A prevalência de diastemas abertos ou oclusos em dentes molares de cavalos e a sua associação com doenças periodontais

The prevalence of open and closed diastemata in cheek teeth of horses and its association with periodontal disease

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Introduction

Equine diastemata are defined as a pathological dental condition that presents as abnormal spaces between two adjacent teeth within the same dental arcade (Carmalt, 2003), and its prevalence varies (e.g. Carmalt, 2003; Ramzan and Palmer, 2011). Presence of cheek teeth diastemata is considered to be grossly under-diagnosed because of its difficult to find when examining animals in vivo (Collins and Dixon, 2005).

Cheek teeth diastemata can be congenital or acquired (Collins and Dixon, 2005). Congenital diastemata are considered a result of absent or abnormally spaced dental buds (Carmalt and Wilson, 2004) thus leading to gap formation (Carmalt, 2003). Acquired diastemata develop primary due to dental displacements, fractured crowns, tooth loss and iatrogenic interference by the premature removal of deciduous teeth (Carmalt, 2003), and also secondary as a result of dental migration (Carmalt and Wilson, 2004).

Carmalt (2003) first introduced a distinguishable classification for the two types; diastemata that, ‘regardless of trapping feed between adjacent teeth and contributing to the presence of halitosis, do not result in any clinically discernible oral pain or gingival pathology’ can be classified as open; In comparison, closed (valve) diastema is described as the presence of painful spaces between adjacent cheek teeth caused by inaccurate angulation. Open diastema should allow for the ingress and egress of feed material and valve diastemata presents as a ‘triangular shaped defect’, where feed material can only ingress (Carmalt and Wilson, 2004).

The primary development of diastemata occurs as a result of insufficient rostro-caudal angulation of the cheek teeth, whereby the dental buds with normal angulation develop too far apart (Dixon, 2006). Consequently, insufficient compression occurs on...
the occlusal surface of the cheek teeth thus allowing interdental spaces to open (Baker and Easley, 2005). As the horse ages the cheek teeth remain tapered in towards their apices and the reserve crown becomes progressively smaller (Dixon, 2006). Tight compression at the occlusal surface of the cheek teeth is maintained by progressing eruption of the angulated rostral and caudal cheek teeth (Dixon, 2006). However as the horse ages and progresses into the geriatric category the reserve crown ultimately wears away and can no longer achieve compression, therefore, as a result diastemata develop (Dixon, 2006).

Diastemata can develop secondarily in conjunction with the development of acquired cheek teeth displacements (Dixon, 2006). Dixon et al. (1999) proposed that cheek teeth displacements occur due to congenital or acquired defects. Congenitally displaced caudal cheek teeth are considered to be more frequent (Dixon, 2006). Dixon (1999) and develop as a result of overcrowding of the dental arcades during the eruption period (Dixon and Dacre, 2005). Open diastemata can occur between the displaced and adjacent teeth suggesting displacements materialise due to abnormal spacing of the tooth bud, rather than overcrowding of the arcades, which, depending on breed type, can also be an occurring factor (Dixon and Dacre, 2005).

Due to the pathological nature of equine diastemata, feed material can become deeply impacted into the gingiva and periodontal tissues (Dixon et al., 2008). As a result of this, periodontal food pockets develop where food impaction becomes deeper and contribute to progressive stretching, inflammation and obliteration of the periodontal ligament (Dixon, 2006). The presence of impacted feed stasis and the results of its decomposition trigger the events of periodontal disease (Klugh, 2005).

Material and methods

Fifty cadaver heads were used in this study. These were collected from Potters abattoir, in Taunton, Somerset, United Kingdom. A convenience sampling method was implemented, as all the horses used for collection of data were the ones available for euthanasia during a single day at the abattoir.

Severity of present periodontal disease was graded from 0-4 by matching the clinical signs described in the periodontal grading system to the clinical signs presented in each cadaver, as proposed by Klugh (2005) (Table 1). The “diastemata prevalence” was visually identified using a torch and dental mirror and the “diastemata prevalence” classification (“open”, “closed”) was established using the definitions proposed by Carmalt (2003) (Table 2).

Due to the dichotomy nature of the variable “diastemata prevalence” (“open”, “closed”), several generalised linear models with links belonging to the binomial family, were adjusted and that with the best fit was chosen. The goodness of fit was evaluated via Deviance and Akaikes Information Criterion (AIC), being the best fit achieved with a logistic regression.

Three factors (“gender”, “jaw” and “side”) and two covariates (“age” and “degree of periodontal disease”) were used to model and predict prevalence of “open” or “closed” diastemata. The levels considered for the different factors were: “gender” (“gelding”, “mare”); “jaw” (“maxilla”, “mandible”); and “side” (“right”, “left”). A backwards stepwise procedure for selection of significant variables and covariates was implemented, and those found to be significant were left in the model.

“Degree of periodontal disease” was also analysed via Mann-Whitney U test for “gender” (“gelding”, “mare”); “jaw” (“maxilla”, “mandible”); “side” (“right”, “left”) and “diastemata prevalence” (“open”, “closed”). Age was also analysed via independent samples Students t test and was correlated with “degree of periodontal disease” via Spearman’s rank correlation.

### Table 1 - Stages of Periodontal Disease (Klugh, 2005)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Clinical signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal periodontium where there is no attachment loss and depth of the gingival sulcus is 5mm or less.</td>
</tr>
<tr>
<td>1</td>
<td>Presence of gingivitis, gingiva swollen and reddened. Gingival sulcus is normal depth and also there is no attachment loss. Any cemental disease remains supragingival.</td>
</tr>
<tr>
<td>2</td>
<td>Feed material is trapped in the interproximal space and further progression presents as a periodontal pocket packed with food stasis, attachment loss is 25% and sulcus depth is greater than 5mm.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate periodontal disease, where further attachment loss occurs, presence of periodontal pockets is similar to stage 2 and sulcus depth is greater than 5mm.</td>
</tr>
<tr>
<td>4</td>
<td>Severe periodontal disease including, gingival recession, ulceration, edema, gross periodontal pocketing, lysis of alveolar bone and loose teeth. In severe cases the cementum is decayed and the secular epithelium is necrotic with possible presence of purulent discharge.</td>
</tr>
</tbody>
</table>

### Table 2 - Classification of diastemata prevalence (Carmalt, 2003)

<table>
<thead>
<tr>
<th>Diastema prevalence</th>
<th>Clinical signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Pathological gaps between adjacent cheek teeth that interrupt the normal consistency of the occlusal surface. Feed material can ingress and egress.</td>
</tr>
<tr>
<td>Closed (valve)</td>
<td>The valve is enclosed rostrocaudally by the cheek teeth, ventrally by the gingiva and dorsally by the occlusal surface of the dental arcade. Feed materials can only ingress.</td>
</tr>
</tbody>
</table>

The statistical package used was the SPSS/PASW© Statistics 18. The Research was approved by the Ethics Committee of the University of the West of England (Hartpury College) (Reference: ETHICS2010/22-S).
Results

This study shows a total of 317 diastemata recorded from the sample of 50 cadaver heads used. From these 36.9% (117/317) were recorded as “closed” diastema and 63.1% (200/317) were recorded as “open” diastema. Also 68.8% (218/317) were observed in the maxilla and 31.2% (99/317) in the mandible. There is a prevalence of diastema accompanied with periodontal disease (198/317, 62.5%) against 37.5% (119/317) not accompanied by periodontal disease. Figure 1 shows the distribution of diastemata through the dentition in our study and in Ramzon and Palmer (2011); the comparison of both studies show a significant difference in the distribution ($\chi^2=293.7$, $P<0.001$).

The “degree of periodontal disease” is significantly different between: “mare” (median=2) and “geldings” (median=1) (Mann-Whitney $U=7261$, $P<0.01$); “open” (median=2) and “closed” (median=0) (Mann-Whitney $U=7568$, $P<0.001$); and “mandible” (median=2) and “maxilla” (median=1) (Mann-Whitney $U=8540$, $P<0.001$). Age is not significantly different (Student $t=1.142$, $P>0.05$) between “open” and “closed”, and also does not correlate with “degree of periodontal disease” (Spearman’s $\rho = 0.051$, $P>0.05$).

For the logistic regression modelling “diastema prevalence” the factors “jaw” ($P<0.05$) and “gender” ($P<0.01$) were found to be significant, as well as the covariate “degree of periodontal disease” ($P<0.001$). The full description of the equation parameters is presented in table 3, where the 95% confidence intervals are also stated, together with the odds ratios. For the factor “jaw”, the level “mandible” was set as the reference and as can be read in the table, “maxilla” led to a 135% increase in the odds ratio of “open” vs. “closed” diastema. Therefore, diastemata have a higher probability of being open if located in the maxilla.

<table>
<thead>
<tr>
<th>Variables in the equation</th>
<th>$\beta$</th>
<th>SE ($\beta$)</th>
<th>$P$-value</th>
<th>95% CI ($\beta$)</th>
<th>OR ($e^\beta$)</th>
<th>95% CI OR ($e^\beta$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Mare</td>
<td>0.855</td>
<td>&lt;0.01</td>
<td>0.301</td>
<td>1.409</td>
<td>1.798 2.905</td>
</tr>
<tr>
<td></td>
<td>Gelding</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaw</td>
<td>Maxilla</td>
<td>0.690</td>
<td>&lt;0.05</td>
<td>0.129</td>
<td>1.251</td>
<td>1.440 2.548</td>
</tr>
<tr>
<td></td>
<td>Mandible</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periodontal disease</td>
<td></td>
<td>0.738</td>
<td>&lt;0.001</td>
<td>0.536</td>
<td>0.940</td>
<td>1.538 2.646</td>
</tr>
</tbody>
</table>

Figure 1 – Comparison of percentages of diastemata observed in the different interproximal positions between cheek teeth in horses. From the centre to the extreme: maxilla, right 1 to 5; maxilla, left 6 to 10; mandible, left 11 to 15; mandible, right, 16 to 20.

Figure 2 - Logistic curve graphing the probability of open diastemata, as function of gender (mare, gelding), jaw (mandible, maxilla) and degree of periodontal disease.

Figure 3 - Logistic curve graphing the probability of closed diastemata, as function of gender (mare, gelding), jaw (mandible, maxilla) and degree of periodontal disease. Obtained as the complementary probability of open diastemata.
Relatively to the factor “gender”, the level “gelding” was treated as reference, and “mare” leads to an increase in 99% in the odds ratio of “open” vs. “closed” diastema. Therefore, diastemata have a higher probability of being open in mares rather than geldings. Finally, the covariate “degree of periodontal disease” was found to be positively related with open diastemata and therefore, the higher the degree of periodontal disease the higher the probability of finding open diastemata. Figure 2 uses the logistic regression fitted to graph the probability of finding open diastemata in dependency of the factors and covariate considered in the model; with figure 3 being its complement.

Discussion

Throughout the literature it is frequently acknowledged that cheek teeth diastemata are more prone to occur within the caudal aspect of the mandibular arcades (e.g. Dixon et al., 1999; Dixon et al., 2008; du Toit et al., 2009). Our results show the same tendency, but with regards to the type of diastemata, our study shows that within the maxilla, open diastemata (oD) has a higher prevalence (P<0.05) than within mandible. The distribution of diastemata through the different interdental spaces of cheek teeth did not show a specific pattern apart from the fact that the number of observations is higher in the mandible. The lack of agreement (P<0.001) with Ramzon and Palmer (2011) in this distribution is the illustration of lack of patterns and existence of some randomness.

Results from the current study illustrate that the majority of diastemata are accompanied with periodontal disease (PD) (198/317, 62.5%), which agrees with the trends of previous studies (e.g. Dixon et al., 2008; du Toit et al., 2008; Simhofer, et al., 2008). The investigation of association of degree of PD with diastemata showed a positive relation between oD and degree of PD (P<0.001). Carmalt (2003) suggest that oD do not associate with discernable oral pain or gingival pathology, such as PD. He also suggested that closed diastemata (cD) is concerned with oral pain and the trapping of feed materials, thus leading to the bacterial degradation of feed material and the development of gingivitis and PD. Carmalt (2003)’s suggestion is not confirmed by this study, however PD has been associated with older (>15 years) horses (Casey and Tremaine, 2010), with the same association being seen with regards to oD and aged horses by Townsend et al. (2008) and, therefore both PD and oD correlate positively with age and associate each other. The observation of Vlaminck et al. (2006) that PD is a slow progressing disease also corroborates this hypothesis, once if it is a slow progress, tends to be prevalent in older animals.

Degree of PD is also shown to be higher in oD than cD (P<0.01). We observe a higher probability of finding oD in the maxilla and therefore we were expecting the degree of PD to be higher in the maxilla, which does not happen. The mandible has in fact a higher degree of PD than the maxilla (P<0.01), resulting from the difference between diastemata cases (much higher in mandibles, independently of type of diastemata). It can therefore be stated from these findings that the maxilla is less likely to contain diastemata, but those that are present have a higher probability of being open and developing PD, whereas the mandibles are more likely to have a higher quantity of diastemata with these, individually, having lower probabilities of being open and therefore developing PD.

Age has been studied as a contributing factor to the prevalence of diastemata and there is literature associating age with PD and diastemata (e.g. Carmalt, 2003; Carmalt et al., 2004; du Toit et al., 2009), however in our study no relations between age, degree of periodontal disease and type of diastemata were established (P>0.05), which may be due to chance, as this relationship has become evident in several previous studies.

With regards to difference between gender it was found that mares have a higher degree of periodontal disease (P<0.01) and also higher odds (P<0.01) for oD vs. cD. This is an aspect not referred before in the literature, but it was already noted by Ramzan et al. (2009) the existence of sexual dimorphism in horse teeth. In humans it was reported that men have higher salivary Ca than Women, and that high level of salivary Ca are positively correlated with dental health (Sewon et al., 1998).

In conclusion there is limited research relating PD with the prevalence of oD and cD. The current study brings some light into this gap, showing the higher probability of development of PD in oD. With regards to gender and jaw, mares and maxilla have higher odds for development of oD than gelding and mandible. PD degree is higher in mares, oD and mandible when each variable is considered separately.

Bibliography


