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Measurement of Equine Cheek Tooth Pulp Cavities From Mesial and Caudal Tooth Edges

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A newer method of treatment for periodontal disease specifically addresses the packing of food material within the interproximal spaces (IPS) of equine cheek teeth. This treatment method increases the width of the space between the teeth. If the IPS is close to the edge of the tooth, burring can open the IPS and expose a pulp cavity. This paper quantifies the distance of the cheek teeth pulp cavities to the edge of the tooth.

1. Introduction

During the past 4 yr, the authors have been treating closed (valved) diastemata (Fig. 1) by burring open the interproximal spaces (IPS) to 6 mm [1,2]. Teeth that trap food usually have a 1- to 2-mm gap present at the visible crown. This narrow space allows food to be compacted into the IPS, and because it is unable to migrate out, anaerobic fermentation of the feed material ensues. This can result in gingival recession, painful periodontitis, malodor, and eventual tooth loss.

Figure 1. A 25-yr-old Quarter horse with diastemata between 306 and 307. There is a 2.2-mm gap between the exposed crowns (white line). The cementum covering on the ends of the teeth has eroded away. - To view this image in full size go to the IVIS website at www.ivis.org . -

There are multiple etiologies for pathological diastemata. Malocclusions are the most frequent cause. Malocclusion such as excessively tall transverse ridges or overgrowths of portions of teeth may force opposing teeth apart sufficiently to allow food entry into the IPS [3-6]. Additionally, maleruption of permanent cheek teeth may lead to crevices or small spaces between teeth allowing initial food entrapment. Periodontitis precipitates local gingival mucosa recession and further packing of food material between the teeth just above the level of the alveolar bone.
Food may pack on one side of IPS beginning at the gum line and progressing to the other side of the space. Tooth to tooth contact may be maintained on the rest of the exposed crown (Fig. 2). In these cases, there may not be an obvious etiology.

Figure 2. A 25-yr-old Quarter horse. Buccal view of 208/209. Occlusal surface is ventral. Hay is entrapped at the gum line (arrows) buccally between 209 and 210. Food was packed through the entire space, and the crown ventral to the food is still in contact. - To view this image in full size go to the IVIS website at www.ivis.org . -

Diastema (open or closed) are more frequently diagnosed in middle-aged to older horses (≥15 yr). The most likely explanation is that time is required for a sufficient gap to form secondary to a malocclusion or cement erosion in the IPS secondary to periodontal pocketing. Food material can be retained between abnormally erupted teeth at any age. A malformed or deviated cheek tooth may permit entrapment of food on both the mesial and caudal ends of the tooth.
The authors have not encountered significant complications from opening or widening a diastema. The most serious concern that critics have is about the technique of pulpal exposure, which we have not documented to date. Pulp exposure could lead to pulpitis and eventual tooth loss. The authors suggest that there is a lack of vital pulp close to the edge of the tooth, and therefore, the chance of pulp exposure is limited. Secondary dentine deposition within the pulp cavities associated with periodontal disease is the proposed mechanism by which the position of viable pulp chambers can vary. Additionally, the horse may be of an age where the pulp cavities have already closed from dentine deposition.

There is some risk of exposing a pulp cavity during diastema burring and opening the IPS just as when an overerupted tooth is shortened. Maxillary cheek teeth have five pulp cavities, whereas mandibular cheek teeth have two main cavities with five or six subdivisions [7]. Pulp cavity location varies from tooth to tooth and horse to horse. A common pulp chamber is present in mandibular cheek teeth from formation until 4 - 5 yr after eruption [8]. After this age, there are two distinct root canals connecting to five or six pulp horns. There is no evidence of communication between the pulp horns. This study did not find any communication between the pulp cavities (horns) measured.

2. Materials and Methods

Fifteen horse heads obtained from a slaughter house or from horses euthanized for reasons that were not dental related were used in this study. Age was determined using standard evaluation procedures [9]. Heads were disarticulated at the temporomandibular joint. A reciprocating saw was used to cut through each cheek tooth arcade at or slightly below the level of the gum line. The positions of the pulp cavities or horns relative to the mesial and caudal limits of the tooth were measured using a digital caliper (Fig. 3) [a].

Figure 3. Measuring pulp cavity distance. - To view this image in full size go to the IVIS website at www.ivis.org . -

Pulp cavities in some teeth were completely filled with secondary dentin deposition. These pulp remnants were also measured and recorded (Fig. 4 and Fig. 5).

Figure 4. Left. A 6-yr-old horse with mandibular arcades incised at the gum line. Five and six pulp cavities are visible in the 07s and 06s, respectively. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 5. Right. A horse (16 - 18 yr old) with pulp remnants (arrows) visible. Pulp remnants contain no lumen. - To view this image in full size go to the IVIS website at www.ivis.org . -

Pulp chambers or remnants were named according to their location: rostral (mesial), caudal, buccal, or lingual (palatal). No measurement was made when a pulp cavity or remnant could not be identified. Unidentifiable pulp locations were called "nil". Measurements were made from the edge of the pulp cavity closest to the edge of the tooth (Fig. 6).

Figure 6. A closer view of tooth 407 from Fig. 3. The rostral edge is to the left. Pulp cavities, A; rostral buccal, B; rostral lingual, C; caudal lingual, D; caudal buccal, E. D measured 8.36 mm from the caudal tooth edge (red line). - To view this image in full size go to the IVIS website at www.ivis.org . -

A pulp remnant was defined as the anatomical location of a pulp cavity whose lumen could not be entered using a 25-gauge needle. Teeth with one or more open pulp cavities were classified as PC, teeth containing only pulp remnants were classified as PR, and pulp cavities that were indiscernible as a cavity or a remnant were classified as "nil". Four pulp cavities were measured or measurement was attempted on each tooth for a total of 96 pulp cavities per horse.

3. Results

Mean pulp distances for the rostral lingual (palatal), rostral buccal, caudal lingual (palatal), and caudal buccal pulp chambers were calculated for the maxillary teeth by combining Arcades 1 and 2 and for the mandibular teeth by combining Arcades 3 and 4. A total combined mean was also calculated for all pulp cavities (Fig. 7).

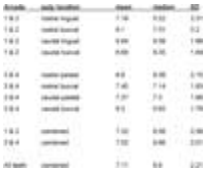

Figure 7. Mean, median, and SD for pulp locations. - To view this image in full size go to the IVIS website at www.ivis.org . -

Distances of pulp chambers ranged from 3.51 to 19.71 mm (mean = 7.11 mm). Five horses had no detectable pulp cavities in any teeth. In these horses, aged 5, 11, 13, 16-18, and 22 yr, the location of the pulp cavity was indefinable or only a pulp remnant remained. Three horses, aged 4, 7, and 11 yr, had all pulp cavities open (Fig. 8).

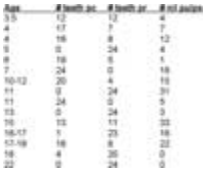

Figure 8. Teeth with one open pulp were classified as a pulp cavity (PC). All PCs in a tooth that had to be closed are called remnants (PR). Unidentifiable pulps are called nil. Ninety-six pulps per horse were measured. - To view this image in full size go to the IVIS website at www.ivis.org . -

A total of 1440 measurements were performed. Ten pulps measured 3 - 4 mm from the tooth edge (0.0069%). Sixty-seven were 4 - 5 mm from the tooth edge (4.65%), and 19 of these were pulp remnants. Fifty-three (68.83%) of the pulps 3 - 5 mm (77 total) from the tooth edge were on the caudal end of the tooth (Fig. 9 and Fig. 10).

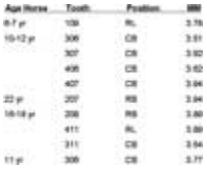

Figure 9. Distance and position of pulps measuring 3 - 4 mm. Caudal position was 60%. - To view this image in full size go to the IVIS website at www.ivis.org . -

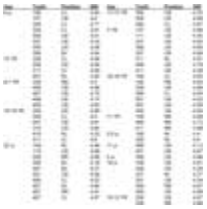

Figure 10. Distance and position of pulps measuring 4 - 5 mm. Caudal position was 70.14%. - To view this image in full size go to the IVIS website at www.ivis.org . -

Of the 1440 pulps measured, 94.65% were either ≥5 mm from the tooth edge or were not present at all.

4. Discussion

Pulp cavities located close to either the rostral or caudal end of the tooth could potentially be invaded when the IPS is burred open with a 6-mm diastema burr (Fig. 11, Fig. 12, Fig. 13).

Figure 11. First pass through the IPS with a cone burr. Width at occlusal surface is 6 mm (Fig. 1 shows the tooth before treatment). - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 12. Second pass through the IPS with a burr slightly wider down the cone. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 13. Finished gap. Burring stops at the gum level. Tooth to tooth contact is present at the bottom of the gap. - To view this image in full size go to the IVIS website at www.ivis.org . -

The low percentage of pulp cavities 3 - 4 mm of the tooth edge (0.0069%) indicates that there is a low probability of invading the pulp using a 6-mm burr. In addition, there is already a gap present (the definition of diastema) that places the pulpal cavity farther from the burr. Because 94.65% of the 1440 measured pulp cavities were ≥5 mm from the tooth edge, it seems that there is a relatively wide margin of safety when using the 6-mm diastema burr. A large percentage of 3- to 5-mm pulp cavities resided on the caudal edge of teeth, which places caudal pressure on the burr. Removing slightly more tooth material from the leading edge of the caudal tooth may lend greater safety to this procedure. This has been previously recommended by Dr. P. Dixon [b]. The authors encountered two conditions that could lead to pulpitis and eventual complications: severely shaping the upper and lower 06 teeth (bit seats) and fracturing off between one-third and one-half of the exposed crown. Bit seats that angle back the crown beginning at the gum line and ending from one-third to one-half of the tooth length distally are probably exposing pulp cavities in young horses. Despite the results presented in this study, we seldom see complications from this procedure. Fractured teeth are not uncommon and are usually an incidental finding during a dental exam.[10] Upper and lower cheek teeth may fracture from one-third to one-half of the tooth length off either side of the tooth. When this type of fracture ends at or above the alveolar bone, clinically evident pulpitis seldom develops. A review of medical records by one author (BAR) indicated that the most common complication encountered in these situations was food trapping at the base of the fracture (4 of 13 cases reviewed). Rounding the edges of the teeth mesial and distal to the fracture eliminated food trapping. Nine cases had already resolved by the gum adhering to the top of the fractured reserve crown. These two clinical observations suggest that the horse has a capacity to resolve pulp horn exposure naturally. Further study is needed in this area.

It is expected that pulp remnants and nil pulps increase as the age of the horse increases, but the data did not point to this conclusion. A larger study is needed to ascertain the validity of this hypothesis.

Footnotes

a. Mitutoyo, U. S. Electronic digital calipers, model 573-234-10, Aurora, IL 60504-9176.
b. Dixon P. Personal communication, 2003.

References

1. Carmalt JL. Understanding the equine diastema. Equine Vet Edu 2003; 15:34-35.
2. Carmalt, JL, Wilson DG. Treatment of a valve diastema in two horses. Equine Vet Edu 2004 (in press).
3. Green SK, Basile TP. Recognition and treatment of equine periodontal disease. In: Proceedings of the 48th Annual American Association of Equine Practitioners Convention 2002; 463-466.
4. Easley J. Recognition and management for the diseased equine tooth. In: Proceedings of the 37th Annual American Association of Equine Practitioners Convention 1991; 129-139.
5. Baker GJ, Easley J. Equine dentistry. New York: Saunders, 1999; 70-78.
6. Dixon PM, Tremaine WH, et al. Equine dental disease. Part 2. A long term study of 400 cases: disorders of development and variations in position of the cheek teeth. Equine Vet J 1999; 63:519-528.
7. Baker GJ, Easley J. Equine dentistry. New York: Saunders, 1999; 3-20.
8. Kirkland KD, Baker GJ. Effects of aging on the endodontic system, reserve crown and roots of equine mandibular cheek teeth. Am J Vet Res 1996; 57:31-38.
9. American Association of Equine Practitioners. Official guide to determining the age of the horse. American Association of Equine Practitioners, 2002.
10. Uhlinger C. Common abnormalities of the pre-molars and molars. In Proceedings of the 37th Annual American Association of Equine Practitioners Convention 1991; 123-127.