EQUINE DENTAL ANATOMY AND ORAL EXAMINATION

Cleet Griffin, DVM, DABVP, DAVDC/ Eq
College of Veterinary Medicine & Biomedical Sciences
Texas A&M University

PART I: ANATOMY

INTRODUCTION
In Merillat’s 1905 textbook Veterinary Surgery: Animal Dentistry and Diseases of the Mouth, the author pointed out an intimate relation between the well-being of the horse and the condition of its teeth, and emphasized that dental procedures “must respect the horse’s mouth”. This principle has far-reaching relevance into the here-and-now, aligning well with one of the most important maxims of practice: “Primum non nocere” (First, do no harm). It is critical in the current era of equine dentistry to remember that dental procedures are to be performed in a safe, medically sound manner. The purpose of this section is to highlight important foundational knowledge in regard to skull anatomy, oral-dental anatomy, dental eruption, and dental nomenclature.

DENTAL ANATOMY AND NOMENCLATURE

Anatomic Abbreviations

<table>
<thead>
<tr>
<th>Teeth</th>
<th>Anatomic Abbreviation</th>
</tr>
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<tbody>
<tr>
<td>Incisors</td>
<td>I1, I2, I3</td>
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<tr>
<td>Canine</td>
<td>C</td>
</tr>
<tr>
<td>Premolars</td>
<td>PM1, PM2, PM3, PM4</td>
</tr>
<tr>
<td>Molars</td>
<td>M1, M2, M3</td>
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Dental Formula of the Horse
The total number of permanent teeth depends on the presence or absence of canine teeth and PM1:
- **Permanent**: 2 (Incisors 3/3, Canines 1(0)/1(0), PM 3(4)/3(4), M 3/3) =36-44 teeth
- **Deciduous**: 2 (Incisors 3/3, Canines 0/0, PM 3/3) =24 teeth

Anatomic Considerations
- Equine teeth have long crowns that eventually form roots, these are classified as **radicular hypsodont** teeth
- There is complex arrangement of calcified tissues and pulp with the teeth of the horse
- Horses prefer to graze and chew about 16-18 hours per day; hard particles adhered to the forage contribute to attrition of the occlusal surface
- Continual eruption occurs at the same rate as attrition, and is believed to happen from tension by the fibers of the periodontal ligament
- The length of crown visible within the mouth is termed the **clinical crown**, and the unerupted portion is the **reserve crown**; the portion of the reserve crown where the roots develop is called the **apical area**
- The “Curve of Spee” is a natural upward curvature of the caudal part of the maxilla and mandible; the upper and lower jaws of the horse have differing width (anisognathia)
- Vestibule describes the space inside the mouth between the cheeks, lips, and teeth.
- Adherence of the gingiva to the tooth forms a tight seal and prevents feed material from entering into the **periodontal ligament space**
- The slim space situated between adjoining teeth is the **interproximal space**
- The **major palatine artery** courses in the submucosa rostrally from the back of the mouth to the incisive foramen in a groove along the lateral border of the hard palate, near the palatal surface of the teeth.
- A large tongue is present in horses, making access difficult to the caudal part of the mouth.
Surfaces of Teeth and Directions in the Mouth

- **Mesial** - the mesial surface of the first incisor is next to the median plane; on other teeth it is directed toward the first incisor.
- **Distal** - opposite from the mesial surface.
- **Vestibular surface** - the surface of the teeth facing the vestibule or lips; **Buccal** and **Labial** are alternatives.
- **Lingual surface** – the surface of the teeth facing the tongue; **Palatal** can be used when referring to the lingual surface of maxillary teeth.

**Triadan system**
Utilized to numerically identify specific teeth. A review of this method is provided:

- Using the three-digit system, the first digit designates the quadrant of the mouth and whether a tooth is deciduous or permanent.
- For permanent teeth: right maxilla, 1; left maxilla, 2; left mandible, 3; and right mandible, 4; deciduous teeth are designated as quadrants 5 through 8 in the same order (Fig. 3).
- The subsequent digits in the numbering system designate each tooth within the quadrant, starting with I1, which is designated as 01. The incisors are designated as teeth 01 to 03; canine teeth, 04; premolars, 05 to 08; molars, 09-11.

<table>
<thead>
<tr>
<th>Tooth Triadan number</th>
<th>Deciduous</th>
<th>Permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>6 days</td>
<td>2 ½ years</td>
</tr>
<tr>
<td>02</td>
<td>6 weeks</td>
<td>3 ½ years</td>
</tr>
<tr>
<td>03</td>
<td>6 months</td>
<td>4 ½ years</td>
</tr>
<tr>
<td>04</td>
<td>-</td>
<td>4-5 years</td>
</tr>
<tr>
<td>05</td>
<td>-</td>
<td>6 months</td>
</tr>
<tr>
<td>06</td>
<td>At birth</td>
<td>2 ½ years</td>
</tr>
<tr>
<td>07</td>
<td>At birth</td>
<td>3 years</td>
</tr>
<tr>
<td>08</td>
<td>At birth</td>
<td>4 years</td>
</tr>
<tr>
<td>09</td>
<td>-</td>
<td>10-12 months</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>2 years</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>3 ½ years</td>
</tr>
</tbody>
</table>

**Eruption Sequence of Equine Teeth, Triadan Table**

**ORAL-DENTAL STRUCTURES**

**Enamel**

- Hardest substance in the body, is an inert mineralized tissue.
- Formed by ameloblast cells at the apical aspect of the developing tooth. Ameloblasts die away once the enamel is completely developed and the tooth begins eruption.
- There are several types of enamel present in equine teeth, each having differing wear and cracking characteristics. The prisms of Type I enamel are more resistant to wear but more susceptible to cracking than Type II enamel.
- Cheek teeth contain predominately Type I enamel, whereas the incisors contain Type II enamel.

**Cementum**

- Cementum is a bone-like substance that provides bulk and substance to the tooth.
- Formed by cementoblasts in the subgingival area of the crown.
- Serves important functions with root formation and periodontal attachment.
- Cementoblasts continue to deposit cementum on the reserve crown throughout out the life of the tooth, covering the peripheral enamel on all sides of the clinical crown.
- The infundibula are filled with cementum.

**Dentin**
• The bulk of the tooth is comprised of dentin, a cream colored calcified tissue (a framework of minerals and organic material)
• Formed by odontoblast cells which reside on the periphery of the pulp
• Cell processes from the odontoblasts extend through dentinal tubules from the pulp toward the enamel
• Generally accepted classifications of equine dentin from the veterinary literature include:
  o Primary dentin - formed during tooth development; extends from the pulp cavity to the dentino-enamel junction.
  o Secondary dentin (regular and irregular) - continuous with primary dentin but appears tan-brown color at the occlusal surface due to absorption of grass pigments; irregular secondary dentin contains fewer tubules than the regular form
  o Tertiary dentin - describes a specific type of dentin produced focally in response to noxious stimuli.

Infundibulum
• Blind pouch of enamel filled by cementum that does not communicate with pulp
• Visible from the occlusal surface, these structures presumably contribute to occlusal enamel surface area and mastication
• All incisor teeth have one infundibulum and the maxillary cheek teeth have two (a mesial and distal infundibulum)
• Mandibular cheek teeth have infoldings of peripheral enamel but do not contain an infundibulum structure
• Infundibular caries of maxillary teeth result from inadequate filling by cementum and can be observed as decay on the occlusal surface of the tooth

Pulp
• The pulp has an intimate relationship to dentin and is comprised of nerves, blood vessels, lymphatics, and connective tissue within the pulp chamber and pulp horns of the teeth.
• Each incisor tooth and canine tooth possesses a single pulp chamber, while each cheek tooth possesses a common pulp chamber that branches into multiple smaller pulp horns extending toward the occlusal surface (the Triadan 06’s contain six pulp horns, the 07-10’s contain five pulp horns, and the 11’s contain up to eight pulp horns).
• The pulp courses from the apex of the tooth to within a short distance of the chewing surface, where a layer of secondary dentin serves as a bridge between the oral cavity and the pulp. With continual eruption and attrition of equine incisors and cheek teeth there is a constant need for odontoblast cells within the pulp to deposit secondary dentin to prevent pulp exposure.
• White and Dixon have shown that that the mean thickness of subocclusal secondary dentin above the pulp horns of the cheek teeth varied from 12.8mm in a four year old to 7.5mm in a sixteen year old. It is important to point out in the study that the thickness of subocclusal dentin varied greatly between individual pulp horns and was as low as 3mm in some teeth.
• Care must be exercised when reducing cheek teeth elongations in order to minimize risk exposing or causing thermal damage to the pulp.

Schematic section of a maxillary incisor tooth, illustrating the calcified dental structures, pulp, and infundibulum.
**Periodontium**

- Functions to hold the tooth within the alveolus; consists of gingiva, periodontal ligament, alveolar bone, and cementum
- Junctional epithelium forms a tight attachment of gingiva to the sides of the tooth
- The **gingival sulcus** and **free gingiva** are located occlusal to the junctional epithelium; the margin of the free gingiva is the **gingival crest**, and the **attached gingiva** is adhered to the alveolar bone
- The periodontal ligament contains collagen fibers, blood vessels and nerves; it attaches to the cementum of the tooth and the alveolar bone through Sharpey’s fibers
- The alveolus is formed by an outer layer of cortical bone, and a dense inner layer of bone termed the **lamina dura denta**; the area where the cortical and compact bone meet to form the edge of the socket is called the **alveolar crest**; the bone at the occlusal extent of the of the alveolus is termed **crestal bone**
- The arrangement of periodontal support between teeth and bone is considered a joint (therefore a tooth can undergo luxation or ankylosis)

![Schematic section of a maxillary cheek tooth. Note that the infundibulum is a blind pouch of enamel and cementum.](image)

**Paranasal Sinuses**

Sinusitis secondary to dental disease is a common clinical entity, and occurs by extension of oral bacteria into the paranasal sinuses secondary to endodontic and/or periodontal pathology involving maxillary teeth PM4, M1, M2, or M3. There are six pairs of epithelial lined sinuses in the paranasal sinus system:

- Frontal sinus
- Dorsal Conchal sinus
- Caudal Maxillary sinus
- Rostral Maxillary sinus
- Sphenopalatine sinus
- Ventral Conchal sinus

The frontal, conchal and maxillary sinuses are of particular interest from a surgical perspective, as are the locations of the infraorbital canal and nasolacrimal duct. Additional information regarding diagnostic approach to sinus-dental disease is covered in more detail by a different manuscript in this section.

**Bibliography:**

PART II: ORAL EXAMINATION

INSTRUMENTATION

Detailed examination requires adequate sedation and is facilitated by specific instrumentation including:

- Dental speculum
- Support for the head (headstand or dental halter)
- Bright light source
- Dental mirror
- Oral endoscope
- Periodontal depth probe
- Occlusal surface explorer
- High pressure water irrigation, dental scaler to assess tooth mobility, and alligator forceps for grasping debris

SEDATION-ANALGESIA

Alpha-2 agonists

- Profound sedative and analgesic effect on the horse
- Alpha-2 agonists typically used during primary dental care procedures include xylazine, detomidine, or romifidine
- Administered intravenously, and may be used alone or in combination with other drugs
- Horses receiving alpha-2 agonists should remain undisturbed for several minutes after the injection
- These drugs inhibit the swallow reflex; horses receiving alpha-2 agonists for dentistry should not be fed hay or concentrate, nor be allowed to graze, for four hours after the procedure

Butorphanol tartrate

- Opioid drug requiring special license to obtain and possess
- Good analgesic properties; causes mild sedation with minimal side effects
- Diminishes tongue movement and chewing after I.V. administration
- Combine butorphanol with an alpha-2 agonist in order to enhance the level of sedation and analgesia for dental procedures and radiographs

Alpha-2 Agonist reversal agents

- Veterinarians performing dentistry should have access to these drugs in event they are needed
- Rare fatal reactions have been described shortly after i.v. injection of alpha-2 antagonists
- Examples of reversal drugs used in horses include tolazoline, yohimbine, and atipamezole

ORAL EXAMINATION CATEGORIES
I. EXTRA-ORAL EXAM

- Look for the presence of facial swellings or draining areas and evaluate the horse’s facial symmetry and facial muscles – pay particular attention to the ear pinnae, temporal muscles, orbits, eyelids, globes, facial bones, and nostrils when evaluating symmetry.
- Unilateral nasal discharge with foul odor is always suspicious for tooth root disease with sinusitis, but other non-dental causes unilateral nasal discharge are possible.

<table>
<thead>
<tr>
<th>Causes of abnormal facial symmetry</th>
<th>Causes of abnormal swelling of the head</th>
</tr>
</thead>
<tbody>
<tr>
<td>muscle atrophy</td>
<td>tooth-root disease</td>
</tr>
<tr>
<td>soft tissue enlargement</td>
<td>eruption bumps</td>
</tr>
<tr>
<td>bony enlargement/indentation</td>
<td>neoplasia</td>
</tr>
<tr>
<td>neurological problems</td>
<td>sinus problems</td>
</tr>
<tr>
<td>skull deformity</td>
<td>trauma</td>
</tr>
</tbody>
</table>

II. OCCLUSION

Normal occlusion

- There is normal rostra-caudal relationship of the maxillary and mandibular dental arches regarding occlusion of incisor teeth and cheek teeth.
- When the horse’s mandible is in a centric position, there is a level incisor bite and the labial edge of the upper and lower incisors meet evenly.
- With cheek teeth, there’s a 10-15 degree slope of the chewing surface with enamel points on the buccal aspect of the upper cheek teeth and the lingual aspect of the lower cheek teeth.
- The rostral portion of the maxillary cheek teeth arch curves slightly toward midline.
- Toward the back of the mouth there is a normal upward curvature of the occlusal surfaces of the cheek teeth known as the Curve of Spee.

Malocclusion
Malocclusions are often described when there are overlong portions of the dentition involving the clinical crown due to a lack of attrition from opposing teeth. This situation is progressive and without intervention can result in poor mastication, soft tissue injury, and overall poor health.

- **Class 1 malocclusions** occur when there is normal relationship of the supporting bones of the teeth but specific teeth are not in the correct anatomic position in the dental quadrant (e.g. supernumerary tooth; overcrowding with misalignment of a tooth).
- **Class 2 malocclusions** occur when there is abnormal rostral-caudal relationship of the dental quadrants so that the mandibular arch occludes caudal to its normal position relative to the maxilla (e.g., overbite).
- **Class 3 malocclusions** occur when the mandibular arch occludes rostral to its normal position relative to the maxilla (e.g. underbite).

III. PERIODONTAL TISSUES

- Periodontal disease can be very painful condition, and often occurs secondary to malocclusion.
- Indicators of periodontal problems include:
  - valve diastemata and periodontal pocketing of roughage
  - gingival recession and bleeding
  - halitosis
  - calculus accumulation
  - mobile tooth
- Radiography is necessary to stage the severity of periodontal disease by evaluating the degree of crestal bone loss
- Clinical investigation of a periodontal problem includes removal of entrapped roughage with irrigation and forceps, followed by measuring pocket depth with a periodontal probe

IV. ENDODONTIC EVALUATION

- Structures of concern include the calcified dental tissues and pulp
- Commonly encountered findings include:
  - crown fractures
  - necrotic pulp exposure
  - infundibular cavities/caries
  - cemental caries
  - tooth root infection / periapical infections
  - traumatic tooth fracture and vital pulp exposure
- Close examination and radiography is indicated if endodontic disease is suspected. In the horse, an endodontic abnormality may occur in teeth that are vital and functional; however in other instances endodontic pathology may be a reflection of a severe dental disease.

V. ORAL SOFT TISSUES

- Oral soft tissues include
  - mucosa of the oral cavity
  - lips
  - cheeks
  - tongue
  - gingiva
- Look for bleeding, irritation, abrasions, and oral masses
- Particular attention should be given to the caudal part of the mouth in order to detect abrasions of the cheeks and tongue due to sharp dental points

DENTAL CHART

Equine dental charts are an important part of examination and record-keeping. An acceptable chart can be handwritten or digital format and allows for detailed documentation and methodical exam. The chart should be organized to allow ample space for annotations and remarks for each exam component, and includes signalment, chief complaint, pertinent history, physical exam findings, timeline of sedation, dental findings, problem list, treatments, and follow-up plans. An occlusal surface diagram is very a very helpful template for
documenting endodontic and periodontal pathology of the cheek teeth. It’s beyond the scope of this manuscript to address detailed dental charting procedures, but further reading can be found in alternate publications for abbreviations and information regarding record keeping of oral findings (Galloway, 2011).

Example of dental chart used in author’s practice

**SUMMARY**
Dentistry is an important component of equine practice, and practitioners performing primary dental care procedures of horses provide a valuable service to their patients and clients. Decision-making in the management of these cases requires a solid working knowledge of normal equine dental anatomy and detailed examination skills.

**Bibliography**


Dixon, P. Cheek Teeth Diastemata and Impactions. *Am Assoc of Eq Prac*, Proceedings from *Focus on Dentistry*, Indianapolis, IN, 2006


