A Review of Equine Periodontal Disease

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Efficient examination and characterization of periodontal disease determines the degree of severity of the condition. Once the disease is staged, the practitioner can determine appropriate treatment; accurately prognose; and monitor progress on follow-up examination. Accurate diagnosis is facilitated in many cases by the use of intraoral radiography. Choice of treatment strategy is based on thorough understanding of anatomy, physiology, pathogenesis, and careful characterization of the disease process. Author’s address: Columbia Equine Hospital, 27841 SE Orient Drive, Gresham, OR 97080; e-mail: equinedental@earthlink.net. © 2006 AAEP.

1. Introduction

Recognition of periodontal disease and appreciating its importance to the equine patient is part of good dental care. Systematic examination and characterization of tissues leads to determination of severity of disease. Appropriate choice of the variety of treatment options available to the practitioner can only be made if one understands the pathogenesis of the disease process. Classification of the stage of the disease process leads to accurate treatment and prognosis and forms a basis for monitoring response to treatment.

2. Anatomy

The periodontium is composed of gingiva, periodontal ligament, cementum, and alveolar bone. Gingiva is that part of the oral soft tissue overlying the crowns of unerupted teeth and encircling the necks of those that have erupted. Mucosa is the thin, fragile part of the oral soft tissue that is continuous with the mucous membrane of the cheek, lips, and floor of the mouth. The two tissues meet at the mucogingival junction. The anatomy is shown in Fig. 1. Inflammation of the gingiva is gingivitis. Periodontitis means the active state of disease.

Periodontal disease is a general term referring to the altered state of the periodontium and encompasses both the active and resting states of the disease process.

The anatomy of the gingiva can be further divided by location.1 Marginal gingiva is the unattached terminal edge of the gingiva that surrounds the tooth in a collar-like fashion. The gingival sulcus is the shallow space around the tooth bounded by the tooth on one side and the gingiva on the other. Attached gingiva is continuous with marginal gingiva. It is tightly bound to the underlying periodontium and alveolar bone and extends to the relatively loose alveolar mucosa at the mucogingival junction. The interproximal space is occupied by the interdental gingiva. Gingival anatomy is identified in Fig. 2.

The normal probing depth of the gingival sulcus of equine teeth varies with location. Incisors, canines, and second premolars have a depth of up to 3 mm. The remaining cheek teeth have probing depths of up to 5 mm.

Radiographic anatomy of the teeth and supporting structures is similar to that of humans and small animals. Normal structures include the alveolar bone, lamina dura, alveolar crest, and periodontal
ligament space. Changes can be seen in all these structures. Intraoral radiographs provide visualization of normal and abnormal conditions.

Important differences exist in the anatomy of teeth and associated structures in horses compared with humans and small animals. The interproximal contact area between cheek teeth is very large, making the interdental gingiva significantly wider buccolingually. There is no cementoenamel junction. The tooth is enveloped by cementum at eruption. The teeth are radicular hypsodont, meaning that root formation occurs as the horse ages and eruption of reserve crown is continuous. New cementum is added to the outside of the tooth during eruption. Equine cementum is living tissue even above the gingival margin.

3. Oral Flora

The normal oral flora is composed of populations of different bacteria. It is the changes in these populations that constitute the infectious process that becomes gingivitis and periodontitis. In the normal state, gram-positive cocci and rods reside on the surface of the tooth. Their populations are significantly higher than other bacterial types, although other types are present. As gingival infection progresses, the populations change. Extension of the process to attachment loss involving deeper tissues is accompanied by significant increases in spirochetes and gram-negative anaerobic motile rods and decreases in gram-positive cocci.

It is important to note that all stages are accompanied by mixed infections and that most of the same bacteria are present in all stages. There is rarely a single organism responsible for the loss of attachment. The important pathological process is one of population change, which results in sufficient numbers of pathogenic organisms to produce an inflammatory response and degradation of host tissues.

4. Immune Response

The fluid produced in the gingival sulcus is called gingival crevicular fluid. It is an inflammatory exudate. It contains leukocytes along with bacteria and desquamated epithelial cells. Antibodies are present as are electrolytes, enzymes, and other organic compounds. The amount of fluid produced increases with inflammation and mastication.

Salivary secretions assist in the defense of the periodontium by mechanically cleansing the oral surfaces; by buffering acids produced by bacteria; and control of bacterial activity through direct enzymatic and immune system action. Antibodies produced within the glands are secreted into the oral cavity and combined with the leukocytic response, providing substantial defense against infectious processes. Salivary buffers reduce acidity that contributes to the decay process and increase pH to inhibit bacterial growth. These characteristics are of critical importance when considering the pathogenesis of periodontal disease in horses.

5. Pathology

The event that incites the change in bacterial population is decay. In humans and small animals, decay is initiated by the accumulation of plaque and calculus. While plaque and calculus are seen on equine teeth, they rarely lead to periodontitis. The difference in horses is that the triggering event is stasis of feed material. Feed material decays when it remains lodged in the small depressions around and between teeth. Figure 3 shows feed accumulation in the gingiva. The decay process
causes inflammation of the gingiva and breaks down cementum and gingival attachment by the mechanisms well described in other publications. Periodontal attachment loss is a continuation of the same process. Because equine crowns are covered by cementum, its decay becomes part of the pathological process. Cemental decay may proceed both apically and interproximally. Destruction of bone and other tissues follows.

The problem of feed stasis and decay is created by contributions from several factors. The concept of range of motion of mastication is important. Reduced range of motion results in increased crushing direction of mandibular action. It also involves, either by cause or result, uneven attrition of occlusal surfaces. The elongated teeth or parts thereof combined with the increased crushing motion cause feed material to be packed into any small depressions that exist in the normal topography of the periodontium. These elongated teeth can also directly abrade the gingiva, thereby opening gingival epithelium to direct infection and beginning the cascade of events.

A second important concept associated with decreased range of motion of mastication is that of orthodontic movement of teeth, that is, how teeth move within the arcade. For example, it is well recognized that when rostral hooks (Fig. 4) are present on upper second premolars (6s in the Triadan system), these teeth occasionally are tipped in a mesial direction by forces of mastication. This movement can result in the creation of widened interproximal spaces. Reduction of this malocclusion often results in closure of the interproximal space. Orthodontic movement can be seen in other teeth as well. As overlong teeth develop, abnormal mastication forces result. These abnormal forces can cause movement of either of the occlusal pair of teeth. Shifting of the tooth results in an enlarged interproximal space, where feed material can accumulate and decay.

The same forces that create orthodontic movement can also limit normal mesial drift of teeth as the patient ages. In so doing, interproximal spaces are created, especially in older horses, such as in Fig. 5. In geriatrics, these spaces are rarely reduced to normal, because the periodontal mechanism for resolving it is compromised by an age-related reduction in function. The elastic trans-septal fibers of the periodontal ligament are partly responsible for mesial drift. Because an increased interproximal space involves a recession of the interdental gingiva, this compromises the elastic fibers. If compromised, they cannot function to keep the teeth in
close proximity as in a normal arcade. Increased interproximal wear alters the close-packed positions of teeth in the mastication battery. Additionally, eruption assists in maintaining close alignment of teeth in the mastication battery. Part of the eruption process involves tissue remodeling and forcing the teeth together in the previously mentioned battery. Teeth of older patients have less reserve crown and therefore less eruptive potential. Aging also reduces metabolic functions. The abnormally positioned geriatric tooth, therefore, has a very limited ability to correct itself, because there is less reserve crown present and reduced ability to correct physiologic abnormalities.

Feed types play an important role. The softer the feed, the larger the range of motion and the less crushing motion used. With soft feedstuffs, such as green grass pasture, a wider range of mandibular motion is used. Feed material is ground in a circular pattern, rather than crushed. This wide range of motion creates a large amount of soft tissue contact, gingival crevicular fluid (GCF), and saliva flow. The soft tissue contact together with saliva mechanically cleanses the teeth, thus preventing feed stasis. Horses secrete 50 ml/min of saliva from the parotid salivary gland. Salivary flow is stimulated by mastication. Without mastication, salivary flow is limited to that amount needed to maintain a moist intraoral environment. Horses in free-range situations feed for ~14 h/day. By calculation only, not by direct measurement, that would mean horses create over 40 l of saliva per day when feeding on grass from one gland alone. The previously mentioned benefits of saliva, mechanical cleansing, acid buffering, and antibody production are very important in prevention of gingivitis and periodontal disease when its flow is both voluminous and continuous. GCF flow and its advantageous components, leukocytes, and antibodies are important also. Together, these two host defense mechanisms provide a substantial barrier to infection.

When horses consume harder feeds such as hay and grain, all the above parameters change in favor of the development of periodontal disease. Range of motion is reduced; teeth and parts thereof become protuberant; feed stasis occurs; and decay and the cascade is set in motion. The saliva that is produced is absorbed by the dry feed to some degree, thus reducing its effectiveness. Because the time of feeding is reduced, the total daily saliva and GCF production is dramatically reduced. The net result is a much greater time for static feed material to decay. Reduced soft tissue contact and reduced range of motion leads to decay of feed material, thus creating the environment for periodontal disease to flourish.

6. Examination and Diagnosis
Oral examination begins with removal of feed debris. The condition of the tooth and periodontium is examined for gingival inflammation and erosion, condition of sulcular epithelium, pocket depth and mesial/distal length, condition of the supragingival and subgingival cementum, attachment loss, and tooth mobility. A typical periodontal pocket is shown in Fig. 6. These measurements are charted. An example of a chart is shown in Table 1. Not all conditions are present in all cases. In early stages of the disease, there may only be slight erosion of gingival epithelium, with only a 4- to 5-mm-deep pocket with only 2–3 mm of extension mesially and distally. Edema and redness may be present in the sulcular epithelium, with no cemental decay and no mobility. Later stages are characterized by increased attachment loss and mobility, with other parameters equally more severe.

Because periodontal disease is defined by attachment loss, determination of the degree of advancement of the disease process is helpful in treatment and prognosis. Attachment loss can be determined by radiography when necessary. Improved radiographic techniques significantly aid the determination of degree of severity of this condition. Guidelines for determination of percentage of attachment loss have been determined for use in small animals. The author uses the Veterinary Periodontal Disease Index adapted for equine anatomy.10

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal: no attachment loss. Probing depth &lt; 5 mm.</td>
</tr>
<tr>
<td>1</td>
<td>Gingivitis: no attachment loss. Probing depth &lt; 5 mm.</td>
</tr>
<tr>
<td>2</td>
<td>Early PD: &lt;25% attachment loss and/or crestal bone loss around teeth.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate PD: &lt;50% attachment loss or bone loss &lt;50% around tooth root(s).</td>
</tr>
<tr>
<td>4</td>
<td>Advanced PD: &gt;50% attachment loss or bone loss &gt;50% around tooth root(s).</td>
</tr>
</tbody>
</table>

The endpoint of periodontal disease is exfoliation. The reason for intervention is to prevent this even-
tuality. Affected teeth gradually become loose when attachment loss no longer withstands mastication forces. Grades of mobility of teeth can be measured. The following is a suggested adaptation of the Tooth Mobility Index used in small animals. This index applies to all equine teeth. Movement is measured at the occlusal surface.

0 None: normal.
1 Slight: represents the first distinguishable sign of movement greater than normal.
2 Moderate: movement of up to 3 mm in any direction and/or is depressible.
3 Severe: movement >3 mm in any direction and/or is depressible.

Diagnosis of mobility is achieved by very careful manipulation of the tooth with molar forceps. It is very important to isolate the tooth as much as possible so that soft tissue interference in the measurement of mobility is minimized. If the tongue or cheek obstructs the view or the free movement of the molar forceps, the diagnosis may be inaccurate.

7. Incisor Periodontal Disease

Gingival recession is a common finding in equine incisors. This condition increases with age. Calculus is found on teeth with normal and receding gingiva. Receding gingiva may or may not have calculus. Therefore, while it is possible that calculus plays a role in some cases, it is not a consistent etiologic agent, and its removal from all patients will not prevent periodontal disease. In cases of incisor gingivitis caused by calculus, its removal, along with general cleaning and polishing, is temporarily palliative. Calculus tends to reoccur quickly on those horses that are susceptible to its development initially.

Incisor periodontal disease is presented in two conditions. The first is characterized by subgingival enlargements that appear radiographically as hypercementosis. The second, as seen in Fig. 7, is a more severe disease. It is presented clinically as a painful condition, with reddened, swollen gingiva suffering varying degrees of recession. Changes in sulcular epithelium vary from mild to necrotic. A hallmark of the disease in this form is cemental lysis instead of hypertrophy. This condition is evident radiographically. Invasion of bacteria results in osteomyelitis and attachment breakdown with increased tooth mobility. Pulpitis and pulp necrosis may result from apical extension of the disease process.

During development of the tooth, the apical part of the crown and root is surrounded by a germinal structure called Hertwig's epithelial root sheath. Further development of the tooth results in remnants of these cells incorporated into the cementum that surrounds the tooth. These are called the epithelial cell rests of Malassez. Because the

<table>
<thead>
<tr>
<th>Table 1. Chart for Characterization of Equine Periodontal Disease</th>
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<tbody>
<tr>
<td><strong>Chart for Characterization of Equine Periodontal Disease:</strong></td>
</tr>
<tr>
<td>Patient: _ _ Age: _ _ Sex: _ _ Breed: _ _ Owner: _ _</td>
</tr>
<tr>
<td>Previous history of dental care: ___________________________</td>
</tr>
<tr>
<td>Location of Periodontal Disease: __________________________</td>
</tr>
<tr>
<td>Tooth Mobility:</td>
</tr>
<tr>
<td>M:0 No movement</td>
</tr>
<tr>
<td>M:1 First signs of movement</td>
</tr>
<tr>
<td>M:2 Movement of up to 3 mm at the occlusal surface</td>
</tr>
<tr>
<td>M:3 Movement of 3 mm or more at the occlusal surface</td>
</tr>
<tr>
<td>Cementum:</td>
</tr>
<tr>
<td>Supragingival: Normal; Stained; Decayed</td>
</tr>
<tr>
<td>Subgingival: Normal; Stained; Decayed</td>
</tr>
<tr>
<td>Gingiva: Normal; Recessed; Inflamed; Ulcerated</td>
</tr>
<tr>
<td>Sulcular Epithelium: Normal; Inflamed; Necrotic</td>
</tr>
<tr>
<td>Pocket Length: ___ mm</td>
</tr>
<tr>
<td>Pocket Depth: ___ mm</td>
</tr>
<tr>
<td>Radiographs: Yes/No</td>
</tr>
<tr>
<td>Findings: __________________________</td>
</tr>
<tr>
<td>Stage of Disease Related to Percentage of Attachment Loss:</td>
</tr>
<tr>
<td>Stage 0: 0%</td>
</tr>
<tr>
<td>Stage 1: 0%</td>
</tr>
<tr>
<td>Stage 2: Up to 25%</td>
</tr>
<tr>
<td>Stage 3: 25% to 50%</td>
</tr>
<tr>
<td>Stage 4: Over 50%</td>
</tr>
</tbody>
</table>

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equine tooth crown and root are enveloped by cementum, these cell rests are present throughout the periphery of the tooth.

In brachydont teeth, the cell rests perform two functions in response to inflammatory insult. The first is creation of a lytic space at the apex of the tooth in pulp disease. This space is lined by cells derived from the cell rests. This lytic space is only visible radiographically. The second function is to send a signal to cementocytes to produce cementum. This is also only visible radiographically.

The two responses represent advancing severity of disease. The lytic form is very painful and the more severe disease. Many patients exist with both types of disease present.

The disease generally starts in the third incisor (Triadan 3) and extends mesially. Most commonly it is present in late teenage patients. A possible explanation for the onset of this condition lies in analysis of occlusal forces on aging teeth. As incisors age, they normally undergo a rostrally directed tipping movement. The third incisors are the most severely angulated teeth. Occlusal forces directed to a tipping tooth may be misinterpreted or misdirected in some individuals by the cell rests and result in disease. Extension to involve other teeth may be a result of occlusal forces or of chemical communication through cytokine recruitment of inflammation.

Tooth mobility staging previously described applies to incisors. Stage 3 mobile teeth are usually extracted. Ideally only 3s are removed. The remaining mobile teeth can be stabilized with an interdental splint.

Interdental splints can be placed to improve tooth stability and thereby reduce pain. In this procedure, the labial surface of teeth must have all cementum removed. This may be a painful procedure requiring the use of local or regional anesthesia. Diamond burs are used to remove cementum. The enamel is etched with 37% phosphoric acid and dentinal bonding agent is applied and light cured. Composite restorative material is placed on the surface. A strip of splint material is pressed into the composite dot on each tooth, thus connecting all teeth. The composite is light cured. Additional composite is placed on top of the strip and light cured. The splint is reinforced with polymethyl methacrylate for further stability.

The use of antibiotics should include treatment of anaerobes. A suggested regimen is a combination of sulfa/trimethoprim given orally at 24 mg/kg, q 12 h, and metronidazole given at 10–5 mg/kg, q 12 h, PO.

Because the suggested underlying cause is an inflammatory event involving the epithelial cell rests, treatment directed at these cells is indicated. The author uses a regimen of trimecinolone administered at up to 1 mg per site with no more than 6 mg used at a time. If additional treatments are needed, they are done on a monthly basis. Injection is done submucosally near the apex of the tooth.

Treatment results vary with severity of disease. Extractions of diseased 3s results in significant improvement in clinical condition. Splinting loose teeth results in reduced pain. Corticosteroid use results in decreased inflammation of gingiva and reduced pain. The character of the treated tissue has not been examined histologically. In cases of tissue lysis, radiographic changes remain. The goal of treatment is suppression of disease, not reversal.

8. Canine Teeth

It is well recognized that canine teeth readily accumulate calculus. Gingivitis is evidenced by edema, swelling, and redness. Pocket depth can exceed 5 mm in severe cases. Cemental decay is usually not present. Attachment loss is minimal and tooth mobility is normal. This condition rarely leads to the need for extraction or any treatment beyond local removal of calculus combined with cleaning and polishing the tooth.

9. Premolars and Molars

Characterization of the condition of the periodontium of cheek teeth follows the previously outlined steps. The early stage of the disease is evidenced by gingival inflammation and/or erosion, cemental decay, slightly increased pocket depth and no significant attachment loss or tooth mobility. This is recognized in clinical situations as a small amount of feed material accumulated in the shallow interproximal areas.

As the condition advances, decay and tissue loss continue in two directions. Cemental decay interproximally can result in increased space or cemental decay can progress apically. These may occur to-
Intraoral radiographic involvement involves the use of 4 × 8-in vinyl cassettes containing a single rare earth intensifying screen. The cassette is inserted into the horse’s mouth and held in place with a cassette holder. Mandibular films are taken using a parallel technique, whereas maxillary films are taken using a bisecting angle technique. This technique produces an anatomically accurate projection of the specific tooth of interest without the complexities of overlying densities. Improved detail allows better and earlier characterization of disease, accurate prognosis, and appropriate follow-up.

10. Treatment

The first and most basic treatment for all stages is occlusal equilibration. By removing overlong crowns, range of motion is increased and stasis of feed is minimized. It may be the only treatment necessary for early stages and is always helpful in the more advanced cases.

Consumption of green grass benefits range of motion by reducing the crushing direction and forces of mastication. The softer feed also promotes flow of saliva and gingival crevicular fluid and the associated immune system components, while assisting soft tissues in cleansing the tooth surfaces.

The significance of this description of tooth mobility is important in treatment. In the author’s hands, all severely mobile (grade 3 in the Tooth Mobility Index) teeth require extraction. Grade 2 teeth can be salvaged by local treatment of periodontal disease in combination with decreasing occlusal forces by reduction of the opposite tooth. Grade 1 teeth receive local treatment.

Treatment of periodontal pockets varies with needs of the individual tooth and its attachment apparatus. When decayed cementum is present, it is removed with a high-speed bur. Decayed sulcular epithelium is removed either with hand instruments or with a high-speed bur.

Adjunctive treatment is used on a case-by-case basis. It should not be the primary treatment. Local antibiotic administration is used as needed. Examples include doxycycline and chlorhexidine solution. Bone augmentation and periodontal surgery are used as needed.

Treatment by enlargement of interproximal spaces is useful in specific cases. In aging patients with triangular-shaped interproximal spaces or the so-called “valve diastema,” removal of a small part of the crown assists in improved flow of feed and reduces decay. Caution must be exerted in all patients with this condition. Young patients have a pulp in close proximity to the occlusal or interproximal surface, whereas aging patients have pulps that have reduced capability of response to insult. The use of this procedure must be carefully evaluated in all cases.

An alternative treatment for enlarged interproximal spaces in patients of all ages involves the use of polymethyl methacrylate (PMMA). The spaces can be debrided of necrotic material including the cementum. Hand instruments and high-speed burs are used. The “diastema bur” can also effectively debride cementum. The goal is to debride as much as possible.

After debridement, the space is filled with PMMA as seen in Fig. 8. The material is mixed according to manufacturer’s directions. When it begins to react, it forms a surface layer or “skin.” With moistened gloved hands, this material can easily be placed and manipulated into proper position. Digital pressure forces the material between teeth and into the periodontal pocket. Further manipulation of the material to extend lingually and buccally around a portion of each tooth assists in retention of the patch. Moisture does not inhibit curing of the material. The elevated temperature of exothermic curing is safe for the oral environment.

The PMMA is placed for the purpose of occupying space. In young horses, growth and normal mesial drift helps close the space. In aging patients, the space may never close. When these problems are encountered, the condition must be characterized as previously described. If PMMA is used, it can be replaced as needed.

Limitations include inability to completely debride the periodontium because of limited instrument length and difficult access. In such cases, the patch prevents further accumulation of feed material and the pocket undergoes physiologic debridement. Granulation tissue and epithelialization follow as underlying occlusal abnormalities are addressed.

Periodontal disease in the horse is an important problem. An understanding of related anatomy
and pathophysiology facilitates its recognition. Accurate treatment and prognosis is based on careful and complete examination.

References and Footnotes

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*Jet Dental Acrylic, Lang Dental Mfg Co., Wheeling, IL 60090.
*PowerFloat, D&B Enterprises, Inc., Calgary, Alberta, Canada T2J 5N8.