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Original Research

Effect of Dental Correction on Fecal Fiber Length in Horses

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ABSTRACT

The aim of the study was to determine if dental correction changes fecal fiber length (FFL) in horses that had never been subjected to dental treatments. Thirty adult horses with mild to moderate dental abnormalities were selected. Dental disorders noted included sharp enamel points, focal overgrowths, shear mouth, step mouth, wave mouth, accentuated transverse ridges, and diastema. The horses were confined to individual stalls and fed Tifton hay (*Cynodon* spp.) 1.5% bwt/d, divided equally between two feedings. Fecal samples were taken for FFL analysis before (Day 0) and after (Day 15) dental correction. Mean FFL, determined by laboratory analysis, was recorded for each horse and time. The results were submitted to analysis of variance using the SAS statistical program, and means were compared by *T*-test ($P < .05$). Dental treatment resulted in significant ($P < .05$) reductions in FFL, with mean ± standard deviation of 3.27 ± 2.27 mm before dental correction and 2.15 ± 1.29 mm after correction. The results suggest that dental treatment improved the mastication efficiency and that FFL can be used to assess the dental health of equines.

1. Introduction

In equines, the availability of structural carbohydrates depends largely on the adequate breakdown of the physical–chemical barrier of plant material to expose the cell membrane content, which occurs mainly by grinding during chewing [1,2]. Inefficient mastication due to pain or biomechanical changes triggered by oral pathologies can impair the grinding of feedstuffs and hence their digestibility [3], causing weight loss and development of colic by impaction besides hampering the performance of sporting animals [4,5].

An efficient and noninvasive method to evaluate oral health and chewing efficiency in equines is to determine the fecal fiber length (FFL) [3,6,7]. Various studies have evaluated the effect of dental correction on the FFL, but in some cases, the results have been contradictory. For example, this led to a reduction of FFL in pregnant mares [8] and in adult donkeys [7]. However, dental correction did not reduce the length of the fecal fibers in pregnant mares [9] and adult Warmblood horses with moderate oral pathologies [10].

The discrepancies between results can be associated with different degrees of dental abnormalities of the animal's evaluated [10]. Animals with severe masticatory disorders tend to present better improvements after dental treatment than animals with mild abnormalities [2,3,9]. On the other hand, a diet rich in concentrate has greater digestibility of dry matter than one based only on supply of hay [1]. Therefore, studies in which the hay/concentrate ratio was not rigorously controlled, before and after dental treatment, can produce misleading results, especially if the horses start to eat a larger quantity of hay after treatment. The use of different methods to measure FFL can also affect the results of investigations [6,7,10]. Therefore, the study reported here was conceived to evaluate the effect of dental correction on the fecal fiber size in horses without the history of previous dental treatment and fed exclusively with Tifton hay (*Cynodon* spp), before and after treatment.

Animal welfare/ethical statement: All procedures including dental examinations and treatments were approved as adhering to animal welfare guidelines by the Ethics Committee of the Espírito Santo University Center (UNESC), under protocol number (246574). The dental treatments were performed by a qualified equine dental technician.

Conflict of interest statement: The authors declare no competing interests. None of the authors has any financial or personal relationships with other people or organizations that could inappropriately influence or be perceived to influence the content of the article.

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2. Material and Methods

2.1. Horses

Thirty horses of mixed breed aged from 4 to 19 years (10 geldings and 20 mares) with no history of previous dental treatments were used. The horses were given a preliminary dental examination to ensure that none had severe abnormalities. They all had a body condition score of 3 or 4 [11] and weighed between 394 and 415 kg. The animals were kept at the same farm located in Colatina, Espírito Santo, Brazil. All animals were clinically healthy and had received routine vaccinations and anthelmintic administration before the start of the trials. The horses were confined to individual stalls with cement floors and wood shaving bedding and fed Tifton hay (*Cynodon* spp) at 1.5% bwt/d, divided equally between two feedings. The animals had a period of 5 days for adaptation.

2.2. Fecal Sampling Protocol and Laboratory Analysis of FFL

Immediately before, and 15 days after dental treatment, fecal grab samples (200 grams) were collected from the rectum to measure particle size. All samples were placed in an oven at 150°C for 2 hours, and then the dried samples were gently sieved through a 1 cm sieve, using a soft bristle brush to encourage fiber separation while attempting to prevent attrition to the fiber length during the process. Thirty fecal fibers from each sample were measured. Fibers were removed from the grid using tweezers, placed on a white surface, and individually measured using an Absolute Digimatic digital vernier caliper (Mitutoyo model 500-196-20, accuracy ± 0.01 mm). The FFL analysis procedure was repeated for each sample on Day 0 and Day 15.

2.3. Dental Treatment

Dental examination and treatment were performed for 2 days after the first fecal samples had been collected (Day 0). All animals were treated by the same veterinary dentist. The horses were sedated with a combination of detomidine (Detomidin; Syntec, Brazil) and butorphanol (Turbogesic; Fort Dodge). After the horses calmed down, an exact examination of the teeth was carried out. The animals were checked for swelling or the lymph nodes of the head, bad breath or ocular or nasal discharge. None of these symptoms were detected. Dental disorders noted included sharp enamel points, focal overgrowths, shear mouth, step mouth, wave mouth, accentuated transverse ridges, and diastema (Table 1). Routine dental treatment (rasping) was performed to reduce overgrowth, remove sharp enamel points, increase lateral excursion, restore balance of the arcades, and establish correct occlusal angles. First premolars were extracted.

2.4. Statistical Analysis

Mean and standard deviations were calculated. For comparison of two means (before and after), the paired *t*-test was used. Two-way analysis of variance was also applied. A *P*-value < .05 was considered significant. The SAS software was used (SAS Institute Inc., Cary, NC, 2012).

Table 1
Prevalence (%) of dental abnormalities in 30 horses.

Dental Abnormalities	Horses
Soft tissue lesions	100
Sharp enamel points	100
Diastema	20
Shear mouth	20
Step mouth	20
Wave mouth	10
Accentuated transverse ridges	10
First premolars	3

3. Results

None of the horses had severe dental abnormalities although all had minor hooks and points. The dental abnormalities are reported in Table 1. Most animals (90%) presented higher FFL before dental correction compared with the value after correction (Table 2). Treatment of teeth had an effect on fecal particle size: after dental treatment, the FFLs decreased (Table 3).

4. Discussion

In this study, horses with good body condition and free of severe chewing disorders and prior dental treatments were evaluated. The dental alterations did not differ greatly among the horses and were corrected by routine treatment (rasping).

Before treatment, the majority of the animals (n = 17; 56.6%) presented FFL greater than 3.6 mm (Table 2), a length considered to indicate the presence of oral pathologies in horses [8,11]. After dental correction, the FFL declined to under 3.6 mm in 16 of these animals (53.3%). A reduction in FFL was also reported in adult donkeys after routine dentistry [7]. In that study, FFL values greater than 3.3 mm were associated with the presence of dental alterations. According to the authors, the measurement of FFL is a useful noninvasive method to monitor the oral health of donkeys. Similar results were observed in pregnant mares after dental correction [8]. Routine dental treatment makes mastication more efficient because it reduces the restriction to occlusal contact, permitting

Table 2
Individual FFL across the 15 days (in mm).

Horse	FFL in Millimeters (mm) After Routine Dental Treatment	
	Day 0	Day 15
1	5	3.5
2	4	3
3	4.5	3.5
4	7.0	3.5
5	3.7	2.5
6	6.8	5.5
7	4	1.5
8	1.5	1
9	1	0.7
10	3.7	2.5
11	4	3
12	0.8	0.6
13	2	1
14	4	2.5
15	2	1
16	1	1
17	2	1.5
18	2.5	2
19	1.35	0.85
20	3.8	3
21	4.3	2
22	2	1
23	2	1.5
24	5	3.5
25	4	3
26	1	1
27	5	3.5
28	3.7	3
29	2.5	2.5
30	4	3.5
Mean	3.27	2.15
Standard deviation	2.27	1.29

Abbreviation: FFL, fecal fiber length.

Table 3
Fecal fiber length in millimeters during the study period.

Fecal Fiber Length (mm)				
Time	Mean ± Standard Deviation	Minimum	Maximum	CV
Predentistry (Day 0)	3.27 ± 2.27 A	0.8	9.5	65.7
Postdentistry (Day 15)	2.15 ± 1.29 B	0.6	5.5	56.8

Means followed by different capital letters differ significantly between times (*t*-test at $P < .05$).

complete mandibular movement and improving the friction of the teeth [1,3,12]. Therefore, the results of these studies demonstrate that dental correction makes chewing friction more efficient, resulting in smaller FFL.

Other studies, however, have brought unexpected and contradictory results. Nine adult Warmblood horses with moderate oral pathologies were submitted to dental correction. During the study, the animals were fed with hay and a mixture of oats, barley, and corn. The dental treatment did not reduce the FFL, but it improved the digestibility. Animals that received a diet with higher proportion of concentrate showed greater improvement in digestibility. There was no correlation between the severity or type of dental alteration and the improvement in apparent feed digestibility [10].

The size of the fecal fiber generally represents the size of the fiber after chewing because this measure does not undergo considerable reduction during passage of the fiber through the gastrointestinal tract. This is true of horses [12,13] and ruminants [14]. This pattern does not apply to starch particles, which are generally more rounded in shape and are largely digested or fermented. In the starch present in unprocessed grains, the structures of the plants act as barriers to the action of amylase in the gastrointestinal tract and may or may not be destroyed during mastication. When grains are destroyed mechanically, the starch granules become more susceptible to digestion by amylase. Therefore, the simple fact of using different types of mills to grind corn, for example, results in different intestinal digestibility rates. This can have direct effects on the digestibility of grains and indirect effects on the digestibility of forage due to the interaction of starch and fermentation fiber in the gut [1,3]. Therefore, the effects of correction of moderate dental abnormalities can have a more significant result on the structure of the particles of concentrated feed, especially grains, than on forage material after mastication. The hypothesis can explain why the effects of dental correction in the study conducted by Zwirglmaier [10] were more accentuated and less variable in horses fed with higher percentages of grain.

These considerations also shed light on why horses with severe dental alterations present more significant improvements in digestibility and reduction of FFL after dental treatment than horses with milder dental alterations and without clinical repercussions, as observed by Carmalt [9] in analyzing 56 pregnant mares. The mares were fed diets with different types of concentrate and hay, as well as a diet composed only of hay. The dental correction did not alter the variables assessed. According to the authors, additional studies are necessary to determine the clinical utility of regular dental correction in apparently healthy horses.

Carmalt and Allen [2] conducted a postmortem study to evaluate the effect of dental correction on digestibility and FFL. Seventeen horses were fed 1 of 3 diets composed only of hay (with variation of fiber length). After 14 days, the animals were euthanized. The size of the feed particles differed significantly among the 3 diets, but the stomach content and size of the fecal particles did not differ among the diet groups. In addition, the size of the fecal particles did not differ significantly from those in the stomach, further evidence that despite the digestive process, there is no additional reduction of the particle size as the ingesta passes through the gastrointestinal tract. This suggests that the chewing process is the main determinant of the reduction of the FFL, as also found by other studies [14]. In turn, Carmalt [15] found that molar occlusal angles ranging between 6° and 19° were not significantly associated with feed digestibility, water balance, or fecal particle size in pregnant mares.

Besides the type of feed given to animals, that is, forage or concentrate, another factor that can contribute to obtaining contradictory results regarding the effect of dental correction on FFL in horses is failure to consider the period for chewing adaptation after dental treatment. The first week after dental correction is a period of fluctuations in the masticatory cycle, demonstrated by changes in the lateral excursion as well as the strength and load of the masseter and temporal muscles [16,17]. Therefore, the existence of this adaptation period can explain why some researchers have not found a reduction of the fecal fiber size immediately after dental correction. In this case, only animals with severe masticatory alterations typically presented a significant reduction of FFL, as observed in donkeys at the Donkey Sanctuary of Woods Farm, Devon, UK [7]. The horses in our study, although not suffering from severe dental pathologies, were adult animals that had never been submitted to dental correction, besides being fed exclusively with hay.

Unexpectedly, Gunnarsdottir et al [5] found that the presence of severe dental pathologies and the FFL were not key factors in the complex etiology of large colon impaction in horses. There was no association between the estimated fecal particle size and the dental alteration scores in the animals with and without colic. The horses that developed large colon impaction did not suffer from worse dentition than the control horses. More surprisingly, the size of the fecal particles was larger in the control animals. Feed ingested containing long fibers require a longer time to pass through the gut, which is a physiological response to offset the slower digestion. The reduction of fiber length increases the passage rate of the ingesta though horses' intestinal tract [12]. These data support the hypothesis that the length of fiber ingested is a factor in the pathogenesis of colon impaction, although the study of Gunnarsdottir et al [5] corroborated the findings of Dabareiner and White [18] that large colon impaction in horses has a complex and multifactorial etiology.

The use of different techniques to measure FFL also could be a contributing factor to the nonsignificant results regarding decrease of FFL after dental correction. Some techniques cause excessive friction of fecal fibers, producing measurements that do not represent the true FFL [6,13]. For the same reason, the use of sieves with different mesh sizes also should be avoided. The technique used in our study and by Johnson et al [7] resulted in findings of significant reduction of FFL in horses and donkeys, respectively. According to the latter researchers, the technique should be validated and used in the assessment of the masticatory and digestive efficiency of donkeys. It can also be a tool for monitoring the need for dental correction to improve animal welfare. This observation can be extended to horses.

5. Conclusions

In conclusion, correction of mild to moderate dental abnormalities in horses that had never received dental treatment resulted in significant reductions in FFL, suggesting that dental treatment improves the efficiency of mastication. Regular dental correction can thus be recommended.

Acknowledgments

Authors' contributions: P.A.D.F., V.V., and D.A.R. participated in the design of the study, supervised the experiments, revised and submitted the final manuscript. P.A.D.F. and C.R.Q. performed statistical analysis and prepared the final draft of the manuscript. All authors were involved in discussing and interpreting the data described in this study, critically read the manuscript, and approved its final version.

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