Periodontal disease (PD) is an altered state of the periodontium. The periodontium is the attachment apparatus of the tooth consisting of the gingiva, alveolar bone, periodontal ligament (PDL), and the cementum. It is responsible for hypsodontic tooth eruption and for the distribution of masticatory forces from the teeth into the supporting bone. PD is an inflammatory process consisting of cyclic intervals of active destruction (periodontitis) and inactive quiescence. These repetitive cycles of disease cause progressive attachment loss resulting in increased tooth mobility and eventually premature exfoliation of the tooth. The predisposing feature to periodontitis in horses is food sequestration in the gingival sulcus, which is usually predisposed by inappropriate interproximal spaces between teeth (diastemata). Periodontal disease is the primary cause of tooth loss in mammals, and was found to be the reason for extraction of 70% of equine cheek teeth in primary practice.

Periodontal disease is a syndrome, which is comprised of gingivitis, periodontitis, reduced peripheral cementum production, alveolar bone recession, and peripheral subgingival caries. It is frequently accompanied by moderate to severe oral pain, which can result in inability to masticate food effectively and cause significant loss of body condition. The extraoral clinical signs associated with PD are similar to those of other dental diseases and are usually indicative of advanced disease. Weight loss, dysmastication, oral dysphagia (quidding), selective appetite, halitosis, hypersalivation, facial enlargements in the buccal area, purulent nasal discharge, biting problems, and behavioral changes have been reported. Since all tissues of the periodontium are innervated, PD is associated with pain. Horses may object to manipulation of the head, mouth, or teeth. Oral signs of PD include:

- feed trapped in diastema between teeth
- accumulation of plaque, calculus, debris, or exudate around the tooth
- gingival inflammation, edema, recession or hypertrophy
- sulcular hemorrhage during examination or odontoplasty
- periodontal pocket or diastema formation
- tooth mobility, migration, or extrusion, and eventual tooth loss.

The condition of each tissue of the periodontium visualized should be characterized. Standardized periodontal indices (plaque, calculus, sulcular bleeding, and gingival indices) are widely accepted in both human and veterinary dentistry and can be used to simplify the documentation of the visual examination. Observation of the extent of pathology can be greatly enhanced using oral endoscopy, which facilitates measurement of the depth of the periodontal pocket with a calibrated periodontal probe. Radiography is helpful in confirming the depth and width of attachment loss and associated pathology.

Tooth mobility is a reliable, positive predictive diagnostic and prognostic indicator. Increased mobility proportionally associates with advancing PD and chances of tooth loss. However, lack of mobility does not always correlate with the lack of or early stage PD. Affected teeth should be manipulated to determine mobility. Tooth movement of 1-2mm is considered normal in geriatric patients, but movement greater than 3mm almost always indicates advanced, untreatable PD.
A degenerative syndrome of the incisors and canine teeth has been labeled “incisor periodontitis”. A large survey of 800 donkeys showed an incidence of PD of 13% involving the incisor teeth. Calculus and chemical or mechanical irritation was responsible for 75% of the mild PD incisor cases. Incisor diastemata and trapped food were the predisposing factor to 19% of the cases. Work by Staszyk and others (2008) has demonstrated with radiography, (high definition micro CT and histologically) that the principle pathology of this disorder is odontoclastic tooth resorption and hypercementosis (EOTRH). This disease will be covered in more detail in the Geriatric Dental talk that accompanies this lecture series. Lower canine teeth often are covered with plaque or calculus, which predisposes to gingivitis and periodontal disease. This is easily diagnosed from a clinical examination but the extent of disease cannot be evaluated until after the affected tooth has been cleaned and scaled. The canines can also be associated with EORTH.

**Endodontic disease** is defined as an infection involving the pulp usually associated with the dental apex or root and surrounding bone. In the horse, this type of disease has several synonyms: apical osteitis, apical periodontitis, periapical abscess, dento-alveolar infection. This type of dental disease is typically seen in young horses with the median age 5-7 years. Early and accurate identification of endodontic disease prior to osseous fistula and secondary effects on the surrounding tissues seldom occurs, but should be diagnostic goals.

The most common clinical presentation associated with infection of the rostral two or three maxillary cheek teeth (06s-07s-08s) is a rostral maxillary swelling with a cutaneous sinus tract or less commonly, ipsilateral nasal discharging tract. Infection involving the upper 06s and 07s has been associated with purulent discharge from the ipsilateral nasolacrimal duct. A foul smelling, unilateral nasal discharge
associated with sinusitis can be seen with apical infection of the caudal three or four maxillary cheek teeth (08s-09s-10s-11s). Involvement of the infraorbital canal has been associated with apical infection of the upper 08s and 09s. Mandibular enlargement with a sinus tract is seen with apical infections involving the first four lower cheek teeth. The caudal two lower molars (10s-11s) usually cause enlargement and drainage under the muscles of mastication.

The proper tooth must be identified and this can be confusing at times, especially when no obvious oral signs or symptoms are present. Oral signs would present as an obvious deep crown fracture, occlusal secondary dentine discoloration or open occlusal pulp horns, and/or discharging tracts through the periodontal space or gingiva. Oral endoscopy has been shown to greatly improve identification of subtle dental changes such as small periodontal pockets, gingival recession, occlusal fissures, and changes to the occlusal secondary dental. In most cases, radiographs will aid in the diagnosis of apical disease. The sensitivity and specificity of radiography in the diagnosis of equine dental disorders are only 52-69% and 70-95% respectively, with periapical lucency, periapical sclerosis, and tooth root clubbing being the most reliable. All of these radiographic changes are associated with chronic disease. Teeth showing occlusal secondary dentine defects often have deep carious lesions involving the crown and are prone to fracture.

Exodontia has been the treatment of choice for most chronic apically infected teeth. Oral extraction has been the preferred method of exodontia with the highest success rate and lowest rate of complications. Oral extraction can be challenging when attempting to remove a periodontal-intact, long crowned, hypsodont tooth in a young horse. There is potential to cause iatrogenic damage that can have long-term welfare ramifications from attempted extraction. Such potential complications have lead to the development of extra-oral approaches to extraction via alveolar plate removal, improved methods of retrograde repulsion, and minimally invasive buccal procedures. After tooth removal, the secondary infection in the surrounding bone, soft tissues, or sinuses must be addressed. Management of these secondary problems can at times be challenging.

**Infundibular Disease** has been described as: infundibular cement hypoplasia, infundibular caries, or patent infundibulum and is beginning to be considered a developmental condition. This accounts for the fact that many of these problems are bilateral and affect multiple teeth in the same animal. Infundibular (infundibulum/-a: Latin, funnel) anatomy and development of the upper cheek teeth is complex. The infundibular invaginations of enamel develop as the crown enamel organ forms with the
The apical aspect of the infundibulum closes at about the time of tooth eruption. The cement lake that fills in this infolded enamel receives its blood supply from the coronal aspect of the tooth while it develops in the alveolar sac prior to eruption. Cement deposition within the infundibulum progresses from the occlusal surface apically. This process may be incomplete at the time of tooth eruption when the occlusal blood supply is disrupted. This disruption usually involves the rostral area of the tooth first, with mucosal communications with the distal infundibular blood supply observed using oral endoscopy for up to 6 months after tooth eruption.

After eruption, maxillary cheek tooth infundibulae display one or more small orifices in the center of the occlusal infundibular cementum. These canals extend through the infundibular cementum to the apical end of each infundibulum and represent the former location of blood vessels during dental development. The differentiation of mesenchymal cells into cementoblasts and subsequent cementum formation depends on adequate blood supply which is provided by these blood vessels derived from the dental sac.

Oral examination only allows visualization of the coronal surface of the infundibulum—not the more apical aspect. Digital radiology gives limited viewing of severely defective infundibula. Computed tomography allows improved imaging of the internal architecture of the teeth. Research conducted by Fitzgibbons et al., on the anatomy of maxillary cheek teeth infundibula in clinically normal horses, has helped to better understand infundibular anatomy, hypoplasia, and caries.

Techniques to fill or restore hypoplastic or carious infundibulae have been described since the 1940s. In the 1990s, the availability of instruments to reach the cheek teeth and air abrasion encouraged practitioners to begin attempting to diagnose and treat these deformed teeth without a good understanding of the disease process. Pearce has reported on 10 years of work with this technique in a clinical setting and has shown the process to be safe for the animal. More recent work by Horbal and Dixon (2017) has shown this technique to be of questionable value and lacking in cleaning and filling infundibulae deeper than 10mm.

Peripheral Dental Caries
Macroscopic destruction of the calcified dental tissues resulting from micro-organisms within the oral cavity metabolising dietary carbohydrates to produce acids which dissolve the mineral component of the teeth has been defined as dental caries. The bacteria digest the dietary carbohydrates and produce the by-product of organic acids such as lactate and acetate which can reduce the pH in the biofilm around the tooth. In the oral cavity, there is a dynamic equilibrium between the calcium, phosphate and fluoride minerals in the oral fluid (biofilm) around the tooth and these minerals within the tooth. If the pH is tipped to below the critical level, the chemical equation can be tipped away from the hydroxyapatite in the tooth, instead driving calcium and phosphorus from the tooth into the biofilm to re-establish equilibrium, leading to an overall demineralization of the tooth (Ritter 2013).

In the horse, peripheral caries (PC) primarily affects the peripheral cementum around the erupted tooth crown of the distal cheek teeth however can extend into the enamel and dentin in more severe cases. Given the lower mineral content of cementum (65% inorganic material) when compared to enamel (96-98% inorganic material), the critical pH required for the demineralization process is higher (less acidic) than that required for enamel, with a pH of 5.5 required for enamel, 6.2 for dentine vs 6.7 for cementum, making cementum much more susceptible to acid attack. There has been research published on the pathology and histopathology of equine PC (Erridge 2012). The risk factors for PC are still poorly understood but it appears to be a regional problem with certain areas having a higher prevalence than others. The prevalence does appear to be increasing in Europe, and a recent study in the UK found a much higher prevalence than previous studies with a prevalence of 51.7%. However the prevalence appears to be substantially lower in many areas of Europe, than the levels seen in this study. Recent research from Edinburgh and out of Australia looked at risk factors. Feeding hay high in WSC, feeding silage and water with low PH were all found to be contributing factors. Equine PC does appear to be reversible if the source of the etiological factor is removed (Borkent 2016).

**Suggested Reading**

Kopke et al. (2012) The dental cavities of equine cheek teeth: three-dimensional reconstructions based on high resolution micro-computed tomography, BMC Veterinary Research, 8:173


Horbal AA, Liuti T, Reardon R, Dixon PM (2017) Infundibular Caries-What are they and why are we concerned? In: Proceedings of AAEP Focus on Dentistry, 87-94
