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Evaluation of the long-term oral consequences of equine exodontia in 50 horses

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Abstract

The aims of this study were to objectively evaluate and quantify the process of post-extraction cheek teeth (CT) dental drift in horses, and to report on associated disorders of CT wear and long-term periodontal health. Fifty horses that had CT oral extraction because of apical infection were prospectively re-examined and a full oral examination, including measurements of some dental parameters, was performed.

Narrowing of the extraction space was noted in all cases with complete closure occurring in 18% of horses. The rate of dental drift was calculated as 15.7% of extraction space/year (range 4–50%) and was not associated with the age at extraction ($P = 0.78$) or frequency of dental care since extraction ($P = 0.48$). There was a significant negative relationship between the rate of dental drift and the duration of time since extraction ($P = 0.008$). Overgrowths were present on the opposite CT row in 98% of horses, including opposite the extracted CT and on the Triadan 06s and 11s. No significant difference was noted in either the number of diastemata ($P = 0.9$) or periodontal disease score ($P = 0.8$) between the extraction and the contralateral cheek tooth rows.

Keywords: Equine dentistry; Cheek teeth; Post-extraction dental drift

Introduction

Techniques for equine cheek tooth (CT) extraction include oral extraction (Dixon et al., 2000b, 2005; Tremaine, 2004), repulsion (Pritchard et al., 1992) and lateral buccotomy (Lane, 1997; Bossauw, 2003). The short-term post-operative complications are well described for each technique (Pritchard et al., 1992; Lane, 1997; Bossauw, 2003; Dixon et al., 2005) and the incidence of complications has been compared between techniques (Lane, 1997; Dixon et al., 2005). However, few reports have examined the long-term consequences of equine CT exodontia on the oral health of the horse. Following equine CT extraction there have been reports of abnormal behaviour during mastication and riding (Dixon et al., 2000b), changes in the wear pattern of the CT rows (Dixon et al., 2000a; Vlaminck et al., 2006) and development of significant periodontal disease (Vlaminck, 2007; Vlaminck et al., 2008).

The clinical crowns of the six equine CT are normally compressed tightly together by the caudally angled clinical crown of the 06s and the rostrally angulated clinical crowns of the 10s and 11s, so that the six teeth act as a single functional masticatory unit (Dixon, 2005). If a CT is removed from the row and there is normal angulation of the 06 and of the 10 and 11 in that row, orthodontic forces would tend to close the extraction space due to continued eruption of these angulated hypsodont teeth. Equine CT dental drift has been demonstrated in an experimental study that demonstrated narrowing of the extraction space 1 year following removal of maxillary 08s (Vlaminck et al., 2006, 2008). Studies in rats, which have a similar anatomical diastema (between the incisors and premolars) to horses, have also shown mesial (rostral) tooth drift into the empty alveolus following dental extraction (Roux et al., 1990; King et al., 1991).

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The aims of this study were to objectively evaluate and quantify the process of CT dental drift and to assess associated disorders of CT wear. The long-term gingival and periodontal health of horses post-extraction was also investigated.

Materials and methods

This study comprises data from 50 horses which had undergone CT extraction (48 by oral extraction and 2 by repulsion) at the Large Animal Hospital at The University of Edinburgh, and were prospectively re-examined. The following data were retrospectively obtained from case records, namely, age at extraction, Triadan position of the extracted tooth and the presence of any intercurrent dental abnormalities at the time of extraction. The time since extraction was calculated and a clinical history taken at the time of re-examination was used to assess the frequency of dental care since extraction. The frequency of prophylactic dental care was categorised as less frequent than yearly, yearly, or more frequent than yearly.

Oral examination and intra oral measurements

Each case underwent a full oral examination following sedation with IV romifidine (Sedivet, Boehringer Ingelheim) (80–120 μg/kg) and butorphanol (Torbugesic, Fort Dodge) (25 μg/kg). A Hausmann speculum was placed and following rinsing of the mouth, a full dental examination was made with the aid of a dental mirror and headlight. The presence and position of dental overgrowths (defined as $a > 3$ mm difference in the height of a CT) and diastemata were recorded. If diastemata were present, they were cleared of food, and the adjacent periodontium was explored with a periodontal probe. Each diastema was scored subjectively on a 1 (mild) to 3 (severe) scale for both severity of related periodontal pocketing and degree of gingival recession.

The rostro-caudal length of each of the four CT rows was measured using a length of 5 mm diameter, semi-flexible PVC tubing with a blunt metallic pin placed at right angles through its distal end, which was placed behind the 11 during measurements. Additionally the rostro-caudal length of the extraction space and the rostro-caudal length of the tooth contralateral to the extraction space were measured. All measurements were taken at the gingival margin. Repeatability of the intra-oral measuring technique was assessed in the first five horses.

Radiographic examination

In 28 cases, open-mouth oblique radiographs of the extraction CT row and the contralateral CT rows were obtained (Barakzai and Dixon, 2003). A marker of known size (20 mm diameter) was placed on the cheek next to the radiographic cassette to allow adjustments for any artefactual magnification. Measurements of the rostro-caudal length of the CT rows, extraction space and contralateral tooth were made using DICOM viewing software (AGFA CR 25, AGFA UK).

Statistical analyses

Repeatability of the intra-oral measuring technique was calculated and the radiographic and intra-oral measurements correlated using a Pearson's correlation coefficient. The length of the extraction CT row was compared to the contralateral and opposing CT rows using a paired Students *t*-test. Total number of diastemata and the sum of periodontal disease and gingival recession scores were calculated for each CT row. A Wilcoxon signed rank test was used to compare the number of diastemata on the extraction CT row pre- and post- extraction, and to compare the number of diastemata and total periodontal disease and gingival recession scores between extraction and contralateral CT rows post-extraction.

The rate of dental drift was calculated as the percentage of extraction space closure per year, and was compared with the frequency of dental care using a Kruskal–Wallis test. Regression analysis was used to compare the rate of dental drift with age at extraction and time since extraction. Regression analysis was also used to compare the frequency of dental care and dental overgrowths. Statistical analyses were performed using Minitab software and significance was set at $P < 0.05$.

Results

Median age at the time of extraction was 6 years (5–9 year interquartile range) and median duration since extraction was 4 years (1½–6½ years interquartile range). The Triadan positions of extracted teeth are shown in Fig. 1 and these comprised 43% maxillary teeth and 57% mandibular teeth, with 87% of all extracted teeth being 07, 08 or 09.

The intra-oral measuring technique was found to be repeatable (coefficient of variation, CV = 8%) and correlated well with radiographic measurements ($r = 0.85$). All horses showed narrowing of the extraction space with 48/50 (98%) of the extraction spaces containing healthy gingiva, without adjacent periodontal disease (Fig. 2). The remaining two horses had undergone extraction within the previous 6 months and had small alveolar sequestrae present, which were removed. The extraction CT row was significantly shorter than both the opposing and contralateral CT rows ($P < 0.01$). No appreciable extraction space was present in 9/50 (18%) of cases (Fig. 3) that were assessed 4–23 years post-extraction.

Exclusion of 12 horses (three had 06s extracted and nine had complete extraction space closure at the time of examination), was necessary for calculation of the rate of dental drift. The mean rate of dental drift was 15.7% of extraction space/year (range 4–50% space closure/year). In a Thoroughbred-sized horse this correlates to around 4 mm extraction space closure/year (range 0.8–10 mm/year). No significant relationship was found between the rate of dental drift and the age at extraction ($P = 0.78$; $r^2 = 0.4\%$), although a significant negative relationship was noted between the rate of dental drift and the time since extraction ($P < 0.001$, $r^2 = 65.2\%$; Fig. 4).

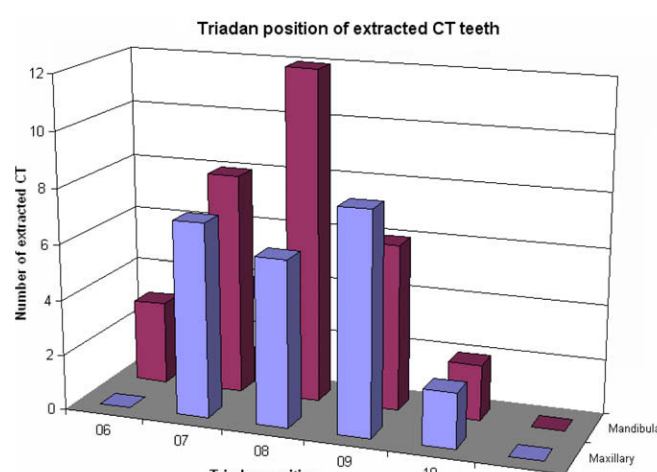

Fig. 1. Bar chart showing the Triadan distribution of extracted teeth.

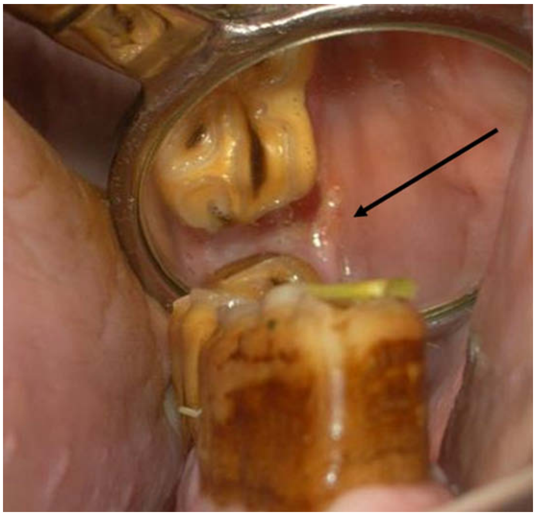

Fig. 2. Intra-oral photograph of an extraction space following CT extraction. Note the healthy appearance of the gingiva with no adjacent periodontal disease (arrow).

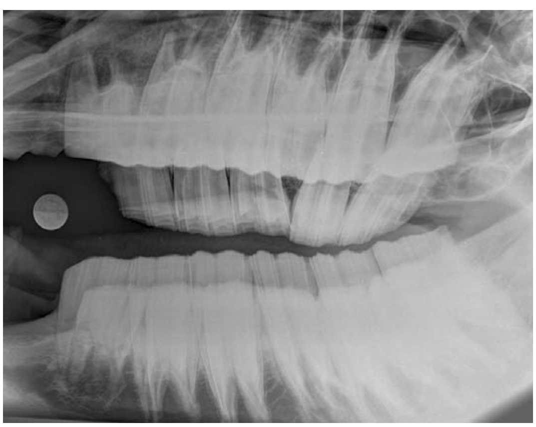

Fig. 3. Open mouth oblique radiograph with a marker of known size. The 09 had been extracted 6 years previously and the 08 and 10 have drifted to fully close the extraction space.

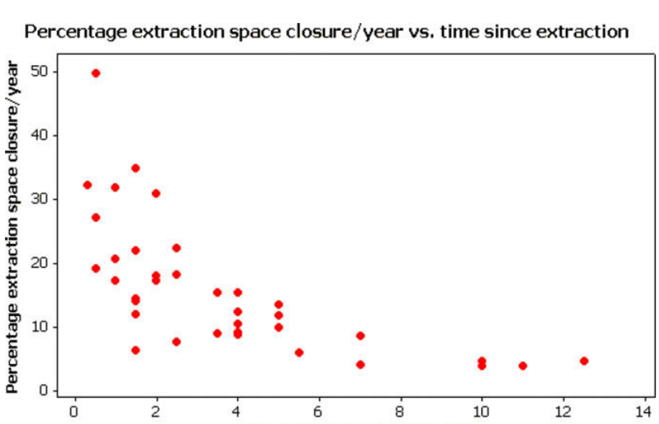

Fig. 4. Scatter plot showing time since extraction against rate of dental drift.

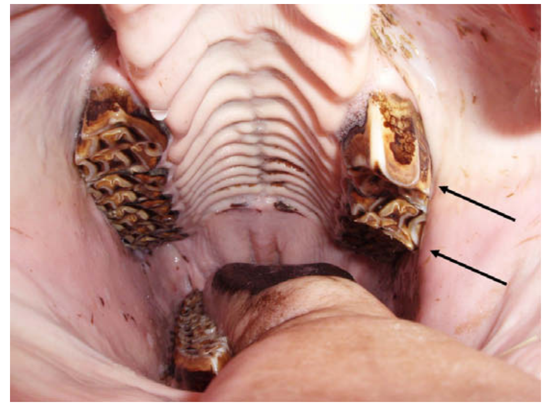

Fig. 5. Intra-oral photograph of a pony which had 307 removed 4 years previously, with no prophylactic dental care in the interim. Overgrowths are present on both 206 and 207 (arrows). Note the marked difference in clinical crown height between 106 and 206.

Table 1
The distribution of dental overgrowths on the opposing cheek teeth (CT) row.

Type of dental overgrowth	Frequency (%)
None	2
Rostral 06	5
Caudal 11	10
Opposite extraction space	35
Rostral 06 and opposite extraction space	15
Caudal 11 and opposite extraction space	7
Rostral 06 and caudal 11	6
Rostral 06 and opposite extraction space and caudal 11	20

A non-significant increase ($P = 0.12$) in the total number of diastemata in the extraction CT row was noted post-extraction in 14/50 (28%) of cases. There was no significant difference in the total number of diastemata ($P = 0.9$) or total gingival recession and periodontal disease scores ($P = 0.8$) between the extraction CT row and the contralateral CT row.

Dental overgrowths were present on the opposing CT row (Fig. 5) in 49/50 (98%) of cases and comprised rostral 06 overgrowths, overgrowths on the CT opposite the extraction space, caudal 11 overgrowths or combinations of these types of overgrowths. The distribution of dental overgrowths present is shown in Table 1. Prophylactic dental care was provided at <1 year intervals in 25% of cases, yearly in 50% and at >1 year intervals in 25% of cases. There was no association between the frequency of routine dental care and the rate of dental drift ($P = 0.48$), although a significant association ($P = 0.008$) was found between greater than yearly interval dental care and the development of caudal 11 overgrowths, with a five times increase in relative risk in less frequently treated horses. All 12 horses which received dental care at greater than yearly intervals had overgrowths in all three positions on the opposing row. Rostral 06 and caudal 11 overgrowths were present in all nine horses that had complete closure of the extraction space.

Discussion

The median age of horses included in this study and the distribution of Triadan position of teeth are similar to those reported in other studies (Pritchard et al., 1992; Dixon et al., 2000b, 2005). The rate of dental drift (15.7% of extraction space/year) was slower than reported by Vlaminck et al. (2006, 2008), who calculated a rate of 39–41% extraction space closure/year (9.1–10.7 mm/year) following repulsion of maxillary 08s or 09s. However, the studies by Vlaminck et al. (2006, 2008) employed radiographic measurements taken at the occlusal surface of CT, whereas the current study used measurements taken at the level of the gingival margin. Open-mouth radiography of cases where the extraction space had not yet closed illustrates that the teeth on either side of the extraction space angulate towards each other as they drift, so that the extraction space between the occlusal surfaces is much narrower than that at the gingival margin (Fig. 6).

Vlaminck et al. (2006, 2008) used repulsion as their technique of dental extraction and this was employed in experimental ponies (i.e. without apical infection), whereas the current study involved only clinical cases of periapical infection, most of which had undergone oral extraction and was mainly in larger horses. The effect of apical infection, method of extraction or breed of horse on the subsequent rate of dental drift is not known. Certainly, periapical infection commonly expands the apical aspect of the affected alveolus and can cause sclerosis of both the alveolus and deeper periapical bony structures which may affect the rate of dental drift. Extraction by repulsion clearly causes more damage to the dental alveolus and surrounding bony structures than oral extraction (Dixon et al., 2005) and this too may have consequences for subsequent movement of remaining teeth.

No periodontal pocketing was present within the extraction space in the current study. This is in contrast to a previous study which reported periodontal disease (Fig. 7) to be present in clinical cases with a small (1–4 mm) extraction space, although 75% of these cases had undergone extraction via repulsion rather than oral extraction (Vlaminck, 2007). Complete extraction space closure was noted 4–23 years post-extraction in our post-extraction population, which is similar to Vlaminck's (2007) findings of complete extraction space closure in 17% of cases, the earliest of which was noted at 3 years after extraction.

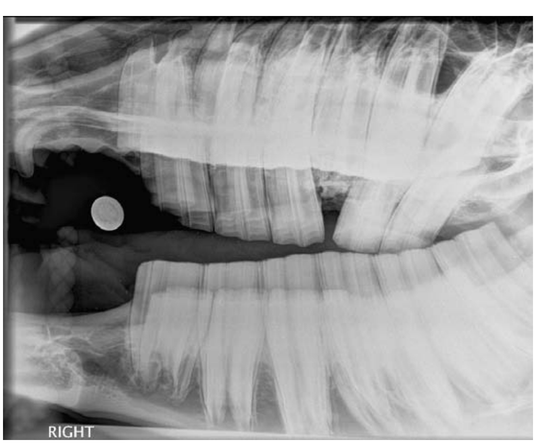

Fig. 6. Post-extraction radiograph where complete closure of the extraction space had not yet occurred. Note the marked angulation of the teeth on either side of the extraction space towards each other which results in the teeth being closer together at their occlusal aspects than at gingival level.

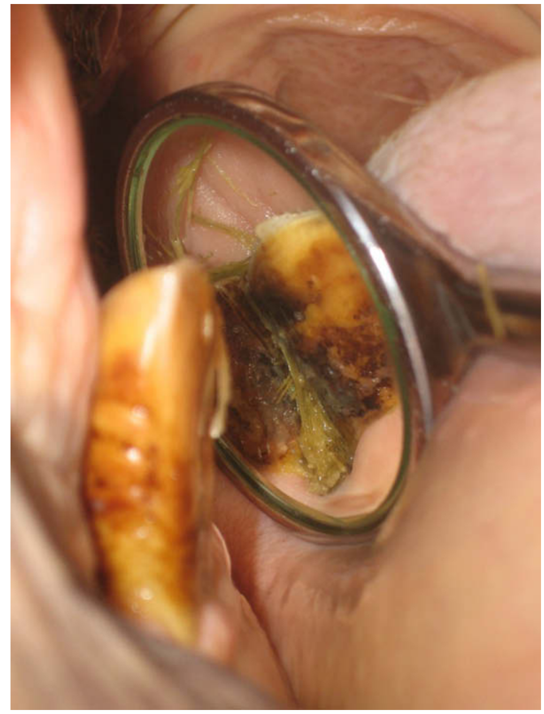

Fig. 7. Diastema with moderate periodontal disease.

No association was found between the age at extraction and the rate of dental drift in this study. Eruption rates of equine CT are anecdotally faster in younger animals (Klugh, 2001; Baker, 2005), therefore one might expect the rate of dental drift to be faster in younger horses. It is possible that this effect may have been present, but it was not detected due to the wide range of re-examination times post-extraction and relatively small number of horses in our study. A negative non-linear relationship between the rate of dental drift and duration of time since extraction was noted (Fig. 4) indicating that the rate of dental drift may not be constant. Vlaminck et al. (2006, 2008) reported that the rate of extraction space closure slowed from 41%/year (10.7 mm/year) after year 1 to 31.2%/year (9.1 mm/year) after year 2.

Due to the relatively small numbers in the present study there was insufficient statistical power to investigate the influence of the Triadan position of the extracted CT, or the influence of the extracted CT being from a mandibular or a maxillary CT row, on the rate of dental drift. It has been speculated that the rate of dental drift would be faster in maxillary than mandibular CT due to differences in the structure of the supporting bones (Vlaminck et al., 2006, 2008).

Continued eruption of angulated hypsodont teeth from two directions is certainly a contributing factor to the marked dental drifting observed in this study. In contrast, in brachydont species angulation of the caudal molar tooth is only one factor in dental drifting with other contributing factors including forces from the cheek and tongue, forces from occlusion and contraction of trans-septal fibres (Moss and Picton, 1970; Picton and Moss, 1974). The contributions of other factors such as the cheek and tongue on equine CT drifting are unknown.

Similar to previous repulsion studies (Vlaminck, 2007), we found an increase in the number of diastemata present in the extraction row in 28% of horses when comparing diastemata present at the time of extraction (ascertained by pre-surgical dental records) and at re-examination, although this increase was not statistically significant. Vlaminck (2007) suggested that development of diastemata between teeth in both the rostral and caudal block of teeth on either side of the extraction space may be due to lack of rostro-caudal occlusal compression. However, we found no significant difference in either the total number of diastemata or total periodontal and gingival recession scores between extraction and contralateral CT rows, indicating that the intra-oral changes present were bilateral. This bilateral increase in periodontal score has been noted previously in a study of 105 horses (Vlaminck, 2007). We propose that such bilateral change may be age-related because diastemata are more common in older horses (Miles and Grigson, 1990; Collins and Dixon, 2005) and it has been suggested that a large proportion of horses over the age of 15 years have significant periodontal disease (Baker, 1970). In order for diastemata to develop as a consequence of dental extraction, the remaining CT would have to drift at different rates. The clinical and radiographic impression from this study is that the rostral and caudal groups of the remaining teeth drift in an 'en bloc' fashion, without development of diastemata between individual teeth.

Following oral extraction in this hospital we recommend 6-monthly dental care, which had not been performed in 75% of the cases included in this study. As a consequence, 98% of cases had dental overgrowths on the opposing CT row at the time of re-examination, with an overgrowth opposite the extraction space being the most prevalent type. This type of dental overgrowth is most likely due to a combination of lack of attrition and increased rate of eruption of the opposing tooth (Dixon et al., 2000a; Dixon and Dacre, 2005; Vlaminck et al., 2006; Vlaminck, 2007). All cases with complete extraction space closure had rostral 06 and caudal 11 overgrowths on the opposing CT row that were now longer than the extraction CT row. A consequence of these dental overgrowths may be a decreased range of rostro-caudal motion of the mandible (Carmalt et al., 2003) and trauma to the oral soft tissues with subsequent 'quidding' in severe cases (Dixon and Dacre, 2005). These overgrowths may cause malocclusion of the teeth, which has been shown in human studies to predispose to temporomandibular joint disease (Okeson, 2003), but an association between dental disease and TMJ disease has not been proven in the horse (Ramzan, 2006).

Further work to evaluate the long-term consequences of equine exodontia should involve serial examinations of a larger cohort of horses post-extraction to attempt to determine the influence of Triadan position, mandibular vs. maxillary position, and age on the rate of dental drift, and determine more accurately the relationship between time post-extraction on the rate of dental drift.

Conclusions

Dental drifting occurs after equine CT exodontia with complete closure of the extraction space occurring in as little as 4 years in some cases. The teeth on either side of the extraction tend to move in an 'en bloc' fashion to close the extraction space, without development of diastemata between individual teeth. Exodontia is associated with the development of dental overgrowths on the opposing CT row which require regular dental care to prevent masticatory difficulties, malocclusions and damage to the oral soft tissues.

Conflict of interest statement

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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