveolar lesions were grouped into 14 categories for statistical analysis. Point of reference for presence or absence of a dentoalveolar lesion was determined as the method that could be used to clearly identify the disorder as being present. Accuracy, sensitivity, specificity, and positive and negative predictive values were calculated with the McNemar χ² test of marginal homogeneity of paired data. When all 3 CBCT software modules were used in combination, the diagnostic yield of CBCT was significantly higher than that of dental radiography for 4
of 14 categories (missing teeth, horizontal bone loss, loss of tooth integrity, feline resorptive lesions), and higher, although not significantly so, for 9 categories (supernumerary teeth, supernumerary roots, abnormally shaped roots, vertical bone loss, buccal bone expansion, periapical disease, inflammatory root resorption, and external replacement root resorption). In conclusion, we found that CBCT provided more clinically relevant detailed information as compared to dental radiography. Therefore, CBCT should be considered better suited for use in diagnosing dentoalveolar lesions in cats.

**Our approach to abnormal relations in the triad class II malocclusion treatment using Heyrex screw**

Ivan N. Makarov

**Introduction**

Orthodontics in veterinary medicine is developing rapidly; veterinary stomatology doctors are gradually mastering the new and more sophisticated and efficient techniques of treatment, which significantly improves the quality of orthodontic treatment. At the present moment, it was determined that in the case of orthodontic pathologies presence that cause traumas to an animal or contribute to the development of other more serious pathologies, such pathologies could be subjected to orthodontic treatment. Abnormal relations in the triad class II malocclusion in our practice are not commonly registered; but this pathology could lead to serious deformations of jaws and especially of the mandible.

**Etiology**

We are going to consider the orthodontic treatment of abnormal relations in the triad class II malocclusion in regard two clinical cases. There are two dogs, the first is male, mini bull terrier breed, 8 months old, the other is also a dog, male, entlebucher sennenhund breed, 12 months old. During our examination, abnormal relations in the triad class II malocclusion were diagnosed with the mini bull terrier on the left and on the right, and on the left with the entlebucher sennenhund. The treatment was conducted in 2015; and it took two months’ time to eliminate the orthodontic pathology with the mini bull terrier and one month with the entlebucher sennenhund. Presumably, the animals did not experience the change from the deciduous mandible canine teeth to the permanent ones. There appeared a high probability that this could lead to the development of a serious pathology. Presumably, the pathology was developing according to the following scenario: late change of deciduous teeth (canine teeth) to permanent teeth violated the occlusion and the jaw formation process, and the mandible canine teeth started to injure the maxilla. Besides, the mandible appeared to be in a block. Accordingly, the mandible started to develop atypically; and, namely, the mandible growth slowed down, which was more noticeable with Patient No. 1. The maxilla being traumatized by teeth 304 and 404 was also deformed; the Patient No. 2 maxilla was traumatized by tooth 304. In these cases, a genetic cause could certainly not be excluded.

Dog owners were proposed with two techniques of treating the said pathology, i.e. amputation of the mandible canine teeth crown part (teeth 304 and 404) or orthodontic treatment.

Difficulties in the orthodontic treatment lie in the fact that in such cases as a rule it could last from two months, the animal should be limited in taking solid feed and large pieces of feed, as well as in receiving treats (bones or small sticks). There were no restrictions in taking dry feed. It was also recommended to exclude games with sticks, toys and congeners. Frequent prolonged walks and races in a muzzle were recommended. Daily thorough oral care had to be ensured. We were obliged to inform a customer about all these peculiarities.

The customers refused to amputate the crowns of teeth 304 and 404. They preferred orthodontic treatment.
Advantages of orthodontic treatment were that when the teeth 304 and 404 were displaced to an anatomically correct position, the growth of the mandible was activated. When the given teeth were moved to their normal position, each time the jaws occlude the mandible canine teeth would slip along the surface of the maxilla canine teeth like along a special plate and would move to a more anatomically correct position, which promoted activation of the mandible growth, as well as lowering the tonus of the masticatory muscles group and exclusion of the temporomandibular joint deformation.

**Biological foundations for the teeth orthodontic displacement**

Teeth displacement is actually based upon the process of bone remodeling, which leads to changing both the solid and the soft tissues of the maxillofacial area. Under exposure of a tooth to external forces, zones of pressure and tension are created in the periodontium tissues, where biological reactions are taking place, which leads to restructures in the bone tissue. That could be clinically detected in the form of a temporary increase in the tooth (teeth) mobility.

Orthodontic displacement is characterized by three phases: 1) initial displacement phase; 2) delay phase; and 3) active displacement phase.

Initial displacement phase. Primordially, tooth displacement occurs due to the elastic properties of the periodontal ligament fibers, and this happens very rapidly. But, there is no restructuring of a bone; displacement is observed within the alveoli boundaries. Besides, redistribution of fluid in the periodontal ligament depth is taking place.

Delay phase. During this phase we observe the absence of a clinically evident displacement. Within this period, active remodeling of the tooth surrounding tissues is taking place.

Active displacement phase. It is manifested by active displacement of a tooth (teeth), which was made possible as a result of the periodontal ligament adaptation and alteration in the alveolar bone during the delay phase. Results of studies conducted on the osteoclasts bone resorptive reaction after activation of the orthodontic apparatus demonstrated that immediately after repeated activation of the apparatus a new group of osteoclasts appears, which causes a significant tooth displacement without increasing the risk of tooth root resorption development.

**Individual diagnostics in orthodontics**

Before identifying pathology, we should understand what the normal conditions are. Besides, it should also be understood that the normal parameters could vary significantly both within a breed, and especially among the multiplicity of breeds.

As a mandatory requirement, we are obtaining the anamnesis and trying to identify causes of the pathology formation, as well as bad habits (exaggerated rope pulling, gnawing hard objects, etc.). On the basis of clinical examination, examination of the oral cavity, analysis of photographs and plaster models of the animal’s jaws, a decision is made on the treatment options. It is recommended to compile a problem sheet, where specific treatment objectives and the order of priority are indicated. All information should be presented to the owner of the animal, detailed information should be provided on the treatment options, pros and cons of each of them, advantages of any option over the others. Besides, information about the duration and cost of treatment should be submitted to the customer. Further, based on the accepted treatment option, a model of the orthodontic device structure is determined.

**Impressions**

At a first glance, making impression is an easy process, but its importance lies in the details, such as the choice of impression material, selection of the impression spoon desired size, determination of the interest area and making the impression of the given area.

**Dental laboratory**

After impressions are taken, they are presented to a dental laboratory, where plaster models are prepared, if the impressions were not manufactured previously. Then, an orthodontic device is manufactured according
Orthodontic device structure fixing

After we receive the orthodontic device structure from the dental laboratory, we are striving to try it on the patient beforehand. It is done in order to determine how perfectly the device structure is fixed and how well it fits. The orthodontic device structure should not interfere with the jaws occlusion; in extreme cases, acrylic excess should be removed by a borer.

Orthodontic device structure activation, activation mode selection, maxilla jaw treatment

Orthodontic device structure activation was carried out in the following mode: the device structure was immediately activated with one complete revolution, which was equal to 0.9 mm (initial displacement phase); then 1/2 revolution was made every day, which was equal to the displacement of acrylic base by 0.45 mm. For 7 days we worked in this mode (delay phase). Then the activation schedule was changed, activation was performed by 1/2 revolution two times a day, which was equal to 0.9 mm per day. We worked in this mode for 2 days with Patient No. 1 and for 4 days with Patient No. 2 (active displacement phase). Upon reaching the full opening of the Heyrex screw for 6 mm and for 8 mm, the activation was stopped; as the canine teeth of the mandibula were displaced into a more correct anatomical position.

Conclusion

Orthodontic treatment of the abnormal relations in the triad class II malocclusion pathology using the braces system, orthodontic chain and Heyrex screw with the acrylic base appears to be an effective technique in eliminating such given pathology. Heyrex screw when activated could ensure efficient displacement of tooth/teeth, where the given force is applied; and that significantly reduces the treatment period.

Mandibulectomy in 8 cats

Lucinda van Stee

Oral squamous cell carcinoma in cats is often deemed an inoperable neoplasia. Its locally invasive nature, combined with the often late presentation and the relative small size of the feline oral cavity, create a challenge into achieving local disease control while maintaining function. Extensive surgical resection of the mandible, according to current literature, is thought to be poorly tolerated in cats. However, the clinical experience of the authors, has been different.

We hypothesize that the majority of cats will have sufficient oral food uptake to maintain their body condition score long-term and that long-term survival is possible. In this multi-institutional retrospective study, we report on the outcome on eight cats, in which an extensive mandibulectomy is performed as treatment for aggressive mandibular neoplasia. Cases were included if surgery involved the removal of the entire anatomic compartment of the mandible and > 50% of the both mandibles.

Eight cats were included in this study, age 8-17 years. All cats had aggressive, malignant neoplasia of the mandible and were treated with a radical mandibulectomy, removing 75-90% of the combined mandibles. All cats had a feeding tube placed at the time of surgery. Seven cats had an oral squamous cell carcinoma, one cat was diagnosed with a giant cell tumor. Margins were infiltrated in the two cases that developed local recurrence, and one case had clean but close margins, without ever developing recurrence. Lymph node biopsies were positive in 1/6 cases.

Six out of eight cats regained the ability to eat and sustain their body weight without the need of supplementation through a feeding tube within 3 months after surgery (range 3 days-3 months). Two cats developed
local recurrence of the tumor and were euthanized at 136 and 291 days post-surgery. The overall estimated mean survival time was 712 days. Of the 6 cats that had no local or systemic recurrence, 2 are still alive at time of submission of this abstract (at 316 and 461 days respectively) and 4 died at 156, 465, 608 and 1023 days post-surgery. The cat that died at 156 days, aspirated food material. Grooming was compromised in some cases, necessitating the owner to take over. Dietary changes from dry kibble to canned food in the direct post-operative phase, facilitated early oral food uptake.

We conclude that extensive mandibulectomy can be considered as a viable option for cats with oral neoplasia in selected cases. Client education and initial aggressive supportive care are key to a good outcome.

Authors of the original study “Outcome After Radical Mandibulectomy for the Treatment of Oral Neoplasia in Eight Cats” Veterinary Surgery 2019: Sarah Boston, Vincent Wavreille, Nicholas Bacon, Dave Szentimrey, S. A. van Nimwegen, Lucinda van Stee
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equine dentistry
Take home message

Radiography is the most common diagnostic imaging technique used for investigating dental and sinus disease. Computed tomography where available provides superior anatomical detail without superimposition of any other structures.

Introduction

Radiography still remains the most common diagnostic imaging technique for most equine practitioners, although gamma scintigraphy and standing computed tomography (CT) are widely available in UK referral institutes. Interpretation of dental radiographs is often challenging in many cases due to unfamiliarity and the complex 3-dimensional anatomy of the equine skull. When obtaining good quality radiographs of equine cheek teeth knowledge of the anatomy and radiographic technique is of utmost importance. This knowledge of anatomy is also important for interpretation of CT images.

Radiography

Multiple radiographic views are required to fully evaluate the equine sinuses and dental apices. The main projections are summarized below.

Lateral projection for investigating the paranasal sinuses. The horse should be positioned with the affected side next to the plate. The plate and plate holder should be positioned vertically, parallel to the long axis of the head and as close to the horse’s head as is achievable. The primary beam should be horizontal and perpendicular to the long axis of the horse’s head and centered just dorsal to the rostral aspect of the facial crest. In order to include all maxillary cheek teeth and paranasal sinuses, collimation should include the caudal aspect of the incisor-cheek tooth interdental space rostrally, the eye caudally and the dorsal aspect of the skull dorsally.

Dorsoventral projection for evaluation of the nasal cavity and ventral conchal sinus. The primary beam is directed perpendicular to the dorsal plane of the skull and the cassette is placed on the ventral aspect of the hemimandibles as far caudally as possible. The primary beam should be centered on the midline between the most rostral aspect of the facial crests and collimation should include lateral aspects of the skull and the caudal aspect of the bony orbit.

Latero30ºdorsal-lateroventral oblique for highlighting the apical portions of maxillary cheek teeth. The horse should be positioned with the affected side next to the plate, with the beam angled 30º from the dorsal plane and centered on the rostral aspect of the facial crest. Care should be taken to avoid inadvertent rostro-caudal angulation as this distorts cheek teeth apices making them difficult to interpret.

Computed tomography (CT)

Most CT scans in the UK are obtained using standing systems where a horse is placed on an air-sled with its head resting on the human CT table. Transverse images of the skull are usually acquired, which can then be reconstructed at a later time into any plane. Computed tomography provides much higher contrast resolution than radiography, usually allowing differentiation of fluid from soft tissue. Disadvantages of CT examination include the initial and maintenance costs of the equipment and the room, potential for damage to the CT machine from fractious horses and expertise and time required to interpret the scan results. If standing CT is employed for examination of equine heads, then a handler is required to be in the room while
image acquisition is taking place, placing them at risk of radiation exposure.

**Interpretation**

**Radiography**

The sensitivity and specificity of radiography for diagnosis of cheek tooth apical infection has been investigated in several studies (Weller et al. 2001; Townsend et al. 2010). These values are likely to be greater in a clinical setting where more information such as clinical examination findings and results of ancillary tests are likely to be available (Weller et al. 2001).

A recent study looked at the sensitivity and specificity of specific radiographic signs in the diagnosis of cheek tooth apical infection (Townsend et al. 2010). This study identified that radiographic signs present in the early stages of apical infection such as loss of lamina dura were less reliable as, although this radiographic sign was highly sensitive for picking up apical infections, it was poorly specific, leading to a high number of false positive diagnoses, which is not desirable in the clinical situation (Townsend et al. 2010). Loss of lamina dura has also been shown to be an unreliable sign in computed tomographic diagnosis of apical infection (Bühler et al. 2013). Advanced signs of cheek tooth apical infection may occur if infection has been present for many weeks, and the apex may develop lytic changes that manifest as periapical radiolucent halos or clubbed appearance of the tooth roots. Increased radiopacity or sclerosis of the bone supporting the tooth is often also noted in more chronic cases. Other more advanced signs of apical infection include abnormal apical deposition of cementum and dystrophic calcification of the nasal conchae in chronic maxillary cheek tooth infections (Tremaine & Dixon 2001). Many of these radiographic signs had low sensitivities but high specificities, which would generate few false positives (Townsend et al. 2010) but many false negatives. A multivariable model revealed moderate/extensive periapical sclerosis along with mild and moderate/extensive periapical halo formation to be most significantly associated with apical infection (Townsend et al. 2010).

**Computed tomography (CT)**

Interpretation of a CT scan is a lengthy process involving reading the raw scans and performing multiplanar reconstructions. All sinus, nasal and dental structures require complete evaluation.

All dental components should be fully evaluated including the clinical crown, each root of the tooth, the infundibulae and the individual pulp canals. The periodontal ligament and periapical area should also be fully examined. Signs of apical pulpitis include gas bubbles within the pulp canals (Henninger et al. 2003; Bühler et al. 2013), widening of the periodontal space, fragmenting or clubbing of the roots and soft tissue attenuation within the periapical space. A high proportion of normal cheek teeth will display apical infundibular cemental hypoplasia (Bühler et al. 2013).

As sinusitis is largely unilateral, evaluation of a CT scan in a transverse plane offers a direct comparison with the unaffected side. Each sinus compartment should be evaluated for normal anatomy and the thickness of it’s sinus mucosa. Soft tissue attenuation can indicate space occupying lesions within the sinuses. Soft tissue attenuation with dots of air attenuation within it is often indicative of inspissated purulent exudate.

Disease of the nasal cavity may be located in the nasal conchal bullae (Liuti et al. 2015). These are the rostrally situated non-sinus compartments of the nasal conchae. Disease of these areas on CT scan can be identified as soft tissue attenuation within the bullae (Dixon et al. 2014).

**References**


Liuti, T. et al., 2015. An anatomical study of the dorsal and ventral nasal conchal bullae in normal hor-
Equine maxillary cheek teeth have less peripheral enamel infolding than mandibular cheek teeth but in compensation, they each contain two infundibulae that provide additional occlusal enamel ridges to help comminute the fibrous equine diet. Anatomical and more recently, computed tomographic (CT) studies have shown that the majority of equine cheek teeth infundibulae, in particular the rostral (mesial) infundibulae of the Triadan 09 position, have developmental defects, i.e. they are incompletely filled with normal cementum, that ideally should be present. Suske et al (2016a) have shown that the accessory blood supply to the caudal (distal) infundibulae lasts for longer than the accessory blood supply to the rostral (mesial) infundibulae, which explains the predisposition of rostral infundibulae to more commonly develop disorders.

Developmental infundibular defects include the very common presence of a small central cemental defect, the site of a previous blood vessel(s) from the dental sac that nourished the developing cementum. These defects are variously termed the “vascular channel”, “central vascular channel” or “central linear defect” and extend for most of the depth of the infundibulum. More clinically important are larger infundibular areas containing less-dense, usually dark discoloured, hypoplastic cementum or even total absence (aplasia) of cementum with possibly fragments of soft tissue remnants, usually more centrally in infundibulae, but often for the full width of the infundibulum towards their apical aspects.

Caries of infundibular cementum is a later, acquired, bacterial-acid mediated disorder that appears to primarily affect infundibulae with pre-existing developmental defects. These defects accumulate and trap food once they become exposed on the occlusal surface due to normal occlusal wear, often in the 2nd decade of the horse’s life. Infundibular cemental caries can later extend to the adjacent infundibular enamel, then even to dentine and pulp. Maxillary cheek teeth, especially the Triadan 09 position, are long known to be prone to develop midline sagittal fractures that were initially described as a variant of “idiopathic cheek teeth fractures”. However, after it became apparent that these sagittally fractured teeth invariably had coalescing infundibular caries, they were later termed caries-related infundibular fractures. Additionally, if infundibular cemental caries later extends to, and penetrates through infundibular enamel and dentine it can infect adjacent pulp horns, and can cause apical infection without development of a sagittal dental fracture.

Clinically, teeth with shorter infundibulae (i.e. Triadan 09 position and older teeth) and the rostral infundibulae are more likely to have occlusal caries, but clinical examinations are often insensitive, because subocclusal infundibular lesions, including cemental hypoplasia and even caries are commonly present in infundibulae that do not have occlusal caries, possibly just normal vascular channels in the latter. Additionally, some “normal-sized” (i.e. circa 1 mm diameter) occlusal vascular channels expanded subocclusally to the dimensions of central linear defects and then, even expand to complete cemental aplasia more apically. There is no clear cut distinction between “normal” infundibular vascular channels and central linear hypoplastic defects (Horbal et al 2019).

Recent CT imaging studies have confirmed two main patterns of developmental cemental hypoplasia, i.e. apical cemental hypoplasia involving the full width of the infundibulum (usually more apically) and central...
linear hypoplasia involving only the more central aspect of the infundibulum over most of its length. Very commonly, combinations of these two types of cemental hypoplasia are present. The radiolucency of the lesions is dependent on the infundibular content, that can vary from complete absence of cementum, to variably calcified hypoplastic cement. As noted, these developmental lesions can later be affected by (acquired) infundibular caries.

Recent histological studies on hypoplastic infundibular cemental areas have shown them to consist of cementum, often tan-coloured, with irregularly-shaped, wide central channels that have multiple, cylindrical-shaped side-branches that extend and taper peripherally to variable degrees. Cementum with extensive, wide, empty channels and cementum histologically often grossly has an irregular moth-eaten appearance. Such areas contain low levels of calcified dental tissue, and consequently have a low HU on CT. More apical, cement-free areas of infundibulae may only contain fragments of soft tissue material. Carious cementum always has disrupted architecture and must have connections with the occlusal surface, sometimes through their central vascular channels. These vascular channels and their side branches contain degraded food and dental debris and with progression, the adjacent enamel and even dentine becomes carious, with bacteria visible within their dentinal tubules.

Suggested reading


Reason for performing study: Sagittal fractures of equine cheek teeth are commonly encountered by the equine practitioner, both acute and chronic presentations may be observed. There are limited reports in the literature on the apical and endodontic pathology associated with such fractures evident on computed tomographic (CT) examination.

Objectives: To document the incidence of apical disease on equine cheek teeth which have suffered a sagittal fracture involving the clinical +/- reserve crown.

Study design: Retrospective study of CT examinations of equine heads with sagittal fractures of cheek teeth present.

Methods: 81 teeth from 49 horses were found to have a sagittal cheek tooth fracture on CT examination. The images were evaluated for apical pathology including gas, widened periodontal space, alveolar sclerosis, root clubbing, cementoma/hypercementosis, lamina dura loss, associated sinusitis and sinus mucosal swelling. An apical infection scoring index was created to give each tooth a score. Those teeth with a value greater than or equal to 5 were classed as apically infected. Hounsfield units were used to verify gas in the endodontic system or at the apices. The ratio of fracture length to tooth length was recorded.

Results: A total of 87 (56 buccal, 17 palatal/lingual and 14 midline) sagittal fractures from 81 teeth were recorded: 74 were maxillary cheek teeth and 7 mandibular cheek teeth. The maxillary triadan 09 (29/74; 39%) and maxillary 10 (23/74; 31%) were over represented. 77% (62/81) of teeth had evidence of apical infection (score greater than or equal to 5) comprising of 80% (59/74) of maxillary cheek teeth and 43% (3/7) of mandibular cheek teeth. Buccal sagittal fractures were classified as apically infected in 73% (37/51) of cases, palatal/lingual sagittal fractures were classified as apically infected in 55% (6/11) and midline sagittal fractures were classified as apically infected in 100% (13/13) of cases. All teeth (6/6) with 2 fracture types were classified as apically infected and 96% (24/25) of fractures involving the infundibulum were classified as apically infected.

Conclusions: This study provides evidence that large proportions of fractured cheek teeth have evidence of apical infection on CT examination and therefore warrant treatment.
Occlusal fissures in the equine cheek tooth: first µ-CT and histological findings

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Introduction

Fissures in equine cheek teeth are commonly encountered during oral examination and have been reported in several papers¹-⁷. A classification of fissure types was proposed in a previous study based on their orientation and the involvement of different tooth substances⁸. Their clinical impact on pulp disease however is still unknown.

The objective of this study was to determine the variation in fissure depth, and the involvement of enamel, dentine and/or cementum in relation to fissure type and the possible communication with pulp horn tips. Secondly, to determine the presence of food particles/bacteria within fissures and to examine pulp morphology of pulp horns adjacent to occlusal fissures.

Material and methods

Teeth extracted for dental pathology and a control group of sound teeth having occlusal fissures were collected and stored in formalin. Teeth (n=27) were scanned using high-resolution X-ray computer tomography (µCT) imaging to analyse fissure characteristics and extent. Histological examination (n=7) of a subset of teeth was performed to identify fissures and examine their topographical relation to the pulp horn (location).

Results

Diseased (extracted) teeth showed fissures in 23/77 teeth and 20/24 sound teeth showed fissures. High-resolution X-ray computer tomography analysis on 27 teeth identified 43 type 1 fissures (35 type 1a, 8 type 1b). The mean length of the fissure of type 1a and type 1b on the occlusal surface was 3.47 ± 1.60 mm and 13.64 ± 7.40 mm respectively. Their mean depth was 13.22 ± 10.76 mm and 7.42 ± 6.42 mm respectively. Fissures were significantly deeper on the buccal side of the teeth and at teeth 09. Fissures could be identified on histological sections with the presence of organic material inside the fissure, the presence of micro-organisms in the continuation of the fissure protruding within the dentinal tubules and the presence of tertiary dentine.

Conclusion

Our results suggest that fissures may develop following a mechanical insult. They potentially provide a pathway for microorganisms to enter the dentinal tubules which can result in a local inflammatory reaction of the pulp. It is assumed that in healthy teeth, vital odontoblasts react by producing tertiary dentin which lacks patent tubules and thus provides a proper seal against further bacterial invasion.

References


Introduction

Diagnostic procedures, treatment options and long-term follow-up of different sinonasal pathology in horses such as primary and secondary sinusitis1-3, sinonasal cysts4, progressive ethmoid haematoma5-6 and sinus neoplasia7-8 have been described in veterinary literature. Equine reports focused on sinus mucocele are rare. Mucoceles are believed to develop following obstruction of the aperture between sinus and the nasal cavity. Progressive deformation of the surrounding structures is the result of continuous mucus production and accumulation in the isolated sinus compartments. The most common causes of occlusion of the drainage towards the nose in humans are chronic infection, allergic sinonasal disease, trauma, previous surgery9-10. In equine literature this pathology has not been reported in some larger cohort retrospective studies1,11. An older case-report briefly discusses mucocele sinusitis in a thoroughbred filly resolved by simple trephination, flushing and antimicrobial treatment12. A more recent case-report describes the use of a caudally based frontonasal bone flap to successfully resolve bilateral sinus mucocele in an American Miniature Horse13. We describe the long-term follow-up of 7 cases of sinus mucocele treated by bone flap surgery and re-establishing drainage towards the nasal cavity.

Material and methods

A retrospective study was conducted of all sinus pathology cases referred to the equine services of the Faculty of Veterinary Medicine at Ghent University between January 2015 and January 2018. Inclusion criterion was uni/bilateral accumulation of fluid within the different sinus compartments in the absence of other sinus pathology such as sinusitis, sinus cyst, PEH or neoplasia. In January 2018, a call was distributed to EVDC Eq specialists to contribute comparable cases from their case load.
Results

Diagnosis of bilateral (n=6) or unilateral (n=1) sinus mucocele in young miniature pony breeds (2.3 ± 0.7 y) was based on clinical symptoms, endoscopy, radiography and/or CT scan of the head. Commonly encountered symptoms included progressive facial deformation, chronic nasal discharge and progressive respiratory distress caused by obstruction of the nasal passages. Standard and oblique radiographic projections were characterised by homogenous attenuation of different paranasal sinus cavities in the absence of any other pathology. CT scan analysis further confirmed the presence of fluid occupying the sinus cavities. A single caudally based frontonasal flap as described by Easley et al. (2012) was used in 6/7 cases to simultaneously access the sinuses on both sides of the head. Perforation of the floor of the dorsal concha allowed for introduction and fixation of nasal tubes to ensure development of a permanent large communication between sinuses and nasal passages. Complications included intraoperative haemorrhage, postoperative incisional drainage, premature nasal tube dislocation and persistent nasal discharge. Long-term outcome following a median period of 19 months was very good in all cases with no recurrence of nasal discharge, normal patent nasal passages and excellent cosmetic results.

Conclusion

Long-term outcome following a frontonasal sinusotomy approach and nasomaxillary drainage repair for treatment of sinus mucocele in miniature pony breeds can be considered positive. Especially young miniature pony breeds seem to be susceptible to the development of this rarely encountered sinus pathology. This should be considered in the differential diagnosis of progressive facial deformation and associated respiratory noises in these breeds.

References

Complications from sinusitis in horses

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Introduction

Sinus diseases can cause disease-related complications in two ways:

1. by the sinusitis itself or by the primary disease responsible for the sinusitis,
2. as a consequence of a medical or surgical treatment of the sinusitis.

In most cases, the negative side effects are local reactions, but severe systemic side effects can also occur.

Complications from sinusitis itself or its primary disease

When the paranasal sinuses are severely filled with pus and the drainage through the nasomaxillary aperture is obstructed, horses can demonstrate signs of headshaking. A possible cause could be the inflammation itself or the mechanical pressure on the infraorbital canal and nerve. Depending on the duration and severity of the underlying disease, the symptoms usually disappear when the sinus disease has been treated successfully. Mechanical irritation of the maxillary nerve with subsequent headshaking can also be caused by dental diseases that extend into the paranasal sinuses or by large paranasal sinus cysts. Such space-occupying masses can also narrow the nasal passages of the contralateral, healthy side when the nasal septum is displaced. These horses stand out with a pronounced nasal stridor; they tend to be very subdued due to the lack of oxygen and they may be presented with complaints of poor performance. These symptoms usually disappear completely after surgical removal of the cyst.

Due to the high pressure, sinus cysts and other expansive neoplasms have been known to cause deformities of the bony orbita and the facial bone, potentially leading to exophthalmos and blindness. For the same reason, an inflammatory or mechanical obstruction of the lacrimal duct can occur. The aforementioned pathological changes can be irreversible.

High-grade, purulent sinusitis and chronic or fast-growing, space-occupying masses often lead to bony deformities in the face, which can be associated with fistula formation. Such sinu-cutaneous fistulas can also be the result of extensive trauma with loss of substance of bone and skin, or when the skin has been insufficiently closed after trephination. The treatment of fistulas lying directly over the paranasal sinuses is more difficult than in other regions of the body. This is due to the permanent airflow during inspiration and expiration and the associated high mechanical stress on the tissue.

Sinus diseases are frequently treated with antibiotics for a long period of time, and often this is not based on a bacteriological examination with microbial resistance testing of the pus. In cases where the primary cause of the sinusitis (for example a diseased tooth) is not eliminated, the pus is often inspissated. This material tends to settle in “blind sacs”, such as the bullae of the dorsal or ventral nasal conchae, where it is not easily treated with systemically administered drugs or even mechanically. This condition can lead to recurrent sinusitis and nasal concha necrosis. The normal anatomical structure of the nasal passages and paranasal sinuses is often severely altered in chronically diseased horses. In the long term, this can lead to altered airflow conditions and reduced clearance of the sinus mucosa even after removal of the pus and necrotic bone. Affected horses are often more susceptible to upper respiratory diseases.

The aggressive bacterial flora, especially in dental sinusitis, only sporadically causes systemic symptoms such as fever and neurological disorders due to bacteraemia and septicaemia. However, the close proximity of the sinuses to the brain allows the direct passage of bacteria through the thin, infected bony lamellae of the sinus system with subsequent meningo-encephalitis. These horses may be presented with ataxia and somnolence. Therapy is very time- and money-consuming and often unsuccessful.

Complications from the therapy of sinusitis

The most common complication after surgical treatment of the paranasal sinuses by trephination or bone-
flap is an infection of the bony suture lines. Despite the external sterile surgical field and good surgical technique, the development of suturitis is easy to explain, as we work in an unsterile, often highly contaminated cavity. The infection spreads from the surgical site along the bony sutures, and produces externally visible, very painful bone protuberations that can extend to the healthy side of the head. Even in older horses the sutures are not completely closed therefore these complications can occur in horses of all ages. In most cases, treatment with systemically administered anti-inflammatory and analgesic drugs and stall rest, will resolve the clinical signs.

After boneflap surgery, in which the bone is replaced, surgical site infections with sequester and fistula formation can develop postoperatively. These must be treated primarily by cleaning and flushing of the wound and removal of the infected, dead bone.

Inappropriate selection of the surgical site or poor surgical technique may cause damage to the lacrimal or infraorbital duct as well as the roots of the upper cheek teeth. Bleeding during surgery or endoscopic procedures can occur; and in the best case they are only a nuisance, due to reduced visibility, in the worst case, however, they can be life-threatening, since they can be severe and difficult to control.

The transendoscopic opening of nasal conchae or their bullae by laser and subsequent flushing is usually an effective treatment for local sinusitis. Since the opening is not very large, there is a risk of closure before the inflammation has completely resolved. In order to avoid recurrence, regular follow-up examinations are necessary until complete healing has occurred.

In many sinusitis, gram-negative anaerobes are the dominant bacteria and for specific antimicrobial therapy metronidazole or doxycycline can be instituted. The oral administration of metronidazole can lead to increased salivation and poor appetite. Doxycycline can cause dysbacteriosis and ulceration in the oral mucosa, which is also associated with hypersalivation.

For the treatment of progressive ethmoid haematoma (PEH), local, transendoscopic injection of formalin is recommended. As a result of this therapy, an injection of formalin into the brain is anecdotally reported with high injection pressure and large injection volumes. The consequence would be central nervous disorders. Until now this has not been observed by the author. However, after injection of PEH in the paranasal sinuses, temporary excessive snorting and headshaking was observed. Presumably it came here to an irritation of the paranasal sinus mucosa by not immediately discharged formalin.

**Conclusion for practice**

The chronic state of many sinus diseases predisposes for the occurrence of complications. The negative side effects that can arise in the context of sinusitis itself, its primary disease, as well as its therapy, are in many cases local problems and easy to treat. If the underlying disease is successfully treated, complications that have occurred can often be cured.

The prognosis is poor when horses have already developed neurological symptoms, or if a malignant neoplasia is diagnosed.

**References**

Available from the author on request.

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### Multi-resistant bacterial isolates after chronic sinus empyema, associated with dental disease: 3 cases

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Approximately 50% of paranasal sinus empyema cases are associated with dental disease. In primary sinusitis cases Streptococci have been isolated most frequently with mixed growths cultured from dentally derived infections. However, most cases are presented with a chronic nasal discharge and receive broad-spectrum antibiotics as a first treatment, based on convenience rather than culture and sensitivity. Cases that are refractory often are prescribed further antibiotics with no additional sensitivity testing. Most referred cases have been treated with several such courses before a definitive diagnosis is made or the bacteria identified.
Some such cases, when exudates are cultured sometimes reveal bacterial species that are widely resistant to antibiotics, extremely cytotoxic, cause considerable morbidity and possible mortality. Three such cases are described, that subsequently underwent extensive imaging, laboratory testing and multiple treatments before a final conclusion was reached. The inference from these is that cases that do not respond to an initial course of antimicrobials with efficacy against the likely causal organisms for primary empyema should be subjected to appropriate diagnosis and sensitivity before prescription of different antibiotics.

**Management of dental alveolus post extraction**

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**Introduction**

The healing of the alveolus after tooth extraction in the horse depends on many factors. An essential point is the specific and careful postoperative management. A uniform approach for every horse is not possible due to the various initial dental diseases and differences in the course of surgery and post-operative progress.

The following abstract primarily describes the follow-up examination and treatment after oral cheek tooth extraction with and without complications.

**Alveolar treatment after uneventful oral extraction**

After tooth extraction, the alveolus is inspected manually and visually by use of a mirror or an oral endoscope. Bleeding as a result of the surgery sometimes precludes an optimal visualization of the bony structures. Remaining dental or loosened bony fragments should be removed. Afterwards, the alveolus should be covered with an appropriate filling material. The formation of granulation tissue can be supported by a gauze formed as a ball and soaked with medical honey. The astringent effect of the formerly used iodoform gauze is less suitable for wound healing. In severely infected alveolus the application could be discussed, however, the carcinogenic effect of iodoform should be kept in mind. A proven placeholder is the two-component polyvinylsiloxane (e.g. Hydro Putty®). After uncomplicated extraction, the author prefers gauzes to the firm substance of polyvinylsiloxane, because of faster wound healing.

Care should be taken not to fill the alveolus completely with any material: the apical aspect should be free to build a solid blood clot. This acts as starting point for the granulation tissue, which then transforms to connective tissue and is ultimately covered by epithelium. When no complications occur, this is usually completed by 6-8 weeks, depending on the depth of the alveolus and the age of the horse.

The first check-up of the alveolus should be performed within the first days after surgery to remove any exudate or fragments of bone or dental material as early as possible. Further follow-up examinations should be planned every week until the wound is completely closed. The alveolus is flushed with water, inspected carefully for any food material, and a smaller gauze or filling material is inserted.

**Alveolar treatment after complicated oral extraction or in case of problems in alveolar healing**

Even though the implementation of new, minimal invasive extraction techniques and improved instruments avoid severe injury to the alveolus, complications and disorders in the wound healing can still occur. Initial infection of the alveolus due to the underlying disease or bony damage during the surgery usually prevents the formation of a solid apical blood clot. As a result of alveolar wall inflammation dry bone walls can occur. It usually takes two to six weeks to eliminate the non-vital bony fragments, and this process is often accompanied by bony swelling, pain and fever. Another manifestation of problematic healing are fistulas due to remaining tooth fragments or bony sequestration. A grey discoloration of parts of the bony wall and the
blood clot combined with malodorous material in the socket indicates an inflammatory process. Necrotic tissue should be removed and the wound is flushed and cleaned with diluted iodine solution.

A major complication after tooth extraction is an open connection between the oral cavity and the sinus system or the nasal passages. To cover these fistulas and to avoid the presence of food in the depth of the alveolus, a temporary polyvinylsiloxane implant should be inserted in these cases.

References
Available from the author on request.

Minimally invasive repulsion (MIR) in 37 standing sedated horses using bespoke repulsion pins

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Introduction

Surgical repulsion of equine teeth has previously been described as a technique for extraction of cheek teeth in horses under both general anaesthesia and standing sedation [1,2]. Complication rates associated with these procedures have ranged from 30-70\% for repulsion under general anaesthesia and 30-49\% for standing procedures. Recent developments to refine the techniques of dental extractions have included improvement in oral extraction instrumentation and techniques and development of novel surgical techniques such as minimally-invasive trans-buccal extraction. In addition, quality portable patient-side radiographic imaging for procedure guidance and standing computed tomography (CT) have resulted in a shift towards accurate minimally invasive surgical techniques with fewer complication rates. Some teeth however still present considerable challenges despite the above technical developments and surgical repulsion can still be a consideration. In one study of sinus disorders, Dixon commented that many of the teeth repulsed under general anaesthesia could in retrospect have been carried out in the standing horse[3]. This study records results of standing surgical dental repulsions in cases where combinations of the above techniques failed or were considered unsuitable due to the anatomical positioning or presentation of the cases. All cases were performed under standing sedation using radiographic or computed tomographic (CT) control.

Material and methods

Records of all horses that underwent dental extractions by the author over a period of 5 years (2013-2017) were reviewed. Those that underwent a surgical dental repulsion procedure were selected for further retrospective analysis. Data reviewed included age at time of procedure, breed, Triadan number of tooth, pathology identified and history including prior iatrogenic damage. A complete oral examination using mirror and oroscope was performed under sedation using detomidine (10μg/kg intravenously [IV]) and butorphanol (0.02mg/kg IV). Lateral-oblique radiographs were performed in each case. For pre-operative radiographs, skin staples were placed at a location either side of the approximately anticipated repulsion site. 5 horses had a computed tomography (CT) examination prior to surgery for procedure planning. Procedures were performed under standing sedation using intravenous continuous rate infusion (20-35mg detomidine and 20-30mg butorphanol in 1000ml saline) administered to effect. Some cases also received acepromazine (0.04mg/kg IV) as a pre-medicant. Regional anaesthesia was provided using either maxillary (modified palatine bone insertion technique) or mandibular (transcutaneous ventral approach) nerve block, and regional alveolar block prior to surgery. Dental alveolar blocks were performed using a 27 gauge needle and luer-lock dental anaesthetic syringes, using 2.2ml cartridges of 2\% lignocaine with adrenaline.

Extraction procedure, technique and equipment

In all cases with the presence of a clinical crown, oral extraction was first attempted as described previou-
For cases lacking a clinical crown (prior fracture, unerupted tooth) alternate procedures considered were minimally invasive transbuccal extraction (MTE), dental bur sectioning or minimally invasive transcortaneous repulsion (MIR). For some procedures, MTE and bur sectioning were ruled out due to location or positioning of the tooth or remnant, and in cases with dental apices close to the border of the mandible with a discharging sinus tract it seemed logical to utilise an existing tract to the dental apex (5 cases).

**MIR equipment and procedure**

A set of bespoke repulsion pins were used for each case. These comprised 3 pairs of modified Steinman pins, each 25cm in length. Each pair was composed of one sharp pointed pin, and one blunt ended pin, both with a 7cm x 2cm cm diameter cylindrical block at the opposite end. This allowed a larger ‘target’ for repulsion, plus the option to use a slot hammer to apply reverse forces should the pin become stuck or require repositioning. The diameters of the pairs of pins were 4mm, 6mm and 8mm.

For the MIR procedure, skin staples were firstly placed either side of the approximated position of the repulsion site, following the anticipated extraction pathway orally to apically. Lateral-oblique radiographs were taken to judge accurate surgical site for a cortical osteotomy to prepare for repulsion. The site was infiltrated with mepivacaine and prepared aseptically. A linear skin incision (1cm for maxillary and 2cm for mandibular) was made, and the periosteum reflected. For mandibular teeth without an existing sinus tract, or where one existed but not in a convenient location, a hand drill was used to create an osteotomy, 2mm diameter larger than the anticipated pin size. For small fragments the smallest size was selected, whereas for larger firm embedded fragments a larger size was selected. Once the cortical bone was penetrated, the sharp pointed pin was then advanced carefully towards the dental apex, occasionally requiring soft taps from a mallet. For some maxillary teeth, or those with an existing discharging tract, the sharp pin was the sole instrument used to create the initial pathway to the tooth. Once the pin had been advanced approximately half way to the tooth, or contacted something firm, a positional radiograph was obtained. The pin could then be advanced further or redirected to the dental apex. Once radiographs confirmed accurate pin placement, the sharp pin was replaced with the blunt pin of the same size. Gentle taps with the mallet were then used to deliver the tooth into the oral cavity.

**Technique for caudal mandibular supernumerary (SN) distomolars**

For SN teeth distal to the mandibular Triadan 11 teeth, the caudal position of the dental apex and angulation meant the surgical site was positioned more dorsally along the curvature and vertical ramus of the mandible. In these cases, the osteotomy was performed as above, however the sharp pin was then passed medial (axial) to the thin mandibular bone, through the pterygoid muscle, then again entered the mandibular bone immediately at the dental periapex. The sharp pin was then replaced with the blunt pin of the same size. Gentle taps with the mallet were then used to deliver the tooth into the oral cavity.

**Results**

37 cases of MIR were performed over the 5-year period of review and accounted for 3.6% of all extractions performed. All procedures were completed at one surgery. All of the tooth or fragments were removed in all of the cases (100% success). 26 cases (70%) were mandibular teeth, 11 (30%) maxillary. The mean age of the horses at presentation was 9.2 years with a range of 17 to 3 years. 14 teeth (38%) were fractured at presentation, with partially or completely absent clinical crowns. 8 of these (57% of fractures) were iatrogenic from a previous extraction attempt by the referring veterinarian. Of the remainder, 17 (74%) had multiple non-vital pulp exposures. 4 cases had concurrent advanced infundibular caries. 3 cases were supernumerary (SN) teeth including 2 SN distomolars (312). In the majority of cases, the tooth or fragment repulsed was loose and simple to deliver orally once the pin was accurately placed. The most challenging teeth to repulse, using the most and firmest blows with the mallet were mandibular teeth with longer histories of disease and more advanced apical changes (cementoma formation, distortion of apices).

Out of 37 procedures, 30 (81%) had no complications extending beyond 3 months. Most cases required little more follow-up than for a standard oral extraction with the surgical site healing in advance of the alveolus within 3 weeks. 34 cases (92%) had completely resolved by 6 months (3 horses developed post extraction sinusitis with one requiring a single sinus trephine and flush to resolve). Three cases (Triadan 307, 309, 410) developed severe mandibular swelling with pathological fracture diagnosed by CT, with one being euthanased due to chronic non-union and swelling (309). The MIR procedure in these three cases was quick and
simple in 2 cases, more prolonged in 1 (Triadan 307, apically enlarged reserve crown and root). One of these (Triadan 409) developed a chronic discharging sinus tract at the surgical site which resolved after 9 months and 2 surgical procedures to debride the tract and socket. All 3 of these cases had received prolonged and traumatic attempts at oral extraction and minimally invasive trans-buccal surgery prior to referral and subsequent MIR. 10/12 of the maxillary cases were repulsed using the 4mm pin set, the other 2 with the 6mm. For mandibular teeth, there was even distribution with the 6mm being most commonly used.

**Discussion**

The results above show that when used carefully and in selected cases, MIR is a highly effective and safe method of dental extraction, and a useful alternative, to oral extraction and minimally invasive trans-buccal procedures that have become popular in recent years. It can be considered part of a surgical plan if other procedures are proving unsuccessful. No other technique has been reported with 100% success for complete extraction (oral extraction success rates reported up to 89% [4], transbuccal surgery 81% [5]). 81% of these MIR procedures had healed within 3 months, with 92% being resolved by 9 months from a single surgery. One previous study reported only 51% of standing repulsion procedures being resolved with one surgery [2].

This case series was predominantly composed of teeth in advanced stages of pathology, many presented with fractures, advanced apical changes, occlusal pathology, many being end stage referrals. The average age of 9 years, and high prevalence of occlusal pulpar exposures and fractures suggests pulps death at an early age, with poor mineralisation of the teeth from secondary dentine deposition. In addition, the teeth with the most severe complications following surgery, were presented with existing mandibular swelling, and followed prolonged attempts at oral and minimally invasive trans-buccal surgery. CT scans showed there to be marked trauma to the lingual mandibular border prior to referral in these cases. It is possible that the presence of the facial crest and anisognathic positioning of the caudal mandibular teeth resulted in sub-optimal angulation of the transbuccal instruments resulting in failure and mandibular trauma.

For the SN mandibular distomolars, this MIR technique is to the authors knowledge previously unreported and can be recommended, although only 2 procedures were performed. Once again, both procedures followed oral extraction attempt which first loosened the tooth prior to fracture, requiring only soft taps with the mallet once the repulsion pin was properly positioned. The author feels it is imperative to pass the sharp pin carefully through the pterygoid muscle to avoid traumatising the thin mandibular bone in this location.

**Conclusion**

MIR can be considered a safe and effective 'last resort' for challenging dental extractions. Chronically diseased and fractured teeth, apical fragments and cementomas especially of mandibular teeth in virtually any location can be repulsed in the standing sedated horse using sharp and blunt bespoke repulsion pins. Careful preparation and patient-side imaging is required, along with a controlled surgical approach. Teeth previously loosened by oral extraction or minimally invasive trans-buccal procedures are considerably easier to repulse in this way and MIR in this way can be recommended as a quick and effective way of resolving a difficult and prolonged extraction.

**References**

Reason for performing the study: Hard, bony mandibular swellings have been reported to be a common sign of osteomyelitis ± apical disease. Nevertheless, no objective data are available concerning the prevalence of these mandibular swellings in the current alpaca population.

Objectives: To determine the overall prevalence of mandibular swellings in the current alpaca population in the Northern part of Belgium and the southern part of the Netherlands. To report if significant differences in prevalence between alpaca farms exist. To determine if there is a clear discrepancy in reported versus observed prevalence of mandibular swellings.

Hypothesis: It was hypothesized that there is a high prevalence of mandibular swellings in alpaca populations. Differences between farms are expected given the existing differences in management practices. Furthermore, it is expected that the observed prevalence will be significantly higher than the reported prevalence given the severity of dental disease often diagnosed in referred cases.

Methods: 25 alpaca farms in the Northern part of Belgium and the southern part of the Netherlands were visited during the months of June 2018 till October 2018. A total number of 348 animals was examined. Animals to be included in the study were selected in cooperation with the owner based on their age and gestational status. Palpation of the external maxilla and mandible was performed with the owner restraining the alpaca. Examinations were performed on sedated and unsedated animals. Age, gender, body condition score (BCS) and known history of possible mandibular/maxillary swelling of each animal was recorded.

Results: The number of animals at each farm examined by palpation ranged from 2 to 51, with a mean number of 14 ± 11 animals. The age of the examined animals ranged from 0.8-16.3 years, with a mean of 5.8 ± 3.2 years. Our study population consisted of 216 (62.1%) female, 67 (19.3%) male and 65 (18.7%) male castrated animals. The detected BCS of the alpacas included in the study population ranged from 1 to 5 (mean 2.48 ± 0.78). No maxillary swellings could be detected during our field study. The overall detected prevalence of mandibular swellings was 12.1% (42 animals). Of these swellings 53.7% (22 animals) was located at the level of the right mandibular branch, 31.7% (13 animals) at the level of the left mandibular branch. Six (14.6%) of the examined animals showed a bilateral mandibular swelling. The prevalence of mandibular swellings at farm level ranged from 0-33.3%. Nevertheless, no significant association could be detected between the farm and the prevalence of mandibular swellings. The prevalence reported by the owners was only 4.3% (15 animals). A statistically significant difference (p<0.0001) was detected between the reported and detected prevalence. Of the participating owners in our study, only 32.0% (8/25) performed palpation of the mandibular arcade on a regular base.

Conclusion: There seems to be a high prevalence of hard, bony enlargement at the level of the mandibular branches. This finding suggests a high incidence of associated dental pathology. The reported prevalence of mandibular swellings is significantly lower than the ‘owner detected’ prevalence. An increased frequency or quality of palpation of the mandibular arcade can lead to an improved early detection of these anomalies and should be followed-up by a thorough mouth examination.

References

Prevalence and characterization of dental disease in Alpacas

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Reason for performing the study: The observation of certain dental abnormalities has been reported. Nevertheless, no objective data are available concerning the true prevalence of present dental abnormalities in alpacas.

Objectives: To report the prevalence of different dental abnormalities in alpacas in the Northern part of Belgium and the Southern part of the Netherlands.

Hypothesis: It was hypothesized that a high prevalence of dental abnormalities exists in New World Camelids. Especially diastemata and associated periodontitis were expected to be present frequently.

Methods: 25 alpaca farms were visited once during the months of June 2018 till October 2018. Animals to be examined were selected in cooperation with the owner depending on their age, economic value and gestational status if female. Examinations were done on sedated animals using a miniature/pony speculum combined with a dental speculum light after thorough flushing of the oral cavity. A dental chart was completed after performing the dental examination using a dental mirror or rigid portable dental endoscope.

Cheek teeth abnormalities were defined in general as any kind of deviation from the normal cheek teeth dentition. This could include normal ageing of the dentition in older cheek teeth, small non-clinically important dental abnormalities and also clinically relevant pathology. Possible specific cheek teeth abnormalities were described, and identification criteria were set. The number, location and specific characteristics of any encountered pathology was recorded.

A questionnaire regarding symptoms linked to dental pathology was completed for each animal in cooperation with the owner. Specific questions were asked regarding following symptoms: quidding, decreased appetite, weight loss and salivation. The presence of mandibular/maxillar swelling/fistulation and/or nasal discharge was additionally recorded for each animal.

Results: The age of the alpacas included in the study ranged from 1-17 years (5.60 ± 3.17). Our study population included 115 (52.4%) female, 51 (22.4%) male and 62 (27.2%) male castrated animals. The total number of animals with any dental abnormalities was 187 (82%). Incisor abnormalities were noted in 95 animals (41.7%). The majority of these abnormalities consisted of diastemata (36 animals, 15.8%), defects in the secondary dentine causing pulpar exposure (25 animals, 11.0%), malpositioned incisor teeth (23 animals, 10.1%) and wear abnormalities (21 animals, 9.2%). Furthermore, mandibular overbites (8 animals, 3.5%), incisor periodontitis (8 animals, 3.5%) and tooth fractures (6 animals, 2.6%) were also observed. In contrast to incisor abnormalities, canine abnormalities were found only in a limited number of 9 animals (3.9%). The prevalence of cheek teeth abnormalities in our study population was 74.6%. Periodontal disease (33.3%), diastemata (25.9%), worn teeth (25%), food entrapment (23.6%), displaced teeth (19.6%), pulpar exposure (10.2%), persisting deciduous teeth (9.6%) and tooth fractures (9.2%) were the most frequently observed
cheek teeth abnormalities in our study population. Clinical signs possibly related to dental disease were noted in a total number of 29 animals (12.7%). Mandibular swelling (22 animals, 9.6%) and weight loss (13 animals, 5.7%) were the most commonly detected/reported symptoms. Quidding (4 animals), decreased appetite (3 animals), mandibular fistulation (1 animal) and salivation (1 animal) were also noted by participating owners.

**Conclusion:** Dental abnormalities are common conditions afflicting alpaca’s which could have a severe impact on animal welfare. During this field study, a high prevalence of different dental abnormalities was detected despite the low prevalence of clinical signs. A thorough mouth examination is only possible when using appropriate instruments in combination with a good sedation protocol. This allows identification of existing dental pathology in this species. Additional diagnostic tools (radiography, CT scan) are necessary in selected cases to allow drawing conclusions about prognosis and treatment.

**References**


Brachynathia treatment using a tension band device: technique and complications

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Introduction

Incisor arcade malocclusion Type II and III, or mandibular and maxillary brachynathia respectively are recognised infrequently in horses. In a large referral population of horses, only 4/400 (1%) were diagnosed with mandibular brachynathia1. Another source2 reports an incidence of mandibular brachynathia of 2-5%. This condition is suspected to have hereditary components although a recent genetic study conducted in Thoroughbred horses was unable to identify a specific locus in the horse genome to be associated with mandibular brachynathia3-4. The condition can be present at birth but may also develop during growth in the first six months of life5 and even spontaneously disappear over time6. Slight malocclusion of the incisor teeth is rarely a cause of clinical problems. Abnormal dental wear, difficulty apprehending food, different riding behaviour and aesthetical deficits influencing sales prices can result from severe incisor malocclusion which warrants corrective treatment despite the ethical questions raised by the possible hereditary nature of the pathology. Decisions regarding future breeding with these animals should be well discussed2. When detected early in life, correction can be achieved through means of temporary inhibiting growth of the ‘overlong’ jaw using a tension wire construction5. Alternative treatments include corrective osteotomy and subsequent fixation with Type 1 external skeletal fixation7 or LCP plates8-9, have been described. One case report describes the use of mandibular osteodistraction in a horse10.

The purpose of this review is to describe the technique of growth inhibition using a tension wire construction with incorporated incisor bite plate and share experiences/complications/follow-up in a case-series of 20 foals treated at the equine clinic of the Faculty of Veterinary Medicine, Ghent University.

Surgical technique

Surgery is performed with the foal under general anaesthesia and positioned in dorsal (mandibular brachynathia) or sternal (maxillary brachynathia) recumbency. Prior to induction of anaesthesia, the mouth is copiously flushed with tap water to remove any remaining food particles. Intubation is preferred through the nose to maximize the limited available space in the oral cavity of these young animals. The mouth is preferably kept open with a full-mouth speculum.

The first step of the procedure is to pass a wire through the interdental space between the 07 and 08 cheek teeth. Using the 06-07 space to fit the wire is more easy but can result in progressive positional changes of the deciduous 06’s in a mesial direction with subsequent tension loss on the wire construction. Originally, the authors passed the wire (stainless steel; 1.2 mm) through an opening made through the cheek adjacent to the interproximal space. A 5-6mm stab incision is made through the skin with a n°11 scalpel blade. Blunt dissection of the cheek muscles is done using Metzenbaum dissecting scissors until the cheek mucosa is reached. The mucosa is finally perforated with the blunt end of the closed scissors while creating counter pressure with the fingers from within the mouth. A 3.2 mm drill bit is used to drill a hole in the designated interproximal space. The use of a drill guide is not absolutely necessary as the tip of the drill bit will easily engage the alveolar bone. The hole is drilled approximately 3-5mm below the gingival margin to ensure firm anchorage of the wires in the alveolar bone. The direction of drilling should carefully follow the interproximal space and be parallel to the horizontal plane of the hard palate, and perpendicular to the long axis of the foal’s head to avoid damage to the palatine artery and surrounding teeth respectively. The skin of the cheek incisions is closed with 2 staples or simple sutures of a resorbable suture material. Alternatively, an intra-oral approach can be used to drill the hole. For this purpose, a right-angled dental drill with 3mm drill bit is used. The hole is drilled from palatal/lingual to buccal under constant visual inspection with a dental scope. This technique is currently preferred by the authors because of its minimal invasiveness.
A 50-cm strand of wire is passed through the hole. When using the extra-oral approach (cheek incision), redirecting the lingual half of the wire to rostral is straight-forward. When using the intra-oral approach, the wire is passed through the mouth into the hole from palatal/lingual to buccal. Regardless of the approach used, retrieving the buccal half of the wire is done using a hook retractor or comparable instrument. This is also best performed under visual guidance of a dental scope to avoid damaging the buccal mucosa. Both wire halves are pulled tightly, crossed as they pass the interdental space and kept as close to the oral mucosa as possible. The palatal/lingual wire passes over the labial surface of the incisors, the buccal is directed to the lingual surface. Fixing the wires at the level of the incisors is done using the Obwegeser technique. This technique uses wire loops to firmly attach the wires to the incisors. Tension on the construction is created by further twisting the wires at the level of the interdental space using a curved mosquito forceps. Any protruding cut ends of the wire are bent towards the labial surface of the teeth and protected with rubber tubes or dental composite if necessary to prevent damage to the lip mucosa.

Finally a bite plate is constructed to guide the longitudinal growth of the brachygnathic jaw. A 3mm thick fenestrated aluminum plate is cut to appropriate sizes to fit within the confines of the incisor part of the overlong jaw. Next, dental polymethylmethacrylate is applied to incorporate the aluminum plate, the adjacent wire construction and the incisors. Leaving the labial surface of the 01 elements exposed facilitates later evaluation of the degree of correction attained.

Postoperative administration of NSAID’s helps in controlling any eating discomfort. Food can be adapted to short fiber sources. Long hay and straw fibers tend to accumulate around the twisted wires in the interdental space. The construction should be regularly checked for wire failure. Wires are removed as soon as complete correction is achieved.

**Results**

The medical records of foals admitted to the equine clinic of the Faculty of Veterinary Medicine, Ghent University between January 2008 and December 2018 were reviewed and 20 cases of brachygnathia were identified. The group comprised of 15 Warmbloods, 3 Quarters, 1 Arab and 1 Miniature horse. These last two were diagnosed with maxillary brachygnathia. All others presented mandibular brachygnathia. Female animals (14/20) were overrepresented in this group. Their mean age was 146,4 (± 50,5) days, ranging from 59 to 264 days. Mean occlusion difference between mandibular and maxillary teeth was 16,1mm (± 7,5mm) with a range of 3 to 25 mm. Wire failure during the treatment period was the most frequently recorded complication (9/20). Other complications included facial nerve paralysis (1) and development of a cheek abscess (1). The wire construction was removed after a mean period of 6,4 (± 3) days. At that time, perfect correction of the brachygnathia problem was only achieved in 8/20 foals. The advanced age of the animals and the absence of any expected further improvement was the main reason for removal of the construction in animals that failed to correct. More details and long-term follow up will be presented during the lecture.

**References**

Is EOTRH more prevalent in the Icelandic breed compared to Warmblood horses?

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Introduction

Clinical1, radiographical2-3 and histopathological4-5 features of equine odontoclastic tooth resorption and hypercementosis have been well described, demonstrating its progressive and destructive characteristics mainly affecting incisors and canines in the equine population. Clinical symptoms more often only appear in the later, advanced stages of the disease. No other solution than extraction of involved teeth is currently the treatment of choice6. Science has not yet been able to elucidate its etiopathogenesis although several hypothesis have been proposed. Prevalence of the disease increases with increasing age and male animals seem to be more affected than female. In most EOTRH studies Thoroughbreds and Warmbloods were overrepresented although a recent study showed also pony breeds to be susceptible for developing the disease5. Feedback from several veterinarians referring dental cases to one of the authors, led to the perception that the disease was more widespread in Icelandic horses compared to other horse breeds. The purpose of this epidemiologic study was to investigate the hypothesis that the prevalence of EOTRH in Icelandic horses is higher compared to Warmblood horses.

Material and methods

Several horse owners / riding schools were contacted for their cooperation in the epidemiologic study. No selection criteria except for traveling time were used for inclusion in the study. Recruitment stopped when two comparable (Icelandic horse, Warmblood) horse populations were examined. A clinical examination of the incisor and canine tooth region was performed by two trained persons (LV and EP) in the not sedated animal. Health information related to these teeth and their surrounding tissues was recorded on custom-made dental record sheets. Clinical symptoms associated with EOTRH included gingival hyperplasia or recession, fistulous tracts, bulbous enlargement of dental structures, tooth mobility and tooth fractures. The presence/absence of a combination of symptoms allowed determining the presumptive diagnosis of EOTRH. Farm management was recorded for each of the horses with respect to feeding and pasture turnout. Preliminary univariate statistical analysis of recorded data was performed in SPSS 25.0 with a significance level set at 0.5.
Results

A total of 236 Warmblood and 221 Icelandic horses spread over 17 horse farms were clinically screened for the presence of clinical symptoms associated with EOTRH in the incisor region. The mean age was not significantly different between both horse populations (p = 0.578). Icelandic horses were diagnosed with EOTRH in 13.1% of cases compared to 4.7% in Warmbloods (p<0.001). Based on clinical appearance of the incisor arcade, a further 10.7% of the Icelandic horses were suspected of EOTRH compared to 3.8% in Warmbloods (p<0.001). The vast majority of these cases had not been diagnosed earlier despite dental care provided by a veterinarian or lay dental technician. The mean age (22.49 ± 6.03 y) of EOTRH diagnosed cases was significantly higher than in EOTRH negative horses (11.68 ± 5.93 y) (p<0.001). Although EOTRH was more often diagnosed in male horses (29/40) compared to mares (11/40), this was not significantly different (p=0.24).

Preliminary univariate statistical analysis showed that administering grass silage was associated with a higher incidence of EOTRH, as well as exclusive pasture turnout as housing management.

Conclusions

It was carefully concluded that the Icelandic horse seems more prone to develop EOTRH compared to Warmbloods. Multivariable analysis of the epidemiological data will allow to draw more objective conclusions regarding possible risk factors for the development of EOTRH. An important limitation of this study is that diagnosis is based on clinical symptoms only and not supported by radiography and/or histology.

References

Life after EOTRH – Follow up on clinical cases after complete maxillary and mandibular incisor extractions

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Introduction

Equine odontoclastic tooth resorption and hypercementosis (EOTRH) has been a recognised equine dental disease for over 10 years now. Initially it was defined based on the clinical and radiological appearance (Barrat et al 2007). Subsequent investigation and studies resulted in the disease being defined based on histopathological features (Staszyk et al 2008). Tooth resorption as a disease has also been described as a disease in cats, dogs and humans. Hypercementosis is a unique feature of the disease in equines.

EOTRH mostly affects incisors and canines, but there have been studies describing the disease in cheek teeth (Moore et al 2016). Historically, this disease has been around for much longer, but was not recognised as a separate disease, often being thought to be age related changes, or incorrectly diagnosed as purely periodontal disease of the incisors. The disease presents clinically with incisor periodontal disease, gingival abscesses with draining tracts. It is characterised by intra-alveolar resorption and cemental deposition resulting in bulbous apical enlargement, which is evident radiographically. Resorptive lesions affect the cementum, enamel and dentine, and is accompanied by inflammatory cell infiltration.

This disease is very painful and conservative treatment has been shown to be unsuccessful. In milder to moderate cases, the worst affected teeth can be extracted and the remaining teeth monitored clinically and radiographically. In severe cases, with extensive resorption, draining tracts and secondary infection, extraction of all the maxillary and mandibular incisors are recommended (Earley and Rawlinson, 2013). The aim of this study was to follow up on cases that have had all their incisors extracted to determine if this treatment was perceived to be successful to owners.

Materials and methods

A small retrospective study was performed on equine patients that presented with EOTRH in an equine dental referral clinic in the UK. Only horses that had all their incisors extracted were followed up telephonically to determine if the treatment was successful and if the owners felt that the treatment had benefited their horses. Owners were asked about the presence of clinical signs before treatment, how the horses were coping with eating and their overall satisfaction of the procedure.

Results

A total of 16 horses were followed up that presented over a 12 month period that had complete maxillary and mandibular incisor extractions. The age range of horses was 18 – 28 years with a mean of 23 years. 11/17 (65%) of the horses presented with clinical signs varying from bridle issues, head shaking and rearing. Only 2 out of the 11 horses with clinical signs felt there was no difference. Horse owners perceived that 4 out of 5 horses with no clinical signs at the time of treatment, were better in their behaviour/ demeanour post-treatment.

Discussion

EOTRH is a painful equine dental disease, which is often difficult for the owners to recognise. The prospect of horses having a procedure involving extracting all the incisors, is very daunting and owners often require consultation on the pros and cons of performing this invasive procedure. In particular, the immediate post-operative care is often more stressful for the owners then the horses. However, the limited study has demonstrated that overall, once the procedure is complete, the majority of owners recognised an improvement in their horses general well being.

References


Introduction

Developmental tooth displacement is a well-known dental pathology and can be an indication for tooth extraction. The clinical presentation of the affected horses may vary and can range from no signs at all to acute and severe complaints like swelling or nasal discharge. Furthermore, not all displaced teeth will be clinically visible due to possible retention and some forms of displacement may also be accompanied by a deformation of the tooth. By means of the following two cases and a literature review, the authors will discuss the different clinical presentations, and the possible etiologies and treatments.

Case presentation

Case 1

An 11 year old German riding pony gelding was presented in the clinic because of foetor ex ore since six months. The oral examination revealed periodontal disease with a fistulous tract palatal to Triadan 206. Using a metal probe, a tooth-like structure was identified within the hard palate. Furthermore, only 2 premolars could be identified in the second quadrant. X-rays and a computer tomographic examination revealed a dental structure in the hard palate, emerging from and attached to the 206, with roots extending into the ventral nasal passage and the nasal septum. The 206 and adhering dental structure were extracted after locally resecting the palatal tissue and intraoral fragmentation under general anesthesia. After extraction there was an oronasal fistula present, and the surgical area was sealed with a large silicone plug. The fistula showed progressive healing and had completely filled with granulation tissue at two weeks post-operatively. The defect in the palate and the alveolus of 206 had healed completely by two months post-operatively.

Case 2

The second case was a six year old Hanoverian gelding, presented with complaints of evasive behavior when right sided pressure was applied on the bit. The clinical examination revealed only two incisors in the 4th quadrant and a mildly dislocated 404. The x-rays showed that the 402 and 403 were in position, but that the 401 was severely dislocated underneath the gingiva, pushing up against the 404. After local anesthesia of the area, the dislocated incisor was extracted through an incision in the overlying gingiva in the standing, sedated horse. The defect was closed with a gauze impregnated with honey ointment, which was changed twice weekly. The surgical area had healed completely by 6 weeks post-operatively and the owner reported no further problems with the bit.

Discussion and overview of literature

The described cases represent atypical presentations of displaced teeth. Check teeth displacements are more common in older equids, and usually occur in a buccolingual or buccopalatal plane (Dixon et al., 1999b, Du Toit et al., 2009; Easley et al., 2011). However, a few authors have described non-erupted, horizontally displaced cheek teeth (Becker, 1962; Edwards, 1993). Typically, tooth displacements are secondary to other dental disorders or due to crowding. Other etiologies may be intrinsic developmental issues, maleruption and external trauma (Easley et al., 2011; Earley et al., 2013). In case 1, the cheek tooth was not only retained and displaced, but also deformed and attached to the 206. This may represent the displaced and deformed 207. The complete structure could possibly be an odontoma or a connate tooth, which is a tooth composed of two or more elements possibly from fusing of multiple tooth germs (Easley et al., 2011, van Delft et al., 2017). In respect to the prevalence of tooth displacements, 23 horses of 349 cases with check
teeth disorders and 3 of 42 cases with incisor disorders had tooth displacements (Dixon et al., 1999a+b). Anthony et al. (2010) reported malpositioning in 1.3% of all investigated horses. The fact that the teeth in both of the cases were retained, stresses the importance of imaging. Treatment of displaced teeth by extraction is indicated when there are clinical complaints related to the displacement itself or if secondary problems like periodontal disease occur (Dixon et al., 1999a+b; Easley et al., 2011).

References

Coronectomy as a treatment option for horses with canine tooth resorption

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Introduction

Equine odontoclastic tooth resorption and hypercementosis (EOTRH) is now a well documented painful disease in aged horses. This disease affects mostly incisors and in some cases canines may be involved as well. A recent radiological study found 94% of horses over 10 years of age had at least mild radiographic changes consistent with EOTRH and 62% had moderate to severe changes. In some cases, equine patients may present with canine resorption without obvious or severe incisor pathology. Resorption affecting the canines is believed to be the same disease process as EOTRH with minimal or no hypercementosis.

Feline tooth resorption is a severely painful disease that affects cats. Feline tooth resorption can be classed as type I or type II lesions. Type I lesions are inflammatory in nature and start at the neck region of the tooth with severe painful gingivitis with the periodontal ligament remaining intact. Complete extraction of teeth affected with type I resorption is the treatment of choice. Type II resorption is non-inflammatory and starts at the level of the cementum below the neck region and results in destruction of the periodontal ligament such that there is no periodontal ligament visible radiographically. In these type II cases, crown amputation is regarded as a feasible treatment for the disease.

It is well accepted that extraction of the affected teeth is the best treatment for EOTRH, but canine extractions can be difficult especially when they are diseased and have root resorption. Crown amputation may be considered a suitable treatment for treating canine tooth resorption in equines as an alternative to extraction. This paper reviews the evaluation and treatment of cases presented to a UK based referral equine dental clinic with canine resorption (with or without incisor EOTRH).

Materials and methods

A retrospective clinical study was performed on data from dental cases referred to a specialist dental clinic. All cases identified with any degree of canine tooth resorption, with or without EOTRH diagnosed in the incisors were included in this study. Based on the radiographic appearance, resorption was classified as external or internal, and the presence of radiographic changes, consistent with EOTRH, in the incisors were noted. Treatment consisted of conservative management (monitoring), complete canine extraction, or canine crown amputation as described in cats with type 2 tooth resorption. Crown amputation consisted of using a water cooled high speed fissure and round carbide burr to remove all the dental tissue to just below the alveolar bone margin. A lateral alveolectomy was the extraction technique of choice for extraction of the canines.

Results

Out of 37 cases with some canine abnormality noted on dental clinical exam, 17 cases were classed as having canine tooth resorption. The ages ranged from 9 – 27 with a median age of 19 years (mean 17.7 years). Only 2 out of the 17 horses were mares with the remaining 15 being geldings. There were 5 cases that had clinical EOTRH of the incisors that required treatment. Out of the canines affected, 12 cases involved only the mandibular canines, two mandibular and maxillary canines, and three cases involving only the maxillary canines. Treatment consisted of the following: no treatment (monitor) – 5 horses; burring and restoration of crown lesion – 1 horse; extraction – 4 horses; coronectomy – 7 horses. Of the cases that had coronectomy only two required repeat treatment with further crown reduction required such that the gingiva would heal over the amputated crown. Short term post-treatment follow up revealed all the cases have resolved and no significant clinical signs were noted apart from mild gingivitis in two cases.

Discussion

This retrospective study has shown that in some cases equine canines may have tooth resorption without clinical signs of EOTRH affecting the incisors. Canines appear to have a more resorptive type lesion and hypercementosis does not appear to be as marked in the canines. In light of a recent study, highlighting the high prevalence of EOTRH radiographic changes in horses older than 10 years of age, it seems likely that many of these cases would have had mild...
radiographic changes consistent with EOTRH involving the incisors. Usually, the disease starts with the corner incisors and progresses towards the central incisors, and canine involvement is related to the severity of the disease process in the corner incisors. However, only 5 cases had clinically significant changes in the incisors that required treatment.

One case presented with mild external resorption mostly affecting the erupted crown and only marginal resorption within the alveolar bone. This case was treated conservatively by restoration and burring to prevent food packing and calculus accumulation that could potentially accelerated the gingivitis. Five milder cases required no treatment and continued monitoring was recommended. This is similar to the management approach of incisors with mild EOTRH.

In four cases with draining tracts and apical abscessation, canine extraction was performed. In some select cases with severe resorption and loss of periodontal ligament definition, coronectomy was determined to be a viable option and thus far have had good success with no further treatment required on short term follow up.

**Conclusion**

Gingivitis associated with the canines and excessive calculus accumulation should be carefully evaluated for canine tooth resorption, especially in older horses. All horses presenting with incisor EOTRH, particularly affecting the mandibular incisors should also have the canines carefully evaluated for possible canine resorption. In cases with severe reserve crown resorption and loss of periodontal ligament on radiographic appearance, coronectomy may be a viable treatment option. Appropriate case selection is essential for coronectomy to be successful and more long term follow ups are required to determine if this treatment is successful.


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### Bit-induced lesions in the equine mouth: prevalence and association with the bit

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### Introduction

A bit is a mean to communicate with the horse, but the wrong choice of bit can have severe consequences for the horse.¹⁻⁸ Studies⁹⁻¹³ have been performed to examine the position of the bit in the oral cavity, but there is still a need to understand the topographic relationship between the bit and the soft tissues of the oral cavity to enable a better understanding of the etiology of bit-induced lesions.

The first objective of this study was to determine the prevalence and provide an overview of bit-induced lesions. Furthermore, a prospective study was performed to examine a possible association between the presence of bit-lesions and the type or size of bit. The second objective was to examine the influence of bit-type, bit-size, rein tension and angle of the reins on the intra-oral movement of the bit.

### Material and methods

The prevalence of bit-induced lesions was examined by performing a retrospective analysis of dental charts (n=3339).

Mouth examinations were performed on horses (within a timeframe of a maximum of 3 days following ridden exercise) to examine the presence of bit-induced lesions. Bit-types included in this study were single/double jointed, eggbut/ring snaffles or a curb bit.
The lateral and caudal movement of different bit types and bit sizes was measured on cadaver heads. These measurements were performed with unilateral and bilateral rein tension (1, 2 and 4 kg) and with the reins in an angle of 20° and 70°.

Results

Bit lesions were recorded in a total of 453 horses (13.57%). Lesions were observed at the inside of the commissure of the lips (37.16%), the corner of the commissures (15.91%), at the mesial gingival tissues of the mandibular 06’s (15.91%), at the lateral side of the commissure of the lips (12.21%), at the bars (11.93%), at the bars before the mandibular 06’s (3.71%) and at the tongue (3.16%).

Mouth examinations were performed on 121 horses. In this population, 57.85% of the horses showed lesions in the mouth. A higher frequency of lesions was observed in horses ridden with a bit that was considered too wide (p < 0.01). Some bit-specific lesions were identified.

The cadaveric study showed that the position of the bit was influenced by bit size, rein tension and the angle of the reins.

Conclusion

The overall prevalence of bit-induced lesions observed in this study population is 37.16 - 57.85%. It is demonstrated that a bit that is fitted too wide is associated with a higher occurrence of bit-induced lesions. Proper adjustment of the bit could possibly reduce the number of lesions in the mouth. There are indications that some bit-types have a higher risk for inducing specific lesions.

It was shown that the position of the bit in relation to relevant structures in the horse’s mouth was influenced by bit type, bit size, rein tension and the angle of the reins. It was concluded that these factors might influence the incidence of bit-induced lesions.

References

Introduction

Endodontics is the study and treatment of the live pulp, the root canal, common pulp chambers, pulp horns, and periradicular tissues. The goal of endodontic treatment is tooth preservation. There are many factors to consider when deciding whether to provide endodontic therapy or not. We will discuss many practical implications and contraindications to endodontic therapy in the horse.

The two main endodontic treatments that should be discussed in relation to equine dentition are vital pulp therapy and root canal therapy. Vital pulp therapy (VPT) treats damaged or exposed vital pulp in an effort to preserve tooth vitality. Root canal therapy (RCT) involves complete removal of non-vital pulp with complete obturation and restoration of the tooth. Equine tooth anatomy is different from several other species which RCT and VPT are performed, presenting unique challenges to applying these techniques in the horse. The biomechanics and functionality of the horse’s tooth also differs from the other species. These differences have to be considered when performing endodontic treatments. The incisor and canine teeth in the horse are the teeth that are most likely good candidates for endodontic therapies, since they have a one pulp chamber extending into a root canal.

Vital pulp therapy

Vital pulp therapy is a treatment utilized when the vital pulp has been exposed in a tooth either iatrogenically, via a fracture or excessive abrasion of the tooth. With acute exposure, the pulp is still vital and most likely bleeding. If identified and treated in the acute phase, VPT may be a viable treatment for the tooth. The steps in a VPT are 1) access to the chamber, 2) removal of 5-10mm of the diseased pulp, 3) placement of a pulp dressing, 4) an intermediate layer of restorative, and 5) placement of a final restoration of composite. We do not actually know the window of time that a VPT will be successful in horses. In brachydont teeth we generally follow a 48 hour window. The author has performed VPT on canine teeth of the horse at 5 days post exposure and still had success. Some research has shown histological differences in hypsodont pulp showing an expanded cell rich zone and a lack of a cell poor zone that may make hypsodont teeth more resilient to insult and possibly more regenerative or reparative than typical brachydont teeth. The remaining blood supply to the pulp and the amount of inflammation present are the unknowns that affect the success. Radiographs must be obtained initially and postoperatively so that on recheck you can evaluate the width of the chamber and the presence of dental bridge forming at the pulp dressing and live pulp interface. The apex of the tooth must always be included in the image to evaluate periradicular changes. The pulp chamber in a successful outcome should be narrowing at the same or greater rate than a tooth of the same age in the horse’s mouth, indicating vitality of the tooth.

Root canal therapy

Root canal treatment involves the complete removal of the pulp tissue. The steps in a root canal are 1) Access to the pulp chamber, 2) Debridement and removal of the remaining pulp tissue, 3) Disinfection of the chamber and canal, 4) Obturation of the canal, 5) Intermediate layer placement, 6) Placement of the final restoration. Radiographs need to be obtained at the beginning, during the first file placement to determine working length, after obturation to check for voids, and after the final restoration. The most important parts of the process are the apical seal and final restoration. In rechecks we are concerned with changes happening in the periradicular tissues such as lucency formation and inflammatory root resorption. If a periapical lucency was present at the time of the procedure it can take up to 18 months to resolve. As long as you can
prove it is resolving we do not consider the RCT a failure. Radiographs are important at 6 month intervals for investigating the success of the treatment.

**Special considerations in the horse**

We must remember that the incisor tooth of the horse is constantly undergoing attrition, so this will affect the final restoration and potentially obturation material choices made. If you are going to obturate with materials that require a composite final restoration, the final restoration needs to be deep enough so that the horse does not readily wear through the restoration exposing the obturating material. The author will often perform the RCT in 2 stages. First stage will be obturated with calcium hydroxide paste with a composite temporary restoration. This is done to further sterilize and treat the canal in cases where there is concern of getting the canal clean in the first procedure. Calcium hydroxide paste has a high pH, is friendly to the periapical tissues, and is easy to place in the canal and to remove at the second stage. In the second or future stages the canal can often then be obturated with composite as a one-step procedure. This fills the entire endodontic canal with a chemical cured composite, negating the concern of wearing through the final restoration. This can only be successful if the canal is well debrided and sterilized. The other advantage to this technique is the tooth has a solid core of composite that can add strength. The best case scenario for assuring a successful outcome is to place a small amount of calcium hydroxide paste at the apex of the tooth then obturate the rest of the tooth with composite. This leaves a medicated dressing at the apex to treat the periradicular tissues while restoring the rest of the tooth.

Of all equine teeth, the canine teeth are most like a brachydont tooth. They do not occlude with other teeth therefore they do not undergo attrition. The canine teeth in the horse also have a finite eruption time. They do not continually erupt like the other teeth of the horse. These teeth can have endodontic treatment similar to the brachydont teeth. Since attrition is not a concern the final restoration is not a concern as discussed for incisor teeth. The obturating materials can also be similar to what is used in other species.

Tooth resorption of any kind is a contraindication to endodontic treatment. If tooth resorption is noted on the preoperative radiograph the author would strongly advise against an endodontic treatment. In the authors experience, teeth of middle-aged horses with tooth resorption that have had endodontic treatment either vital pulp therapy or root canal treatment end up in having an extraction within 36 months. The author therefore does not perform endodontic treatment on teeth known to have preexisting tooth resorption.

**Conclusion**

The incisor and canine teeth can be good candidates for endodontic treatment. One must be diligent in the diagnostic workup. There are some differences in the techniques utilized in the horse. The steps of the procedure, the follow-up, and rechecks are the same as what would be recommended in other species.

**Further reading**

Introduction

Endodontic treatments of cheek teeth in the horse are challenging due to the anatomy and function of these teeth. The equine cheek tooth has a short root canal, a common pulp chamber that often segregates with age, and long pulp horns that extend to the chewing surface. These anatomical features increase the difficulty in performing endodontic treatment of these teeth. In the brachydont tooth the common pulp chamber is located above the gum line, allowing direct access with a bur into the common chamber. The common chamber then provides access with files into the root canal of the tooth. In the horse we are accessing the pulp horns at the chewing surface and trying to place files that will extend the length of the pulp horns to the common chamber that is situated at the base of the reserve crown. This makes access to the root canal often by chance as we must first feed the files the length of the pulp horn then through the common chamber and then into the root canal. This is also complicated by the fact that the common chamber often segregates with age in the horse and the root canals can bifurcate especially in the palatal root of the maxillary teeth. The clinical signs of endodontic disease in the horse often go unnoticed by clients. The horse often continues to eat without demonstrating significant signs of discomfort. There are cases where bony swelling occurs and the horses may be febrile but these cases are infrequent. The horse may present with a nasal discharge due to secondary sinusitis in the cases of maxillary cheek teeth involvement in the 08-11 teeth. In mandibular teeth there is often an enlargement of the mandible and possible a draining tract. When questioned, the owner often reports that the horse had an episode that was treated with antibiotics and now there is a persistent draining tract present. Endodontic disease is most often found on a routine oral examination where there is pulp horn exposure noted with feed impaction.

Materials and methods

Selection of cases for endodontic treatment is extremely important. One must fully acquire the proper diagnostics in order to provide an appropriate treatment plan. This most often includes radiography, but in some cases should include Computed Tomography (CT). If the affected tooth has more than one disease process it would be advisable to refrain from endodontic treatment as the success rate will be lower. Examples would be teeth with endodontic disease and concurrent periodontal disease, and or tooth resorption. The reasoning behind this is that it is not good science to treat a tooth for endodontic disease and have the tooth go on to fail for other reasons.

Endodontic treatment of cheek in the horse of yet is not a perfected treatment and is expected to carry a higher failure rate than in other species. This is most likely a combination of the complex anatomical features of equine cheek teeth that complicate the debridement and sterilization of the endodontic system of the tooth. The other issue that we encounter is the inability to obtain imaging during the procedure to ensure that an appropriate obturation of the endodontic system has been accomplished. A CT study is the only way of fully imaging these cases to ensure a proper obturation has been performed. To combat this issue the process is often performed in stages utilizing mendicants in the canal to chemically sterilize the canal. In certain cases, the canal may always have materials left in the root canal, common chamber and pulp horns that is friendly to the apex of the tooth to combat the challenges of obturating the endodontic system fully.

The process of performing an endodontic treatment of the tooth has been described in three primary ways. Two of these are retrograde procedures and one is an orthograde procedure. The first retrograde procedure is performed by surgically exposing the apex of the tooth and performing an apicoectomy at the level of the common pulp chamber, removing the diseased material from the pulp horns, disinfecting the endodontic system and then performing a retrograde obturation of the pulp horns. The tooth may also need
to have the occlusal surface restored with composites in the cases where exposed pulp horns are noted orally. If the occlusal surface is not restored to a significant depth the horse will expose the obturating material with normal attrition and cause failure of the procedure. The second retrograde process that has been utilized is to extract the affected tooth and then perform the apicoectomy at the common chamber ex vivo. The endodontic system is debrided, sterilized and obturated and the tooth is reimplanted in the alveolus. The concerns of the having the occlusal surface being restored are treated by the tooth having the majority of the pulp horns filled with a composite material. The apex is treated with a material that is friendly to the apical tissues such as Mineral Trioxide Aggregate (MTA) or a calcium hydroxide product. The orthograde procedure is performed intraorally as a crown down procedure. This is done by accessing the endodontic system through the pulp horns on the occlusal surface. This is often done through a pulp horn that is already exposed orally. These teeth are instrumented and sterilized in the conventional manner utilizing long H files, K files or reamers. A variation to the currently described technique utilizes a modified approach where it is assumed that the endodontic system will not be fully cleaned with the orthograde approach. The modification utilizes calcium hydroxide to medicate the endodontic system, with the high pH of this material expected to effectively sterilize the endodontic canals of the tooth. The calcium hydroxide is placed in the prepared endodontic canals, and covered with an intermediate layer and a temporary restoration of a resin based product. This procedure is repeated in 2-3 months and again as needed depending on the progress of the patient. If all pulp horns are exposed it is an easy decision to instrument all pulp horns. The challenge is when the tooth has segregated the common chamber and certain pulp horns are non-vital and certain pulp horns remain vital. This poses a diagnostic challenge to decide whether to open the non-exposed pulp horns or leave them and only treat the exposed and non-vital portion of the tooth. Exposing a vital pulp horn that is bleeding then creates the need to perform a vital pulp capping further adding to the treatment plan.

Results/Discussion

The goal of all of these procedures is to retain the tooth in the dental quadrant and minimize the discomfort of the inflammatory condition of endodontic disease. One must perform regular rechecks to assess the progress of the patient. Secondary conditions may take time to heal, such as draining tracts, secondary sinusitis, and oral nasal fistulas. Some of these secondary conditions can require further treatment to correct these conditions. Client communication and client demands can be tedious with endodontic treatments. The client can often be initially on board with endodontic treatment, but become frustrated with repeated treatments and expenses that can often cost more than an extraction process. In our practice environment clients are often only concerned with the overall cost and will be resistant to endodontic treatment due to the repeated treatments that are involved.

Recheck imaging should be evaluating the treated tooth for evidence of a resolving periapical lucency, tooth resorption, and resolution of secondary conditions. The treatment will result in the horse having an improvement of clinical signs as reported by the owner. This can result in the owner getting a sense a false security and not being proactive with rechecks. You must get these horses back for rechecks and repeat treatments. We have to remember that the tooth is now non vital or at least a portion is non vital and now has no sensory input from the pulp. This means that the horse will use this tooth without any self-preservation from spinal reflexes. These teeth must be watched closely for evidence of fracture lines and lesions on the occlusal surface indicating stress of the clinical crown. These teeth may even benefit from being slightly reduced to remove mastication forces. The client must understand that once an endodontic treatment has been performed there is always a chance of failure and the need for further treatment of the tooth or possibly eventual extraction of the tooth. That said, with the success demonstrated by many veterinary dentists the option for endodontic treatment should always be discussed with the client for teeth that are good candidates.

Conclusion

Endodontic treatment of cheek teeth in horses is still not a perfected straight forward treatment. A strict protocol of diagnostics must be performed to be sure the tooth is not affected by another concurrent disease process and if so the tooth may be better extracted. The biggest challenge often is getting clients to understand that this is not a one and done procedure and the tooth must be closely followed for the rest of the life of the tooth. This however does not mean that the option for endodontic treatment should not be offered to
clients with horses with endodontic disease that are good candidates.

Further reading


How to perform a safe maxillary dental nerve block and how to deal with complications

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Analgesia of the maxillary nerve – the second branch of the trigeminal nerve – is considered an essential tool for performing many potentially painful procedures on the ipsilateral hemimaxilla in the standing, sedated horse. Nonetheless, before applying maxillary nerve analgesia, the clinician should carefully evaluate the necessity of performing such, in order to avoid potentially hazardous situations and short or long-term complications.

Preparation and prerequisites

The clinicien must understand the intricate and delicate anatomy and the potential adverse effects. Profound knowledge of the anatomical landmarks and the maxillary nerve block technique is essential in order to position and orientate the needle. The maxillary nerve runs deeply in the pterygopalatine fossa, from the foramen rotundum to the maxillary foramen, here it enters as the infraorbital nerve. The close proximity to the eye, meninges and brain is evident. An aseptic technique is mandatory for perineural regional analgesia of the maxillary nerve; this includes clipping of a wide area, a full surgical skin preparation, and wearing sterile surgical gloves.

A nose twitch and/or chemical restraint (e.g. Xylazine, Detomidine & Butorphanol) can help to reduce the danger of sudden defensive reactions of the horse, which may jerk the head or kick with the front limbs, causing failure of the procedure or injury to itself or the manipulators. Violent head jerks or even collapse of the animal due to contact of the needle tip with the nerve have been reported. Inadvertent injection of the local anesthetic solution into a blood vessel has been mentioned to cause severe neurological signs and breakdown and should be anticipated. Performing the nerve block whilst the horse is confined in a stock may therefore not be advisable. The staff must be positioned in a manner to be protected from harm.
Approaches

Different needle approaches have been described to target the maxillary nerve bundle.

A perpendicular or lateral (lateral-medial) approach has first been described by Bemis in 1917 and has been refined as the „maxillary foramen block“ (Vlaminck 2001, Fletcher 2004): A 6-7.5cm long needle is positioned directly ventral to the zygomatic process of the malar bone, level with the lateral canthus of the eye, orientated perpendicular to the skin surface and inserted and advanced until close proximity to the maxillary nerve.

A frequent alternative route for needle directory is from slightly more caudal in a 60° rostromedial trajectory – also known as the caudolateral or oblique lateral approach (Newton 2000, Tremaine 2007, Roberts 2012). For this, a slightly longer needle (7-10cm) needs to be used.

Both, lateral and caudal, approaches aim at the V2 nerve bundle from ventral of the zygomatic arc underneath the orbit, carefully avoiding the transverse facial artery and vein which lie ventral alongside this bony brim in the subcutaneous tissue. These two approaches have been investigated to be of equal accuracy (Bardell 2010). In addition to these two most common approaches, a less frequently mentioned, retrobulbar or dorsal approach has been described. A 10cm long needle is inserted from dorsocaudally through the retrobulbar space (Stephenson 2004, Klugh 2011).

For the perpendicular approach, it has been suggested that reducing needle advancement to just beyond the inner fascia of the masseter muscle would reduce risks of adverse effects, in avoiding deeper vital structures, providing good analgesia. This technique is referred to as the „extraperiorbital fat body insertion“ (Staszyk 2008) and is widely used today.

Ultrasonography can be used to guide needle placement and instillation of local anesthetic solution perineurally in real-time. It has been stated to significantly improve accuracy and to reduce complications. On the other hand, it is more time consuming and needs handling experience and expensive specialised equipment (O’Neill 2013, Nottrott 2014).

The most frequent complications and how to avoid resp. deal with them

Probably the most frequent, immediate and obvious adverse effect is the formation of a „retrobulbar“ hematoma:

In case hemorrhage occurs, the horse’s head should be lifted high instantly to minimise extravasation of blood. Cold can be applied to the head to enhance vessel constriction. A hematoma in the pterygopalatine and orbital region can push the extraorbital fat body in a retrobulbar direction, compress any of the approximate nerves and may lead to related clinical signs. Blepharospasm, ptosis, mydriasis, miosis, or even, in case of severe optic nerve compression, (transient) blindness have been observed. Proptosis may occur due to a retrobulbar space-occupying hemorrhage or inadvertent anaesthesia of the oculomotor muscles.

With an aseptic technique it is unnecessary to administer antimicrobials, but non-steroidal anti-inflammatory drugs may improve comfort of the animal and help resolve the clinical signs more quickly, which is usually within two days. Other side effects may consist of superficial corneal ulcers, or uveitis; symptomatic and topical antimicrobial treatment may be indicated. To minimise these risks the use of a low dose lidocaine (2ml/100kg bodyweight 2% solution) has been advised (Rieder 2016).

Infectious complications caused by contamination during injection should be addressed immediately with consequent systemic antimicrobial medication.

Subcutaneous hematoma formation from the transverse facial artery can simply be prevented by avoiding its puncture and by applying pressure on the skin area directly after the needle has been retracted.

Dehydration of the cornea may be due to reduced lacrimation and may be alleviated by the use of topical ophthalmitic ointments, this may prevent superficial corneal ulceration (Klugh 2011, Rieder 2016).

Before injecting the local anesthetic solution, needle aspiration must be performed. Erroneous injection in a vessel close to the central nervous system could lead to fulminante collapse of the animal.

Peripheral nerve injury may arise from direct laceration, compartmental compression, hypoperfusion and exposure to neurotoxic anesthetic solution. Subsequently, temporary or permanent neuropathies may ensue. Although maxillary nerve neuropathy has so far not been attributed to nerve blockage, the association between iatrogenic neuropathy and peripheral nerve blockage has been stated in human and veterinary medicine (Hogan 2008, Whitlock 2010). Whether intraneural injections are of long-term consequences to the patient
is still controversial. Needles with 45° short bevel angles produce less frequent fascicular damage than needles with 14° long bevels (Selander 1977, Macias 2000).

Practically, failure to desensitise the ipsilateral maxilla can be considered a complication. In this case, the needle insertion may be repeated, preferentially and if possible at a later time point, or alternatively, a deep infraobital nerve analgesia can be attempted. In refractory cases general anesthesia could become inevitable.

Conclusion

Successful administration of maxillary analgesia demands specific knowledge of, firstly, regional head anatomy of the horse, and secondly, potential sources of failure. Good ambient control is vital. This is preferentially achieved in a hospital environment. Mild complications are encountered frequently, but are for the vast majority reversible and of little long-term clinical importance. Severe complications are fortunately very rare. Regular performance of the nerve block improves outcome. A good multimodal analgesic strategy is beneficial and can obviate the need for the maxillary nerve block in some cases.

Different therapeutic approaches for periodontal disease

Introduction

Periodontal disease is caused by a big variety of predisposing factors. Clinical findings are very different depending on the cause and the severity of the problem. So treatment has to be adjusted to the individual situation.

Cleaning

One of the most important parts is cleaning the interproximal space. This sounds easier than it is done. Food is compressed into small spaces with high chewing pressure. High pressure water and air in combination with small dental probes are used to remove the material. One should recognize that the food material is highly contaminated with bacteria. With the cleaning process the germs will be spread into the blood and into the air with the produced mist. Antibiotic treatment of the horse and a mask for the dentist should be considered. High pressure air also in combination with sodium bicarbonate powder blasting can be very helpful in cleaning but should be used with caution because of the risk to push bacteria deep into the tissue and the risk of inducing subgingival or subcutaneous emphysema. The powder blasting provides mild debridement. Some cases need widening of the interdental space with a burr to have a chance to clean interproximal food impressions. Because periodontal disease is a very painful situation local anesthesia or nerve blocks should be considered for cleaning and treatment.

Treatment options

Deep periodontal pockets with interproximal bone loss

Deep periodontal pockets are usually seen with interdental bone loss. So the goal is to use a treatment that allows growing of interproximal bone. There are some treatments available that introduce bone regeneration: Bone chips, different absorbable bone cements.

Other temporary inlays into the subgingival pockets have to be redone frequently: Pastes containing antibiotics, calcium hydroxide or chlorhexidine. They have to been covered with a stenting material to prevent flushing out. Periodontal dressing material can be used for stenting the interproximal space to protect the
tissue underneath temporary.

If deep subgingival pockets are filled with non-absorbable material like composite or acrylat this doesn’t allow bone regeneration but can avoid food contamination into the pocket. This can be an option for old horses where no or only minimal regeneration can be expected.

**Diastemata above gingival line**

- Diastema widening is a treatment that is well documented (Paddy Dixon et al.) Widening the space especially in valve diastemata allows food to move out the space during the chewing cycle. Drilling has to be done very careful to stay in the direction of the interdental space and water cooling is recommended to prevent exposing and thermal damage of the pulp. Because many pulp horns are positioned very close to the mesial and distal border of the tooth there is a risk to expose pulps. If one is performing this technique one should be prepared for pulp capping if necessary.

- Bridging Diastemata with composite or acrylate is another treatment option. After debridement and disinfection the diastema is air dried and filled with composite or dental acrylate material. Chemical bonding to the adjacent teeth is usually not very effective because of dental movement during the chewing cycle. So this type of filling is usually temporary and is one option to cover a subgingival treatment. To achieve a long term interproximal filling for several months it is beneficial to have some mechanical fixation of the interdental filling. The treatment with interproximal fillings conserves the occlusal surface and stabilizes adjacent teeth. The disadvantage is a higher amount of operating expenses.

All treatments of periodontal disease have to be rechecked frequently and have to be redone or adapted to the current situation. Because the severity of the disease is often high at the beginning of the therapy we recommend the first check up a few weeks after the initial treatment. With improving the situation the interval can increase up to more than 6 month. Because of interdental attrition the bridging material can get a little bit smaller and can get mobile. Therefore it has to be rechecked frequently and has to be replaced or some material has to be added to be functional again. The risk can be dislocation of bridging material with causing soft tissue damage. In humans also material intolerance has been observed.

References

How to assess the cheek teeth infundibula for cemental hypoplasia/caries

Richard Reardon

Equine maxillary cheek teeth (Triadan 06-11 in the 100 and 200 arcades) each contain two crescent-shaped enamel infoldings (the infundibula), which extend for most of the length of the crown (1). These infundibula are thought to have evolved to increase the surface area of occlusal surface enamel ridges for mastication of fibrous, cellulose-rich plant material and to compensate for the more extensive infoldings of peripheral enamel of mandibular cheek teeth.

During infundibular development the enamel is laid down by ameloblasts, cementum is later deposited on this enamel from the periphery of infundibula, proceeding centrally (2,3). Ideally cementum should be deposited in the infundibulum until it is completely filled or only a narrow (circa 1mm diameter), central, cement-free channel (“the vascular channel”) remains. The vascular channel originally contains vasculature mainly originating from the dental sac overlying the occlusal aspect of the developing tooth that nourishes the developing cementum. It has been shown that some blood supply to the infundibulum remains following dental eruption, allowing continued deposition of cementum (when the overlying occlusal dental sac is lost), by a rostral and a caudal accessory vessel which enter the periphery of each infundibulum sub-occlusally (3).

Gross evaluation of maxillary cheek teeth from cadavers has demonstrated that infundibular cemental hypoplasia is common, with one study, of 396 cheek teeth from 33 cadavers, reporting that infundibula are rarely (approximately 10%) completely filled with normal cementum (1), while another reported cemental hypoplasia in 51% of 688 cheek teeth without evidence of dental disease and 72% of 55 diseased teeth (4). Computed tomographic (CT) studies have also reported high frequencies of infundibular defects: 52% of 150 teeth evaluated in one study (5), and 90% of infundibula from 64 teeth examined in another that combined CT and gross examination (6).

Defects in infundibular cementum can be the result of: hypoplastic cementum, where there is porous and often discoloured abnormal cementum (sometimes containing food debris); cemental aplasia, where areas of the infundibulum have no cementum; or cemental caries that is generally believed to be a sequel to cemental hypoplasia (1–4,6). The mesial infundibula have been observed to be more commonly and severely affected with cemental defects than the caudal infundibula (5–7), which is hypothesised to be a consequence of more prolonged presence of the accessory vasculature to the caudal infundibula than to the rostral (3). The Triadan 09s are also more commonly affected than other Triadan positions.

Infundibular caries develops when defects in the infundibular cementum become exposed to the oral environment. This allows cariogenic bacteria and food into these defects, which leads to a local acidic environment that induces cemental caries (4,8,9). Infundibular cemental caries can progress to affect the infundibular enamel and even surrounding dentine and can lead to pulpar and thus apical infection (4,10). Infundibular caries also results in structural weakening of the tooth and sometimes coalescence of both infundibula with subsequent midline sagittal fracture formation (11,12). Equine infundibular caries is currently classified using the Honma scale as modified by Dacre (2005 (13)), based on the involvement of: cementum (grade 1), enamel (grade 2), dentine (grade 3), and loss of structural integrity of the tooth (grade 4).

A wide range (8% - 90%) of infundibular caries prevalence (1,2,4,6,7,14,15) have been reported. This wide range is likely to be the result of inconsistencies in distinguishing between the apparently normal “vascular channels”, infundibular cemental aplasia/hypoplasia and infundibular caries. The age of the surveyed populations is also important as there is clear cut increasing prevalence with age, because severe cemental aplasia and hypoplasia usually involves the more apical aspect of infundibula, areas that are not occlusally exposed by dental wear until horses are in their second decade of age.

Assessing the infundibulum for hypoplasia / caries in clinical practice can be performed in two main ways: gross occlusal clinical evaluation and computed tomography.
Occlusal evaluation

Visual: Appreciation of the normal occlusal appearance of the tooth/infundibula is essential. Careful visual evaluation of the occlusal appearance requires a bright light and mirror or preferably an oroscope and is most accurately performed with the horse sedated. The presence of defects in infundibular cement should be evaluated. Caries can be graded according to which dental tissues are involved using the modified Honma scale (described above). The presence of a small central defect “the vascular channel” is considered normal, but should be closely evaluated as in some instances they can communicate with larger apical hypoplastic / aplastic cementum lesions. Such communications can allow ingress of carious bacteria which in some cases will produce gas during fermentation, visible as bubbles emanating from the cemental defect.

Surface probing: The surface of the infundibular defects should be palpated with a pick and probed to determine depth, which in many cases will require removal of impacted feed. The extent and depth of infundibular lesions should be evaluated, to allow decision making regarding appropriate treatment. In some cases, where communication between a small defect (e.g. vascular channel) and a deeper aplastic/hypoplastic lesion filled with carious material is suspected careful debridement of the surface cement is indicated to more fully evaluate the lesion. Enlargement of the occlusal surface of an infundibulum should only be performed if subsequent placement of a restoration is intended.

Computed tomographic evaluation

It is very common to see radiolucent areas of abnormal cementum in the infundibula (see earlier), particularly at certain Triadan positions such as the 09s. It can be difficult to determine the cause of these radiolucent sites i.e. cemental aplasia, hypoplasia or caries using CT. In general, very radiolucent (gas dense) lesions apically with some cementum occlusally are likely to be cemental aplasia, lucencies that communicate with occlusal surface and/or disrupt the enamel are likely to be caries, while lesions that have dentinal involvement are always caused by caries. It is frequently not possible to ascribe a Honma grade to caries using CT. As a consequence, decision making about the need for infundibula treatment is difficult using CT alone. Although extensive infundibula radioluencies that are open or close to the occlusal surface certainly warrant occlusal evaluation. It could be argued that restoration of extensive radiolucent (hypoplastic) lesions is justified to try and minimise the likelihood of subsequent feed ingress and caries, when these areas become exposed with normal occlusal wear.

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References

Tooth dissection/ partial coronectomy for equine cheek teeth extractions

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Introduction

As the practice of equine dentistry has advanced in the last 15-20 years, so has the development of instrumentation and techniques that aid management of equine dental disease. This manuscript will discuss the use of rotary burs to aid extraction of diseased cheek teeth, including partial coronectomy and tooth sectioning techniques. Partial coronectomy\textsuperscript{1,2} has been described as a technique that involves partial removal of clinical crown of the diseased tooth to the level of the crestal bone in a manner that eliminates crown interlock. The creation of this 3-4 mm space facilitates loosening of the tooth by allowing less pressure to be applied to the clinical crown with spreaders and luxators. Tooth sectioning\textsuperscript{2,3} can facilitate extraction of teeth with minimal clinical crown, or root abnormalities such as dilacerations or malformations. Both of these techniques can provide alternatives to more invasive techniques such as tooth repulsion and invasive lateral buccotomy that may carry a higher complication rate\textsuperscript{4,6}.

Instrumentation

Rotary burs can include a variety of diastema widening burs, and double cut carbide (tile cutting-type) burs. In the author’s practice, the primary instrument utilized in partial coronectomy and tooth sectioning is the VersaFloat\textsuperscript{TM} with NSK IC 300 head fitted with a 3x52 mm double cut carbide bur (Fig. 1). The NSK IC 300 head is at a 90 degree angle there is also an NSK KC 300 head at a 45 degree angle. The VersaFloat\textsuperscript{TM} has water irrigation, which is a must for prevention of thermal injury 8–11 and improves visibility by reducing dust production. There are extended length burs available in 57 and 76 mm lengths\textsuperscript{a} (Fig. 1). Some
of the extended length burs come with shorter flutes (Fig. 1), which allows a more precise cutting surface at the greater depth. There are likely other instruments that could be adapted for partial coronectomy and tooth sectioning, but the author has limited knowledge of these.

**Indications for use of rotary burs in exodontia**

The partial coronectomy technique can be potentially beneficial in nearly all cheek tooth extractions due to the reduction in crown interlock, which facilitates more rapid loosening of the tooth. This is particularly beneficial in teeth in the middle of the dental quadrant (08-10s). Cheek teeth with non-vital pulp exposure, advanced infundibular caries, or crown fractures benefit from partial crown removal because this allows spreaders or luxators to be applied to the tooth with minimal pressure on the diseased/fragile clinical crown. Teeth that benefit from tooth sectioning may have fractured or diseased clinical crown, dilacerated roots, root malformation or dysplasia that may affect normal delivery of the tooth in one piece.

**Preparation of the patient**

- The horse is sedated and restrained in a standing stockade. Oral examination and appropriate diagnostics are made to formulate a treatment plan. Careful planning of the extraction process should always include adequate time allotment for the procedure to minimize stress on the operator. Appropriate regional anesthesia is necessary to facilitate patient compliance during tooth sectioning and partial coronectomy procedures.
- Traditional extraction methods are utilized to initiate the extraction process, including sulcular incision, gingival elevation, molar spreading, and use of extended luxators. Transition to partial coronectomy or tooth sectioning occurs when pressure applied to the clinical crown is likely to induce potential fracture or crumbling of the clinical crown. In teeth with fractured clinical crowns, or extensive tooth decay, this transition may be made early in the extraction process, often before spreaders are applied to the tooth.

**Discussion**

The techniques described here are useful for augmenting good intraoral extraction technique. While they are most helpful for extraction of decayed or fractured teeth, they can also useful for extracting non-decayed teeth with apical infections by potentially reducing surgery time and minimizing trauma and stress placed on adjacent cheek teeth. Tooth sectioning can be performed in conjunction with partial coronectomy, or as a separate technique. It is most commonly performed in mandibular teeth but can be useful for extraction of maxillary teeth as well. Sectioning of maxillary teeth is particularly helpful in older horses, as they sometimes have dilaceration or enlargement of the palatal root that inhibits delivery of the tooth with extraction forceps.
These techniques can be technically challenging to learn, and practice with cadaver specimens is recommended to gain experience prior to use in clinical patients. Keys to success include adequate sedation for the patient and appropriate regional nerve blocks, which minimize tongue or head movement which can be detrimental to the success of the procedure. Frequent intraoral examination with oroscope or mirror, combined with intraoperative radiography is also vital to guiding the successful completion of crown removal techniques. With practice, good success rates of intraoral extraction can be achieved.1

References


Association of the appearance of the frontonasal suture line with horse age

Richard J. M. Reardon, Padraig M. Dixon, Karen Chan, and Justine Kane-Smyth

Introduction: Craniofacial sutures are specialised fibrous joints that are the primary site of craniofacial bone growth and distribute the forces of the teeth during mastication (Rafferty et al 2003). In humans the facial sutures usually do not close until between the 7th and 8th decade (Rice 2008). Closure times of the equine facial sutures have not been defined and may be relevant when considering conditions affecting the suture lines such as “suturitis”.

M&M: Frontonasal suture lines were collected from cadaver specimens (n=90) at an equine abattoir in Ireland using a 79mm core drill. Horse ages were recorded from their passports. Photos of the bony specimens were collected and reviewed by two observers, blinded to horse ages who graded the gross appearance of the suture lines as visible or not visible (Figure 1). Four samples, two from each gross appearance group, were submitted for histopathology following decalcification. Ten samples (5 from each gross appearance group) underwent computed tomography (CT) evaluation, 4 in a cone beam CT (PegasoTM) and 6 in a HD CT (GETM) scanner. Samples were subdivided into five age groups: 1-5, 6-10, 11-15, 16-20 and >20. Visibility of frontonasal suture lines between age groups was reported.

Results: It was not definitively possible to identify the frontonasal suture line on histological sections or CT images for any specimen. Agreement between authors about gross visibility of suture lines differed in 7/90 cases. Frontonasal suture lines were visible in horses from 1 to 28 years old. The youngest horse in which the suture line could not be grossly identified was 4 years old. The percentage of horses with visible suture lines decreased with increasing age (Table 1).

Discussion: The histological appearance of suture lines has been demonstrated in other species (zebra fish and mice). Visualising the suture lines in the equine histological sections proved challenging, which may have been related to the complex anatomy of these structures. It was not possible to identify the suture lines
using either the cone beam or HD CT scanner with narrow slice thickness. Micro CT may allow imaging of these structures. Gross appearance is unlikely to be an accurate measure of whether a suture line is open or closed, but proved the only method that facilitated assessment in this study and is a method used for estimating age of human skeletal remains. There was reasonable agreement between two reviewers regarding the gross appearance of the suture lines. Variability in age at which the suture lines are not visible has also been recognised in human cranial suture lines.

**Conclusions:** Age of loss of visibility (closure) of the frontonasal suture line is inconsistent between horses. Closure of the frontonasal suture lines appears to occur late in life, similar to facial sutures in humans. This suggests that horses could develop suturitis for most of their lives.
Behavioral signs associated with equine periapical infection in cheek teeth

Jaana Pehkonen, Leena Karma, and Marja Raekallio

There are no studies focusing on signs of equine dental pain associated with periapical infection in cheek teeth (CT). Moreover, the capability of owners to recognize signs of dental pain in horses has not been reported. We hypothesized that periapical infection usually induces pain that manifests itself in the behavior of the horse. Removing the infected tooth would reduce the expression of such behavior. Owners of 54 horses whose CT had been removed due to periapical infection were included. They filled an internet-based questionnaire including 23 questions about eating behavior, bit behavior and general behavior of their horses observed before and after the operation. The number of behavioral signs exhibited by each horse before and after CT removal were compared using Wilcoxon signed rank sum test. Values of $P < 0.05$ were considered statistically significant.

Avoidance behavior, asocial and aggressive behavior were commonly reported by the owners. Removing the infected CT significantly reduced the expression of these behavioral patterns suggesting that they were associated with dental pain. Half of the cases had been diagnosed during a routine dental examination indicating that many owners did not seem to realize that the undesirable behavior might have been associated with dental pain. This study denotes the importance of training owners to recognize behavior related to dental pain in horses. Also, routine dental examinations are an essential part of horses’ wellbeing.
posters
**Dental abnormalities in police dogs: their association with animal aptitude, training and dental care**

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Police dogs are trained daily according to their function, such as patrol and crowd control, search and detection of weapons and narcotics, search and detection of explosives, search and rescue and tactical intervention. The main aims of this study were to evaluate the frequency of dental abnormalities in a population comprising 73 working dogs of the Canine Operational Group of the Portuguese Public Security Police (CO-G-PSP) and then to investigate possible associations with the dog's function, their behaviour during training and dental prophylaxis. Teeth were assessed by visual inspection of the animal while awake and the alterations documented on a dental chart. An individual questionnaire was completed by the handlers regarding their dog’s behaviour and welfare as well as diet and dental care. Results revealed that periodontal disease was the most frequent pathology, with severity increasing with age (p=0.001). Dental wear was present in almost all animals (87.7%), whereas tooth fractures were less observed (2.5%). Although few dogs were subjected to prophylactic care, most presented good dental health, without signs of oral discomfort, which could affect welfare and training performance. An association was also found between function and temperament both in inactivity (p=0.002) and under training (p≤0.001). The presence of abnormal behaviours was also found to be associated to function (p=0.032).

**Clinical and radiographic evaluation of autologous platelet rich fibrin and hidroxiapatite in mandibular exodontia sites in dogs**

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Recently, the use of autologous platelet concentrates (PC) has been proposed as an aid for enhancing bone formation and soft tissue healing. Platelet rich fibrin (PRF) is the 2nd generation of PC that uses only autologous centrifuged blood (without adding substances like anticoagulant and calcium chloride); also hidroxiapatite (HXA) has become a common osteoconductive material. This study aimed to evaluate the efficacy of PRF in alveolar healing, mixed with HXA and grafted in mandibular sockets. Alveolar sockets (28) from 4 canine patients who had to undergo extraction of biorradiculated mandibular teeth (14), were used. After autologous PRF preparation, a mixture of PRF-HXA or HXA was placed in different sockets of each patient; other alveolar sockets were only filled with PRF or left without filling (control). Bone healing (determined by a gray scale -histogram- with Image Tool® 3.0 in digitalized radiographs), were recorded around 30, 60, 90, and 180 days. Additionally soft tissue healing (Landry’s index) was recorded around 10 days. Mean values of bone density collected between 30 and 90 days for PRF-HXA and PRF, were significantly higher compared to HXA and without filling, respectively (p<0.05), beyond 90 days no differences were found. Sites where PRF was used, exhibited faster soft tissue healing and less inflammation. PRF could be helpful in promoting early soft tissue healing and bone regeneration, both mixed with HXA and as sole filler, in extraction sites in dogs.
Epidemiological study on diseases that affect the dental enamel in canine patients of the Faculty of Veterinary Sciences (UBA)

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The more important diseases that involve the dental enamel in dogs are: Attrition (At), abrasion (Ab), caries (Ca), enamel hypoplasia (Hp) and dental resorption (RD). There are no epidemiological data of these lesions in our country, so the aim of this work was to study the prevalence of these conditions in dogs treated at the Small Animal Surgery Department of the Veterinary Teaching Hospital (F.V.S - UBA). In addition, the prevalence of periodontal disease (PD) was also established, in order to relate it to the pathologies studied. The study was carried out on 300 dogs over 6 months of age with complete permanent dentition, anesthetized, both for causes related to dentistry, as well as for other causes.

All the dogs studied underwent a clinical examination of the oral cavity, in order to detect the presence of the diseases of interest. The injuries observed were recorded on a dental chart designed ad-hoc.

The percentages of affected dogs were calculated for each type of injury (at least one). The results obtained were: Ab: 13.66%, At: 50%, Hp: 2%, Ca: 1%, RD 1.33% and EP: 82.33%. In small size dogs, a higher prevalence of PE and low presence of attrition / abrasion was found; in large size dogs (more than 20 kilos), lesions due to tooth wear and mild PE were more frequent. That is, an inverse relationship between attrition / abrasion and the presence of PE was observed. Tooth decay and tooth resorption were lesions with a very low prevalence.

The importance of clinical examination and intraoral radiology in feline tooth resorption

Raluca Mihaela Zvorasteanu and Elena Carmen Nenciulescu

Between 30% and 70% of the cats suffer from feline odontoclastic resorptive lesions (FORL) or tooth resorption (TR), a noncarious odontogenic destruction of cat teeth, with or without replacement of the roots by bone. It affects all cats, young and adult, male and female, pure breed or mixed. Although the etiology of this disease is yet unknown, the involvement of genetic predisposition cannot be ruled out, taking into consideration the many cases of tooth resorption in pure breed cats.

There are two types of tooth resorption: type 1 – without replacement of the tooth roots by bone and type 2 – with replacement of the tooth roots by bone. These lesions are covered by sore gum and pulpar tissue. They are generally located at the cemento-enamel junction cement or at the furcation of the multi-radicular teeth.

Initial lesions may be asymptomatic, with the exception of halitosis, for a long time. In advanced stages the animal has trouble chewing which results in weight loss and even anorexia. Most commonly affected teeth are the third mandibular premolar (307/407), the fourth mandibular premolar (308/408) and the fourth maxillary premolar (108/208).

When dealing with FORL patients it is important to always take intraoral radiographs in order to decide therapeutic options. A series of full mouth radiographs is mandatory for analyzing the distribution, extent
and shape of the roots and lesions. The roots of teeth with type 1 TRs have an intact and identifiable periodontal ligament and a similar radiopacity to the roots of the adjacent teeth. Radiographically, the roots of teeth affected by type 2 TRs are less radiodense than the roots of adjacent teeth, the periodontal ligament disappears, and the root structure becomes hard to identify.

The only treatment option is extraction of the affected tooth. Extracting the root may be complicated because of the resorption and ankylosis. For type 1 TR, the tooth must be completely removed. Crown amputation of teeth with type 2 lesions results in less trauma to the patient and the healing will be faster and better than full extraction. Root atomization is not indicated. After extractions the patient must be regularly checked and full mouth radiographs should be taken.

It is important to diagnose and treat tooth resorption correctly, in order to prevent complications (iatrogenic jaw fracture) and to prevent pain in these patients.

Evaluating the relationship between age and pulp canal/dental root ratio on dental x-rays of 53 Yorkshire Terrier dogs

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The evaluation of teeth morphology in radiographic images, namely, the pulp canal/dental root ratio (CRR), has been presented as a reliable method for estimating age in both humans and animals. There are few studies relating the CRR to age in canids, thus, the main objective of this study was to evaluate a possible relationship between these parameters in dogs.

Intraoral x-rays from a total of 53 Yorkshire Terrier adult dogs were obtained at a veterinary dental practice. Images of both mandibles were taken using a parallel view technique. Root and pulp canal width from the first mandibular molar teeth were measured using a geometrical imaging program (NIH ImageJ). All measurements were repeated 2 times and their mean was considered as the final value and subsequently used to calculate CRR for both the mesial (MR) and distal (DR) roots. Dogs were divided into 3 groups according to age: under 24 months, MR: 0.21±0.09, DR: 0.24±0.11; 25 to 96 months, MR: 0.12±0.04, DR: 0.11±0.03; and over 96 months, MR: 0.09±0.03, DR: 0.09±0.03. CRR, MR and DR all decreased with age, and a statistically significant, negative moderate association was found between age and CRR of both MR and DR roots (rs(97) = -0.545, p<0.001 and rs(98) = 0.578, p<0.001, respectively).

This work contributes to the knowledge of CRR in dogs and its relationship with age and reinforces the interest in the use of intraoral x-ray images as a tool for age estimation in this species.
Canine Chronic Ulcerative Stomatitis (CCUS) treated with Platelet Rich Plasma (PRP)

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Introduction

CCUS is a severe condition that it is commonly seen in some dog breeds. It is frustrating for all involved in the case: patient, owner and doctor. Ulcerative lesions are extremely painful. Other symptoms include: halitosis, ptyalism and anorexia.

CCUS is an abnormal response of the immune system that gets intolerant to the dental plaque. Any small amount of dental plaque leads to huge local inflammatory reaction. It may be associated in some cases, like ours, with periodontal disease or with other immune-mediated diseases.

Treatment in these cases starts with a proper professional cleaning, training owners to minimize plaque accumulation, topical therapy with antiseptic, analgezic and antibacterial gels, antibiotics, vitamin B3, anti-inflamatory drugs and pain controllers.

We decided to try an innovative treatment that would increase the local immune reaction. Lately, PRP-Plateled Rich Plasma has gained a lot of teritory in dentistry. Human severe gingivitis are treated with local injections of PRP, and having excellent results.

Purpose

The purpose of this case was to see whether the Plateled Rich Plasma is helpful even in CCUS, as in my every day practise for human stomatitis is having good results.

Materials and methods

A 7 years old caniche dog was presented to our office, being at the second episode of CCUS. Symptoms were characteristic to CCUS:

- Severe halitosis
- Gingivitis
- Faucitis – inflammation of the cavity at the back of the mouth
- “Kissing ulcers” regarding canines, premolars, molars on the cheek, lip and tongue mucosa. They develop in contact with the teeth surfaces and more precisely, with the dental plaque.
- Appetite lost
- Pyalism – ropey saliva coming out of the mouth
- Severe pain

We decided to manage the situation with:

- Professional cleaning and scaling
- Training owners to keep dental plaque in control
- Antibiotics for aerobic and anaerobic bacteria, to prevent a supra-infection
- Anti-inflamatory drugs to limit the inflamation and the pain
- Pain killers
- Vitamin B12 and butafosfan- for stimulating general immune response
- Vitamin C
- Topical antiseptic, anesthesia gels applied on the tooth surface, containing chlorhexidine 0.12%
- Plateled-Rich-Plasma-PRP

Patient’s blood is centrifugated for 10 minutes, at 2500 rotations /minute, separating the plasma with
proteins and growth factors by the blood. The idea is that injecting PRP into damaged tissues will stimulate the body to grow new, healthy cells and promote healing. Because the tissue growth factors are more concentrated in the prepared injections, body’s tissues will heal faster.

When the local situation would allow us, we would have to extract all the teeth that were affected by periodontal disease, with severe gingival recession, stage 3 of mobility.

**Results**

24 hours check up was amazing:
- bad breath
- gingivitis
- faucitis
- pain’s intensity
- ulcerations were healing
- no more saliva coming out of the mouth
- appetite regained

Seeing this spectacular results, we decided to extract all teeth that were affected by periodontal disease and had stage 3 mobility, with severe recessions: 106, 109, 110, 207, 209, 310, 406, 410. Regarding dog’s condition, the extractions were all resorbable sutured and the clot was protected with a resorbable periodontal cement.

Seven days check up was also the second PRP appointment, revealed the results, that were according to our prognostic: good.

**Conclusions**

Classical treatment: antibiotics, vitamins, oral hygiene, topical applications with chlohexidine 0.12% have a good response in CCUS.

PRP (Plateled rich plasma) with the growth factors and proteins injected around the ulcers has shorten the time for healing, made tissue regeneration quicker.

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Comparative temporomandibular tomography features between mesaticephalic and brachycephalic cats

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The feline temporomandibular joint (TMJ) is a complex synovial compound ginglymoarthroidal joint of the articular head of the mandibular condylar process and the mandibular fossa of the squamous portion of the temporal bone.

Morphologic and morphometric studies using computed tomography of the feline TMJ are needed since pathology of this region can occur.

The purpose of this study was to describe morphometric measurements of the TMJ using computed tomography and compare them in 2 craniofacial phenotypes.

Twenty computed tomography exams were obtained from 20 cats: 10 mesaticephalic and 10 brachycephalic cats were collected from 3 veterinary centers. Six parameters were measured: width and depth of the mandibular fossa, height and length of the mandibular condyle and 2 different angles between the mandibular fossa and the condylar process.

Three of six parameters - width of the mandibular fossa, height of the mandibular condyle and angle 2 - resulted statistically different between the 2 skull types. Moreover, temporomandibular joint conformation differed slightly between groups. Brachycephalic group had larger mandibular fossae and shorter mandibular condyles.

Normal morphometric measurements can be valuable for the veterinary radiologist when evaluating the feline TMJ. The procedure permits to compare the normal physiology of the TMJ during articulation assessment, in order to identify when pathological alterations occur. Moreover, the study identified significant differences between the two craniofacial phenotypes, which need to be considered not only during interpretation but also if, in future studies, they can increase the risk to TMJ disease.

Antibacterial activity of propolis versus triple antibiotic paste on dental caries in dogs

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Introduction

Propolis, the resinous hive product collected by bees, contains about 55% resinous compounds and balsam, 30% beeswax, 10% ethereal and aromatic oils, and 5% bee pollen. The composition of propolis varies according to the type of plants available to the bees. Therefore, propolis has various odors, colors and probably therapeutic properties depending upon the season and source [1]. Propolis has antimicrobial, anti-inflammatory and immune stimulant prosperities. Propolis has a good antibacterial activity against E. faecalis in the root canals, suggesting that it might be used as an alternative intra-canal medicament [2].

Triple antibiotic paste (TAP) consisting of a mixture of ciprofloxacin, metronidazole and minocycline is
commonly used for sterilization of infected root canal [3]. Due to the disadvantages of TAP, search for an ideal new intra-canal antimicrobial is continuing. Therefore, this study compared the antibacterial efficiency of propolis versus TAP as intra-canal medicaments on dental caries in dogs.

Materials and methods

Ten dogs with severe dental caries were divided into two equal groups (5 teeth each) including; group I (TAP group) and group II (Propolis group)

Under general anesthetic regimen, complete aseptic conditions and cotton roll isolation, the infected teeth were filled with sterile saline as a transport fluid. A sterile paper point #30 was placed in the root canal as long as possible, allowed to saturate, and transferred under complete aseptic condition to tubes containing one mL of 0.9% sterile saline solution.

Each sample was carefully homogenized by being vortexed for 30 seconds. Serial 10-fold dilutions (1:10, 1:100 and 1:1000) were performed in normal saline solution. Then 0.1 mL from each dilution was smeared to be inoculated on surface of the plate media (BHI agar plates), incubated for 48 hours at 37ºC. The colony-forming units (CFU) per 1 mL were enumerated. After 48h, Petri-dishes were examined for bacterial growth (base line). Each plate was divided into 4 quadrants and dotted colonies were marked by a marker pen.

According to the group, either propolis paste or TAP paste was applied as intra-canal medicament.

For preparation of propolis paste, three-hundred grams of frozen Egyptian propolis were ground and dissolved in 300 mL of ethanol 96% at 37ºC to obtain 100% (w/v) extract. The mixture was stored in a bottle and incubated at 30ºC for 14 days. After incubation, the supernatant mixture was filtered twice with Whatman no. 4 and 1 filter paper. The filtered mixture was concentrated for 6 hours at 30ºC (1500 rpm). The final extraction of propolis obtained a density of 150mg/mL, which was manipulated using glycerin until a creamy consistency was obtained.

Triple Antibiotic Paste consisting of Metronidazole 500mg tablet, Ciprofloxacin 250 mg tablet and Doxycycline 100 mg capsule was prepared according Sato et al. [3]. The prepared pastes were inserted to fill the canals using a lentulo spiral. The teeth was sealed using sterile cotton pellet and temporary restoration, Coltosol® F (Coltene Whaledent, Switzerland).

After 3 weeks and under the same aseptic conditions as well as anesthesia, the temporary restoration, sterile cotton pellet, and the paste were removed by copious irrigation with sterile saline solution. Then the root canals were dried and post exposure to intra-canal medicaments bacteriologic sampling was carried out by the previously described method. After bacteriologic sampling, the root canals were re-irrigated using 10 mL of sterile saline solution and 10 mL of NaOCl 2.25% solution and dried with sterile paper points for endodontic therapy.

For bacterial count, visible colonies produced before and after intra-canal medicaments were counted in every plate. The number of colonies/plate was multiplied by the corresponding dilution factor and by 10 to determine the total colony forming units (CFU) per mL of sample. Antibacterial effectiveness of the different intra-canal medicaments was assessed by determining the percentage of reduction in colony counts (%RCC) before and after application of the intra-canal medicaments.

The percentage of change was calculated as:

\[
\frac{CFU \text{ (Base line)} - CFU \text{ (3 weeks)}}{CFU \text{ (Base line)}} \times 100
\]

The data were collected, tabulated and statistically analyzed.

Results

As regards % change in bacterial counts, there was no significant difference between TAP and propolis groups (P<.001). Both groups showed a decrease in mean % reduction in log10 CFU.
Discussion

A complete elimination of necrotic tissues and infection from the root canal is essential for a successful endodontic therapy [4]. In the present study, the antimicrobial agents were kept inside the dental roots for 3 weeks which is sufficient for canal disinfection as mentioned before [3].

A single antimicrobial agent is not sufficient for effective disinfection due to the complexity of root canal infection, thus mixed antimicrobials are commonly used during endodontic therapy [5]. Staining of the teeth is a common disadvantage of TAP therefore propolis was applied in the present study as an alternative intra-canal medication due to its natural origin and its antimicrobial and anti-inflammatory actions.

Regarding the antimicrobial action of both propolis and TAP, there was no significant difference between them. The antimicrobial activity of propolis could be attributed to functional and structural damages of the microbial cell wall, inhibition of bacterial RNA-polymeras and immunomodulatory, anti-oxidative, and healing effects [6].

Conclusion

Propolis could be used as an alternative to TAP for disinfection of the root canals during the endodontic therapy in dogs.

References


Common dental disorders in donkeys in Egypt

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Introduction

Donkeys played an essential role in Pharaonic Egypt, as they still do in the Nile valley, as the principal load-carryers. The total population of donkeys in Egypt is less than 5 million in 2005 according to FAO (http://www.fao.org). Donkeys in Egypt fed on roughages, greens, grains (white and yellow corn, beans and seeds of dates) and sugar cane according to geographical distribution.

Dental diseases can have detrimental effects on donkey’s welfare as it can cause decreased feed efficiency and severe oral discomfort. Also these affections can lead to weight loss and subsequent sores from poorly
fitting harnesses, and furthermore may contribute to injuries from beatings, because the donkeys are too weak to work normally.

In this study, we are representing the most common dental disorders in different age groups of donkeys in 6 governorates in Egypt for better understanding of the pathogenesis of dental disorders, particularly those occurring in geriatric donkeys.

Methodology

A total of 296 donkeys with various dental affections were enrolled in this study. The study was carried out in 6 governorates at upper, middle and lower Egypt including; Cairo, Giza, Fayoum, Beni Sweif, Aswan, and Marsa Matrooh. The donkeys were classified into 4 groups according to the age as follows; Group 1 including donkeys 0-5 years old (n=32 donkeys), Group 2 including 6-10 years old donkeys (n=102), Group 3 including 11-15 years old (n = 95) and Group 4 including donkeys 16+ years old (n=67). These donkeys included 243 male and 53 female donkeys.

Results

All donkeys had either single or mixed dental disorders. The recorded dental disorders in group 1 (32 donkeys) included:

- Sharp enamel point (N=16), retained deciduous tooth (N=11), periodontal disease (N=9), cranial hook (N=6), soft tissue injuries (N=5), under bite (N=5), premolar cap (N=4), ramps (N=3), supernumerary incisors (N=3), calculus (N=3), dental displacement (N=3), dental caries (N=2), diastema (N=1), worn to gum (N=1), excessive transvers ridge (N=1), and long incisor teeth (N=1).

In group 2 (102 donkeys), the recorded affections included; sharp enamel point (N=87), upper hook (N=50), excessive transvers ridge (N=18), long incisor (N=14), periodontal disease (N=16), dental fracture (N=9), soft tissue injuries (N=56), ramps (N=29), corner hook (N=6), dental caries (N=13), dental overgrowth (N=12), dental displacement (N=11), dental calculus (N=4), diastema (N=7), wave mouth (N=5), steps (N=3), worn to gum (N=3), retained deciduous teeth (N=3), overbite (N=1), and wolf tooth (N=1).

In group 3 (95 donkeys), the recorded affections included; sharp enamel point (N=84), upper hook (N=55), soft tissue injuries (N=47), ramps (N=45), dental overgrowth (N=22), long incisor (N=19), dental displacement (N=20), excessive transvers ridge (N=17), periodontal disease (N=16), dental caries (N=14), steps (N=14), diastema (N=13), worn to gum (N=13), fracture (N=11), dental calculus (N=9), molar table angle change (N=9), loose incisors (N=7), wave mouth (N=7), missing teeth (N=3), and retained deciduous teeth (N=1).

In group 4 (67 donkeys), the recorded affections included; sharp enamel point (N=59), periodontal disease (N=45), soft tissue injuries (N=44), diastema (N=40), steps (N=33), dental overgrowth (N=30), long incisor (N=30), worn to gum (N=28), dental displacement (N=27), ramps (N=24), dental calculus (N=21), loose incisors (N=14), missing teeth (N=14), fracture (N=13), dental caries (N=10), excessive transvers ridge (N=9), molar table angle change (N=8), wave mouth (N=7), corner hook (N=6), overpowering teeth (N=4), dorsal curvature (n=3), retained deciduous teeth (N=1), under bite (N=1), wedge mouth (N=1), over jet (N=1) and supernumerary teeth (N=1).

Conclusion

Donkeys are prone to several dental affections and the incidence of most of these affections increases with the age.
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