Equine Dental Development and Its Relationship to Dental Disease

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Introduction:

Dental procedures have been routinely performed on horses for over 350 years; but only recently have we begun to understand in detail the marvel of equine dentition. A basic understanding of dental development and anatomy is the foundation for being able to perform a meaningful oral examination, diagnose dental disease and plan and carry out successful treatment. Hypsodont dentition continually changes in number, shape, position, and function throughout the horse’s life. Studies looking at the gross, histological and ultrastructural anatomy of teeth in various aged horses have given veterinarians a better understanding of tooth development and age-related changes. Advanced imaging technologies (CT and MRI) have allowed practitioners and researchers the ability to look at the internal structures of teeth in live horses and pathological specimens. References can be found in the articles cited for additional reading.

Dental Development

Dental development occurs in a series of distinct steps. Tooth formation begins by an invagination of epithelial cells into the jaw ectomesenchyme. The three hard tissues making up the tooth (enamel, dentine and cementum) begin formation and the tooth crown determines its final shape. An extension of the dental lamina of deciduous teeth protrudes and acts as the permanent tooth bud.

A functional periodontium that provides anchorage of the tooth to the alveolar bone cannot develop before the epithelial enamel organ has finished enamel production and disintegrates. At that stage, the cementoblasts come into contact with the completed enamel surface. Cementoblasts start to deposit cementum on the exposed enamel surface and collagen fibers of the periodontal ligament are integrated into this cementum. The periphery of the tooth and the alveolar bone form the 2 borders of the periodontal space which can be visualized radiographically as a radiolucent line, while the alveolar bone appears as a delicate radiodense line termed the lamina dura.

Shedding Deciduous and Erupting Permanent Teeth

The jaws of a newborn foal can accommodate only a few small teeth. Because tooth crown once formed cannot increase in size, the larger jaws of adult horses require not only more, but larger teeth. This accommodation is accomplished in horses and most other mammals with two dentitions. The progression from primary to secondary dentition involves the shedding (or exfoliation) of 24 deciduous teeth and the eruption of 36 to 44 permanent teeth. This process occurs between the 1st and 5th years
of life, with the deciduous incisor and premolar teeth being shed in the 24 months between 21/2 and 41/2 years of age.

The permanent incisors develop lingual and cause resorption of the lingual aspect of the deciduous incisor apex as the eruption force moves the tooth labial. Deciduous premolars erupt from beneath the corresponding deciduous tooth and odontoclastic activity in the tissue between the teeth leads to apical resorption and upward pressure. The erupting permanent tooth leads to exfoliation of the “cap”. The pattern of deciduous tooth eruption and cap shedding along with eruption of the permanent teeth is symmetric for the right and left sides of the mouth. This eruption schedule has been used for centuries to help age horses with fair accuracy. Recent work has shown a tendency for the mandibular teeth to erupt slightly ahead of maxillary teeth and typically, fillies shed caps about a month later than colts.

Due to the complex nature of tooth formation, jaw growth, and tooth movement into functional occlusion, it is not surprising that disturbances in this process occur. Congenital absence of a tooth or teeth may indicate some local or systemic abnormality. Premature loss of a deciduous tooth may lead to early eruption, maleruption, or abnormal development or infection of the permanent tooth. Delayed eruption of teeth is more common and can be related to congenital, local, or systemic factors. Local factors preventing tooth eruption are most common. Early loss of a deciduous tooth, with consequent drifting of adjacent teeth to block the eruption pathway, and crowding of teeth in small jaws providing little room for eruption, with consequent impaction of teeth are two examples. Prominent eruption bumps on the lower jaw are a common finding in 2 to 5 year-old horses due to tooth crown development being ahead of jaw growth and expansion. These bumps are self-limiting in most cases, but may be quite deforming to the facial area and nasal passages of young horses with small, refined heads and disproportionally large teeth.

**Dental Wear and Continual Eruption**

For equine hypsodont teeth to become functional and to remain so throughout life (20-30 years) considerable movement is required to bring them into occlusion and maintain position. The occlusal surface wears from attrition at a rate of 3-7mm per year. Tooth development and movement is complex and has a dramatic impact on dental and oral health.

Tooth movement can be broken down into three phases: pre-eruptive, eruptive and post-eruptive. Pre-eruptive tooth movement occurs by the deciduous and permanent tooth germs within the tissues of the jaws, before they begin to erupt. Eruptive tooth movement occurs by a tooth to move from its position within the bone of the jaw to its functional position in occlusion. Bone remodeling of the jaw has been linked to tooth eruption. The periodontal ligament plays a role as does the lengthening of the crown and root formation. In the equid, the tooth crown is mostly developed at the time of eruption but the true roots form slowly over several years and continue to mature throughout the life of the tooth. Post-eruptive tooth movement is responsible for maintaining the position of the erupted tooth. This process is more complicated in the equid than most other domestic species because of the length of the hypsodont tooth crown and its constant occlusal attrition caused by the abrasive nature of silicate in forage.
The horse’s teeth have an occlusal surface that changes from smooth, cement and enamel covered at eruption to one that is worn to the point of exposing the dentine and leaving the sharp columns of enamel layered between soft cementum and dentine. This configuration of tissues allows for a self-sharpening, continually wearing occlusal surface. The hypsodont teeth erupt and the alveolar bone, periodontal ligament, and gingiva are constantly remodeling to keep the tooth in proper occlusion with its opposite counterpart.

Once the horse has its permanent dentition (usually at 5-6 years of age) the teeth continue to erupt and move in the jaw throughout the animal’s life. The hypsodont equid tooth will not have a true enamel-free root at its apex at the time of eruption. Roots form over several years and continue to mature throughout the life of the tooth. Hypsodont teeth continue to erupt in response to crown attrition and maintain a consistent erupted crown height. The enamel-containing reserve crown of the tooth becomes shorter as the tooth wears. The roots become more prominent over time and the apical opening and pulp cavities will narrow. Forces of mastication—both normal and abnormal will affect tooth movement throughout the life of the horse. Normal masticatory forces will cause the teeth to wear in an even manor and slowly drift interproximal, maintaining a tightly packed abrasive surface for forage mastication. The jawbones and periodontal structures are in a constant state of remodeling to accommodate this physiologic tooth movement. Abnormal masticatory forces cause orthodontic tooth movement that can lead to malocclusions and abnormal dental wear.

During the process of eruption and occlusal wear, the pulp horns and chambers of the hypsodont tooth are actively producing secondary dentine to maintain a 5-7mm (range 2-30mm) barrier between the oral cavity and the vital pulp. This process causes changes in the size and conformation of the pulp canals as the tooth ages. The mechanism that leads to the constant production of occlusal secondary dentine is not fully understood, but the forces of mastication probably play a role. The conformation of the pulp chambers changes from occlusal to apical in the reserve crown of the teeth.

Equine cheek teeth have a complex endodontic cavity which is characterized by major age-related changes and individual variation. Up to a dental age (i.e. post eruption age of the tooth) of 2 years, equine cheek teeth have a common pulp chamber in their apical aspect that divides into separate pulp horns towards the occlusal surface, such that each mature cheek tooth eventually has 5-7 pulp horns. When root formation occurs, the pulp cavity becomes completed by the development of root canals. On the occlusal surface, the dentine overlying each pulp horn appears as a dark brown area (regular secondary dentine) with a bright center (i.e. a focal area of irregular secondary dentine). Thus, the positions of the individual pulp horns are clearly visible. Cheek teeth 07-10 have 5 pulp horns each; the 06s and the lower 11s have 6 pulp horns; and the upper 11s have 7 pulp horns. An endodontic numbering system to aid in the identification of specific pulp horns during clinical examination has been modified and this modified system is now in general use (duToit 2008).

The continued production of dentine causes narrowing of the pulp cavities and the common pulp chamber eventually disappears. The pulp system becomes divided into separate pulp compartments. A pulp compartment consists of at least one pulp horn and at least one root canal. With increasing age, this pulp compartment segmentation becomes more pronounced. The resulting configuration of
individual pulp compartments within one cheek tooth is more complex in maxillary than mandibular cheek teeth. Kopke et al, (2012) recently described the age-dependent changes and spatial configuration patterns of cheek teeth pulp compartments.

Pulp Horn Numbering System duToit 2008

Continued deposition of secondary dentine circumferentially in the pulp horns results in narrowing of the pulp horns as horses get older. Equid teeth have deposition of regular secondary dentine, irregular secondary dentine, and even tertiary dentine on the occlusal aspect of the pulp horns to prevent pulpar exposure as the teeth wear. This subocclusal dentine layer does not become thicker with age, as was traditionally believed. In fact, many older teeth have a thinner layer of subocclusal secondary dentine than younger horses. It has also been shown that great variation can occur even in the individual pulps of a single cheek tooth, with some normal teeth having as little as 2mm of subocclusal dentine. This feature is of major clinical significance when teeth are being floated (rased). While high levels of enamel (inert tissue) overgrowths can be removed, great care must be taken in reducing dentine. The distance of the pulp horn to the rostral (mesial) and caudal (distal) periphery of cheek teeth has been investigated by Bettiol et al. (2010), who showed similar small distances (3-5 mm) between pulp and tooth margin in some teeth, and also great variation for this parameter in others. Knowledge of this feature is of great clinical significance when performing diastema-widening (to treat periodontal disease associated with cheek teeth diastemata) to avoid pulp exposure.
The occlusal pressure placed on and exposure of dentinal odontoblast processes at the occlusal surface is believed to play an important role in regulating the deposition of subocclusal secondary dentine. This hypothesis was recently supported by Marshall et al. (2012) when he showed that overgrown cheek teeth often have less secondary dentine than adjacent normal teeth. This indicates that the absence of occlusal stimulus; which decreases dentinal deposition, outweighs the increased thickness due to reduced/absence of wear and to the increased eruption present in poorly or unopposed teeth.

Each incisor contains one infundibulum and each functional maxillary cheek tooth (06th to 11th) possesses 2 infundibula--one in its mesial aspect and one in its distal aspect. The upper cheek teeth infundibula extend almost the entire length of the crown (clinical and reserve crown) and thus can reach a length of up to 100mm in young teeth (Fitzgibbon et al. 2010). The incisor infundibula are considerably shorter extending for only 10–30 mm into the dental crown. Cement filling the incisor infundibulum is usually incomplete leaving a large central, infundibular cup. In contrast, maxillary cheek teeth may have a complete cemental filling with a small central opening, which is the site of a former infundibular central artery. This blood vessel provided nourishment for infundibular cementogenesis prior to tooth eruption. When the tooth breaks through the oral mucosa, the central infundibular blood vessels disrupt. Recent studies suggest that the central infundibular blood vessels are supplemented by an apical blood supply that continues for several years post eruption. In addition, blood vessels were demonstrated that enter the infundibula from the mesial side (mesial infundibulum) and from the distal side (distal infundibulum), respectively slightly subocclusally. Hence, infundibular cementogenesis does not cease abruptly when the tooth emerges through the oral mucosa.
The periodontium consists of the alveolar bone, attached gingiva, periodontal ligament and peripheral cementum. The equine periodontium is responsible for continual tooth eruption as well as structural occlusal cementum production. Staszyk and co-workers (2015) have shown the age related changes that take place as the equine tooth matures and erupts.

The Equine veterinarians who practice dentistry should review and understand the process of dental development and eruption. When the concepts are understood and applied, one will readily recognize most of the dental pathology seen in clinical practice.

**Additional Reading:**


