http://dx.doi.org/10.1590/1678-4162-12678

Arq. Bras. Med. Vet. Zootec., v.75, n.3, p.415-424, 2023

Influence of oral health on the facial expressions and on the acupuncture examination in equines

[*Inflluência da saúde da cavidade oral na expressão facial e exame de acupuntura em equinos*]

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ABSTRACT

The present study investigated the influence of oral health on horses' facial expression, reactivity of the acupuncture points and the perception of trainers and owners. We investigated 87 adult horses involved in sports or working activities. Pain was scored in person and by photography by an evaluator "blinded" to the animals' dental condition, using the Horse Grimace Scale (HGS). The acupuncture examination was performed by the same evaluator. Animals were evaluated before (T0) and 15 days (T1) after dental treatment. All horses included in the study had dental disorders. Statistically significant results were seen in median HGS scoring (3 vs. 1, p = 0.001) and number of reactive acupoints (11.2±5.6 vs. 4±2.9, p = 0.001). Additionally, complaints by the trainers/owners were lower at T1 compared with T0. There was a reduction in the pain reaction to application of pressure on following acupoints: dental point (44 vs. 4), Stomach-7 (31 vs. 3), Tiple-Heater (TH)-17 (27 vs. 4), and TH-16 (22 vs. 4). We concluded that acupuncture can be an adjunct method for diagnosis of dental disorders and treatment follow-up.

Keywords: horse grimace scale, dental disorders; mouth, welfare

RESUMO

Este estudo avaliou a influência da saúde bucal na saúde geral de cavalos, por meio da expressão facial, do exame de acupuntura e da percepção geral dos treinadores/proprietários. Avaliaram-se 87 cavalos adultos, envolvidos em atividades esportivas ou de trabalho. A dor foi avaliada pela Horse Grimace Scale*, presencialmente e por fotografia, por um avaliador que desconhecia a condição dos animais. Os exames de acupuntura foram realizados sempre pelo mesmo avaliador. As avaliações ocorreram antes (T0) e 15 dias (T1) após o tratamento odontológico. Todos os cavalos estudados apresentavam alterações odontológicas. Observou-se redução significativa na mediana do escore de dor (3* vs. *1, P = 0,001), no número de acupontos reativos (11,2±5,6* vs. *4±2,9, P = 0,001) e nas reclamações dos responsáveis em T1 em relação a T0. Também houve redução na sensibilidade nos acupontos 'ponto do dente' (44* vs. *4), estômago-7 (31* vs. *3), triplo aquecedor (TA)-17 (27* vs. *4) e TA-16 (22* vs. *4). Concluindo, o presente estudo mostrou que a acupuntura pode auxiliar no diagnóstico de problemas odontológicos e no acompanhamento pós-tratamento da cavidade bucal.*

Palavras-chave: bem-estar, cavalo, cavidade bucal, expressão facial

INTRODUCTION

Dental disorders are the third most common cause of equine diseases in North America. Since these affections have great importance in the clinical practice of horses, there is increased interest in the field of equine dentistry (Dixon, 2017).

The presence of excessive enamel points (EEP) is the most frequent dental disorder in horses with prevalence of 70–90% in domesticated horses (Dixon *et al*., 2000). The EEP is related to pain or discomfort during mastication or work. Moreover, it may lead to ulceration of buccal mucosa, oral pain, weight loss, and training problems (Pagliosa *et al*., 2006; Easley *et al*., 2011). Another common finding is the presence

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Submitted: January 25, 2022. Accepted: January 27, 2023.

of the first premolar (wolf teeth) in 13-80% of horses depending on the breed studied (Dixon and Dacre, 2005; Fernandes Filho *et al*., 2014). The "Wolf teeth" (Triadan 05) are usually blamed for oral discomfort and behavioral and training problems due to interference with the bite and are extracted as a result. However, some authors claim that these teeth generally do not cause problems unless they are large, sharp, malpositioned or impacted (Dixon and Dacre, 2005; Easley *et al*., 2011; Fernandes Filho *et al*., 2014). Hence, the need for their removal is controversial (Scrutchfield, 2006; Dixon, 2017). Other dental disorders such as retention of deciduous teeth, diastema, periodontitis, hooks, steps, and ramps can also result in oral discomfort, and must be corrected (Dixon and Dacre, 2005; Easley *et al*., 2011; Amaya *et al*., 2012).

Even though it is accepted that these dental disorders are usually associated with changes in the masticatory pattern, dysphagia, weight loss, gastrointestinal disorders, and different levels of discomfort and pain (Ashley *et al*., 2005; Ardila and Montoya, 2009; Amaya *et al*., 2012; Dixon, 2017), they may not always manifested with apparent clinical signs, and horses could experience dental conditions without receiving an early diagnosis or timely care (Amaya *et al*., 2012; Alencar-Araripe *et al*., 2013; Coneglian *et al*., 2020). Our recent study revealed that horses manifest discomfort or pain with modification of facial expression due to disorders of the oral cavity using the Horse Grimace Scale (HGS). This study presented an additional method of identifying pain due to dental disorders (Coneglian *et al*., 2020).

The application of pressure to acupuncture points is a technique commonly used in the diagnosis of different conditions in horses, besides serving as a parameter for general evaluation of animal welfare (Fleming, 2006; Michelotto *et al*., 2014; Pellegrini *et al*., 2018). Although the use of acupuncture in veterinary medicine has been documented for thousands of years, Western scientific research on its efficacy is much more recent (Ramey, 2005; Le Jeune and Jones; 2014, Michelotto *et al*., 2014; Mariani *et al*., 2019). Some acupoints are diagnostic for temporomandibular joint, head, and mouth conditions, and considered as the dental point (Cain, 2015), other related points are Stomach (ST)-7, Triple Heather (TH)-16, TH-17, Gall Bladder (GB)-1, GB-20, Small Intestine (SI)-10 (Fleming, 2006; Xie and Preast, 2011); however, this has not been adequately investigated.

The present study aimed to evaluate the influence of dental treatment on the general welfare of the horses, using the pressuring of acupoints, pain score using the HGS and owners'/trainers' perception, at baseline and 15 days post treatment.

MATERIAL AND METHODS

The present study is a cohort study, approved by the Ethics Committee on the Animal Use of the Pontifícia Universidade Católica do Paraná, Brazil, registered as number 01083/2016.

A total of 87 adult horses were included (33 Thoroughbred, 26 Criollo horse, 12 Quarter Horse, 9 Brazilian Mangalarga Marchador, 6 cross breed and 1 Arabian), 49 females and 38 males, aged between 1.8 and 24.0 years (4.48±3.75), from the cities of Guarapuava and Curitiba, Paraná State, south region of Brazil. All the selected horses were involved in sports activities, such as racehorses (n = 33), barrel racing or calf roping (n = 41), working cow horse (n = 3), pace (n = 9), and horse therapy (n = 1). All the horses were engaged in full-time activity before and during the study. Exclusion criteria included horses under any clinical care, those that developed any clinical condition during the study period and those received dental treatment in the previous six months. The evaluations were performed at the horse's environment and preferentially without changes in their routines.

At baseline T0, the following investigation were carried out in order to evaluate the selected horses: HGS for pain scoring; general physical examination mainly for heart and respiratory rates; locomotion observation; acupuncture examination to evaluate reactivity by pressurizing the acupoints; evaluation of the oral cavity; finally, further anamnesis was carried out with regard to the perception of the responsible person about the horses with regard to quality of chewing and working. After 15 days of oral cavity treatment (T1), horses were re-evaluated in the same environment using the same methods.

For the evaluation of the pain score, six facial characteristics of the horses were monitored as described by Dalla Costa *et al*. (2014): ears set back, orbital tightness, tension above the eye area, prominent tense masticatory muscles, tense mouth and pronounced chin, and tense nostrils and flattened profile. The evaluations were made by the same researcher and for each of the characteristics, the observer gave a score using a 3-point Likert scale (0= not present, 1= moderately present, 2= obviously present). Consequently, the maximum possible HGS score was 12. The researcher stood approximately 1 meter away from the horse, in silence, not facing them, and behaving as neutrally as possible. After direct observation, the horses' faces were photographed.

The photographs were taken in a lateral position under natural light, approximately 1.5 m away from the animal, showing only the face of the animals as described by Coneglian *et al*. (2020). A 12-megapixel camera of the Motorola Moto Z3 Play mobile phone was used to obtain the photos, resulting in photos with a resolution of 4032x3024 pixels. These images were randomly arranged and were further analyzed by one additional evaluator trained in the HGS use, unrelated to the study and blinded to the dental condition of the animal (Dalla Costa *et al*., 2016; Coneglian *et al*., 2020).

Next, acupoints pressure was performed by the same trained examiner, who assessed the reactivity of the acupuncture points. The examination was initiated only after the horse was comfortable in the examiner's presence, with relaxed eyes and ears. The diagnostic acupuncture was initiated with finger pressure over the temporomandibular joint and adjacent regions, followed by pressuring acupoints and testing their reactivity throughout the acupuncture channel paths using a rounded plastic needle cover as a probe (Alfaro, 2014; Michelotto *et al*., 2014; Cain, 2015; Mariani *et al*., 2019).

The acupuncture diagnosis was carried out with continuous and uninterrupted pressure initially superficially followed by a deeper pressure exerted with the probe, starting on the head and neck (Stomach - ST, Large Intestine - LI, Triple Heater - TH, Small Intestine - SI, Gall Bladder - GB, and Bladder – BL Channels) and progressing along the chest (Lung – LU-1 and Kidney - KI-27 acupoints), back and abdomen (back *Shu* points of the BL Meridian), and sacral and hind leg regions (BL, ST and GB Meridians). Finally, front *Mu*-alarm points were investigated (Michelotto *et al*., 2014; Cain, 2015). At the end, different musculoskeletal problems were diagnosed according to patterns of reactive acupoints as described by Cain (2015).

Painful acupoints were identified when the horse became uncomfortable, presented local muscle contraction, moved away from the examiner, presented behavioral changes as irritation, or attempt to bite or kick (Alfaro 2014; Michelotto *et al*., 2014; Cain, 2015; Mariani *et al*., 2019).

After physical examination was completed which included determination of vital parameters (heart and respiratory rate, mucous membranes, and temperature), the animals were observed while walking and trotting. Anamnesis was conducted with the person responsible for the animals, using a standard questionnaire for dental care where complaints were discussed, including possible changes in chewing or during training, as well as expectations regarding athletic or work performance. According to the observations and complaints reported, each horse was classified in each category according to its masticatory quality and the quality of its performance in relation to work with reins, receiving scores ranging from 0 to 2 described below.

For assessing the masticatory quality the following was considered: score 0, animal without difficulty to feed, does not leave leftover food nor throws down food already chewed; score 1, animal that leaves food or overturns already chewed food; and score 2, included animals with obvious difficulty in chewing, overbalancing the head during feeding, dropping already chewed foods, history of weight loss and / or colic.

For evaluating the work with reins it was considered: score 0 when there were no complaints of difficulty driving the animal during exercise or work; score 1, animal shows reluctance, or reaction on the mouth during exercise or specific work; and score 2 for animals with clear riding difficulty, heavy animal on the reins and / or works constantly with the

head high or swinging excessively, and works with the mouth opened or does not perform certain types of maneuvers.

An examination of the oral cavity was performed by a veterinarian with experience in equine dentistry. For this purpose, the horses were sedated with detomidine (20 to 30 µg/kg IV, Syntec, Santana de Parnaíba, SP, Brazil), and a full mouth speculum was used (full mouth speculum, Ortovet, São Paulo, SP, Brazil). A detailed observation and palpation of the oral cavity was made, including palpation of both hard (teeth and supporting bones) and soft tissues (lips, cheeks, tongue, palate, gingiva, buccal mucosa, salivary glands and ducts, and muscles of mastication) (Easley *et al*., 2011). The condition of the oral cavity was recorded in an odontogram adapted from Easley *et al*. (2011). The animals then received appropriate treatment directed towards each dental disorder detected.

Data distribution was analyzed using D'Agostino-Pearson test. Statistical analysis was performed as follows: to obtain the differences in the number of reactive acupuncture points and pain score between T0 and T1, the Wilcoxon test was used. The sensitivity and specificity of acupuncture test was calculated to evaluate the predictive values of the acupuncture pressure diagnosis. Correlations between the number of reactive acupuncture points, HGS scores of the animals and the trainers' complaints regarding masticatory quality and problems during the training were evaluated using the correlation test of Spearman. For the analysis of the relationship between dental disorders and the number of reactive acupuncture points, pain score and complaints of the trainers, the Mann-Whitney test was used. The statistical analyses were performed using the software IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp, New York, USA). For all the analyses, $p < 0.05$ was considered significant.

RESULTS

All 87 horses presented some dental disorders, with 70 (80.5%) animals suffering from more than one affection at a time, 7 (8.1%) with five or more diseases, 63 (72.4%) with two to four, and 17 (19.5%) had only one condition (excessive enamel points).

The presence of excessive enamel points was seen in 84 (96.6%) of the horses, ulcerations of the buccal mucosa in 38 (43.7%) and presence of wolf teeth in 30 (34.4%) (Table 1).

Despite the dental problems, all animals evaluated had cardiac rate of 32 ± 3 beats per minute and respiratory frequency of 11± 2 movements per minute throughout the study, considered normal.

In T0, only one of the investigated horses did not present reactive acupoints in the pressure of acupoints examination. The remaining 86 animals showed reactivity in one or more acupoints (11.2 ± 5.6 acupoints), which lowered in T1 (4.0 ± 2.9 acupoints) and it was statistically significant ($p = 0.001$).

Table 1. Dental disorders found in investigated working horses and their percentage of occurrence.

Dental disorders	Number of affected animals (n)	Percentage of occurrences (%)
Excessive enamel points	84	96.6
Ulcerations of the buccal mucosa	38	43.7
Wolf teeth	30	34.4
Hooks / Ramps	19	21.8
Retained deciduous	14	16.1
Stepmouth	8	9.2
Periodontal Disease	6	6.9
Diastema	5	5.7
Others	11	12.6

The most prevalent reactive acupoint was the dental point, which was painful in 44 (50.5%) of the animals in the T0 and 4 (4.5%) ($p = 0.001$) in T1. Other prevalent acupoints which showed significant reactivity in T0 vs. T1 were ST-7 (31 vs. 3, $p = 0.001$), TH-17 (27 vs. 4, $p = 0.001$), TH-16 (22 vs. 4, $p = 0.001$) (Fig. 1).

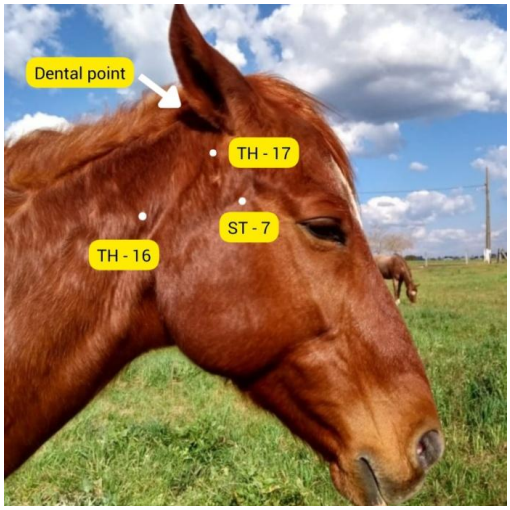

Figure 1. Most reactive acupoints in the investigated horses and non-reactive points after the treatment of the oral cavity: Dental point, located on the tendon between the atlas and occipital bone, caudal to the ear; Stomach (ST) -7 , located in the temporomandibular joint, ventrally to the zygomatic arch; Triple Heater (TH) -17, located in a depression between the jaw and the mastoid process, caudoventrally the ear; and TH-16 located caudoventrally to the mastoid process, between the first and second cervical vertebrae, over the caudal border of the brachiocephalic muscle.

The sensitivity and specificity of these points were also evaluated for diagnoses related to three of the main dental conditions found (Tables 2 – 4).

Considering the reactive acupoints and acupuncture channels involved, in T0 vs. T1 the GB Meridian was affected in 37 (42.5%) vs. 3 (3.4%) and ST in 18 (20.6%) vs. 5 (5.7%).

Considering diagnostic patterns observed during acupuncture examination, in 49 (56.3%) of the evaluations, horses were suggested to have imbalance related to thoracolumbar, coxofemoral, stifle or hock regions, and this number lowered to 16 (18.3%) after dental treatment and without any other clinical intervention or management modification.

Table 2. The Sensitivity (S), specificity (SP), positive predictive value (PPV), and negative predictive value (NPV) of the points; dental point, Stomach (ST) -7, Triple Heater (TH) -17, and TH-16 for the presence of ulcerations of the buccal mucosa

	S	SP	PPV	NPV
Dental point	0.56	0.69	0.65	0.61
ST7	0.55	0.62	0.44	0.71
TH17	0.55	0.61	0.42	0.87
TH 16	0.76	0.66	0.39	0.75

Table 3. The Sensitivity (S), specificity (SP), positive predictive value (PPV), and negative predictive value (NPV) of the points, Dental point, Stomach (ST) -7, Triple Heater (TH) -17 and TH-16 for the presence of a wolf teeth

	S	SP	PPV	NPV
Dental point	0.40	0.72	0.60	0.54
ST7	0.42	0.69	0.43	0.68
TH17	0.22	0.60	0.36	0.80
TH 16	0.50	0.70	0.20	0.63

Table 4. The Sensitivity (S), specificity (SP), positive predictive value (PPV), and negative predictive value (NPV) of the points, Dental point, Stomach (ST) -7, Triple Heater (TH) -17 and TH-16 for the presence of hooks and ramps

	S	SP	PPV	NPV
Dental point	0.11	0.67	0.26	0.42
ST7	0.41	0.89	0.68	0.73
TH17	0.51	0.91	0.15	0.72
TH 16	0.13	0.75	0.68	0.95

Median (3 vs. 1, p = 0.001), maximum and minimum HGS pain score significantly reduced in T1 in comparison with T0, by both the direct evaluation and photographic analysis (Fig. 2).

There was a positive correlation between pain scoring and the number of reactive acupoints (p = 0.0001, r^2 = 0.543).

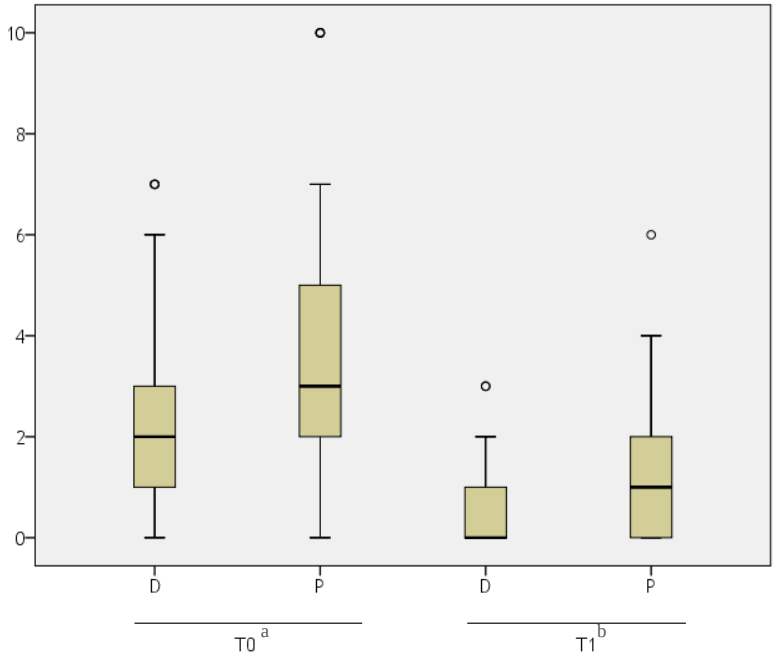

Figure 2. Median and inter quartiles of pain scores for 87 horses assigned by each evaluator according to the Horse Grimace Scale (HGS) [(in direct physical presence (D) and from photographs (P)], in pretreatment (T0) and 15 days after dental treatment (T1) (p = 0.0001). Different letters between time points represent statistical differences.

Of the 87 trainers, 64 had no complaint about mastication or did not know how to report it; 23 horses had low masticatory quality according to trainers or owners, and 22 (95.6%) of them presented an improvement in the masticatory pattern after dental treatment according to the trainers' remark. Regarding the quality of work 60 (68.9%) animals presented some difficulty in working with reins according to the perception of their owners/trainers and after dental treatment 58 (96.6%) improved.

The correlation between the number of reactive acupoints and pain scoring in relation to the owners'/trainers' complaints was also evaluated. There was a weak to moderate positive correlation between the number of reactive acupoints and complaints regarding the quality of mastication (p = 0.016; r^2 = 0.2587) and quality of work (p = 0.0001; r = 0.435), as well as pain scoring and quality of mastication (p = 0.001; r = 0.336) and work (p = 0.001; r = 0.435).

The presence of ulcerations in the buccal or lingual mucosa showed a significative influence on pain scoring (p = 0.001) and number of reactive acupoints (p = 0.001), as well as on the perceptions regarding the difficulty of working (p = 0.001) but had no effect on the perceptions regarding the masticatory quality of the animals (p = 0.341).

There was no significant difference between the animals with or without wolf teeth regarding the pain scoring (p = 0.872), number of reactive acupoints (p = 0.425), quality of work (p = 0.518) and masticatory quality (p = 0.179).

Finally, it was observed that the presence of hooks and ramps had no effect on the pain scoring (p = 0.098), on the total reactive acupuncture points (p = 0.130) and on the quality of the work (p = 0.954) but had a significant influence on the masticatory quality of these animals (p = 0.004).

DISCUSSION

In the present study, the objective of evaluating the influence of dental treatment on the general welfare parameters of working horses was accomplished, thereby demonstrating that after dental treatment the animals presented reduction in the pain scoring and the number of reactive acupoints.

The fact that all the horses had dental disorders, with the majority presenting with 2 to 4 conditions concomitantly, corroborates with a previous study (Amaya *et al*., 2012), where high prevalence of oral disease (76.5%) was seen. Furthermore, the evidence that excessive enamel points were the most prevalent condition (96.6%) was in accordance with the literature (Dixon and Dacre, 2005; Easley *et al*., 2011; Amaya *et al*., 2012), and this probably led to a high prevalence of ulcerations in the buccal mucosa (Dixon and Dacre, 2005; Easley *et al*., 2011).

The presence of wolf teeth was the third more frequent observation and was probably underestimated, as eventually some animals lose these teeth during the exchange of the second premolar (Dixon, 2017) or had received dental treatment at some time during their lifetime, at which point this tooth is usually extracted.

We observed here that the horses with different conditions may not clearly manifest clinical signs, thus remaining in their work or sports activities; also, their cardiac and respiratory rates were within the parameters considered normal for the species (Speirs, 1999). This might represent a welfare problem, if the level of discomfort or pain due to oral conditions is not observed and quantified, horses endure working even with dental problems. These results confirm that recognition of dental pain is complicated by the hidden nature of disorders which often go unnoticed until the later stages (Ashley *et al*., 2005; Ardila and Montoya, 2009; Amaya *et al*., 2012); additionally, this is a risk for other gastrointestinal diseases or painful conditions in the rest of the body (Dixon and Dacre, 2005; Amaya *et al*., 2012; Alencar-Araripe *et al*., 2013).

Amaya *et al*. (2012) studied 400 horses, and even though 76.5% of them presented dental affections, most of the animals did not present clinical signs that would call the attention of their owners. In this regard, our previous study demonstrated the value of Horse Grimace Scale (HGS) in identifying horses with pain due to oral conditions (Coneglian *et al*., 2020). The current study also showed that animals had less findings during acupuncture examination and pain scoring after dental treatment than before the treatment.

The reduction in the total number of reactive acupoints after dental treatment may be of great importance for the overall health of the investigated animals. Le Jeune and Jones (2014), studying the correlation of acupuncture exam with a conventional lameness examination, found that horses that are sensitive to palpation in a greater number of acupuncture points were more likely to be lame and should undergo a full lameness examination and other diagnostic testing. Our previous study demonstrated the presence of stifle diseases in athlete horses which did not show any clinical signs, using the pressure of acupoints (Michelotto *et al*., 2014; Mariani *et al*., 2019).

In this study, the most prevalent reactive acupoints at T0 related to oral cavity conditions, were the dental point, ST-7, TH-17 and TH-16. These points are cited in the literature as diagnostic points for TMJ conditions, as well as in the region of the oral cavity as a whole

(Fleming, 2006; Xie and Preast, 2011; May, 2008; Cain, 2015). The 'dental point' is an *ASHI* (painful) point located on the tendon between the atlas and occipital bone at the posterior base of the ear (Cain, 2015). The significant reduction in sensitivity at this point after treatment observed in our study agrees with the statement made by Cain (2015), that after dental treatment the acute reaction of this acupoint tends to disappear.

The ST-7 sensitivity could be related either to a problem with the TMJ itself, masseter myofascial pain or both (Fleming, 2006; May, 2008; Xie and Preast, 2011). As one of the causes of TMJ pain are dental disorders (Easley *et al*., 2011), sensitivity at ST-7 could lead the veterinary to further examine the horse's mouth and dental status.

The point TH-17 is a crossing point of the TH and GB channels and is cited as a diagnostic point for painful processes in TMJ, dental disorders, cheek swelling and in cervical instability (Fleming, 2006; Xie and Preast, 2011). May (2008) stated that the TH-17 is normally reactive in animals with dental changes especially when these are associated with changes in the TMJ, which require chiropractic adjustments. These changes end up limiting the rostral movement during chewing (Easley *et al*., 2011; Paiva Neto *et al*., 2018) which predisposes to maladjustments in the TMJ area.

Another important acupoint in this study was the TH 16, this point is shown as the diagnostic point for alterations in the face and head and pain in the TMJ (Fleming, 2006; Xie and Preast, 2011).

In general, the studied acupoints (Dental Point, S7, TH17 and TH16), presented higher specificity than sensitivity for the different dental affections. This information could then be useful to the veterinarian since the elimination of these reactive points after a dental procedure would help in the indicating if the dental treatment was successful.

It is noteworthy that there are six different acupuncture channels converging on or close to the TMJ, three come from the front legs (LI, SI, and TH), and three travel to the hind legs (GB, ST, and BL) (Fleming, 2006). ST, TH and GB channels, most frequently affected in the studied animals, have their pathway through the TMJ area (Fleming, 2006). This fact may be responsible for the greater involvement of these channels in animals with dental disorders, as dental conditions are closely related to TMJ pain (Easley *et al*., 2011). Moreover, GB and ST channels pass over TMJ region,directly to the hindlegs, and may being related to hindlimb lameness in horses, mainly due to stifle, hock and coxofemoral diseases (Alfaro, 2014; Michelotto *et al*., 2014; Cain, 2015; Mariani *et al*., 2019). Considering that animals with a greater number of reactive acupoints are more likely to present locomotor alterations or imbalance, these results suggest that although the studied animals were working normally and did not present obvious lameness, the dental alterations could be present together with musculoskeletal disorders. The diagnosis of these conditions, oral and musculoskeletal, in athlete horses under normal training has been previously described (Alfaro 2014; Michelotto *et al*., 2014; Cain, 2015; Mariani *et al*., 2019).

In addition, the results of HGS also confirm that even in the absence of obvious clinical signs, dental changes caused discomfort in the investigated horses. Its positive correlation with the number of reactive acupoints and complaints of owners/trainers regarding chewing and working quality, highlights the importance of associating HGS in the routine clinical examination.

In the present study, the horses were observed in person, as previously described by Coneglian *et al*. (2020), which can be easily applied in the field, but it can underestimate the discomfort degree of the animals since horses tend to minimize the signs of pain when in the presence of a human (Torcivia and McDonnell, 2020). To reduce this factor the researcher stood approximately one meter away from the horse, in silence, not facing them, and behaving as neutrally as possible. Another issue to be considered is the fact that the pain score attributed to the animals due to the physical presence of an evaluator was always lower than that attributed by the evaluators assessing photographs. This fact had previously been reported (Coneglian *et al*., 2020). To reduce this difference attention should be given to the photographs to ensure that they reflected more closely what was observed on videos or face-to-

face analysis (Dalla Costa *et al*., 2014, 2016; Coneglian *et al*., 2020).

The animals that presented ulcerations of the buccal mucosa showed a greater number of reactive acupoints, pain scoring and complaints concerning the work quality. The correction of dental excessive enamel points at an early stage is the key to prevention of the ulcerations of the buccal mucosa. This is possible with regular (annual or biannual) dental inspections and appropriate treatment (Dixon, 2017).

For the presence of the wolf teeth there was no significant difference in any of the studied parameters. It is noteworthy that in relation to the pain scoring it may have been underestimated in animals with wolf teeth, since animals that present discomfort due to its presence will do so during exercise and not during rest. However, the necessity for removing wolf teeth is controversial even though its extraction may be recommended (Scrutchfield, 2006; Dixon, 2017). In the present study the presence of the wolf teeth caused no harm as might be popularly believed, agreeing with other authors that these teeth generally do not cause problems unless they are large, sharp, poorly positioned or impacted. (Dixon and Dacre, 2005; Easley *et al*., 2011). These data are important as many horsemen believe that wolf teeth are primarily responsible for oral discomfort, but problems and abnormal behavior of horses at work (Dixon and Dacre, 2005; Scrutchfield, 2006; Dixon, 2017).

Considering hooks and ramps, their occurrence had a significant effect on the masticatory quality of the animals. This can be explained since the horse must be able to move the jaw from side to side (lateral excursion), forward and back (anterior/posterior movement) and up and down to reinforce the grind to chew food properly. The presence of ramp and/or hook may reduce or restrict the rostral movement of the mandible during chewing (Easley *et al*., 2011). This was demonstrated in practice by Paiva Neto *et al*. (2018), studying the influence of occlusal adjustment by tooth wear in masticatory biomechanics of horses showed that the occlusal adjustment increases the range of mandibular movements in horses. It is noteworthy that the assessment of masticatory acuity was subjectively performed by the caretakers, which may have led to an erroneous assessment. To reduce the chance of errors, the caretakers were instructed about the characteristics to be observed, such as chewing speed, leftover food, or the presence of partially chewed food on the floor of the stable.

In the present study, the same researcher carried out the evaluations with acupuncture and HGS, although he did so in the most impartial way possible, this is a bias that must be considered. To reduce this factor, a photographic assessment of the animals was also performed by additional researcher trained in the HGS use, but unrelated to the study and condition of the animal.

CONCLUSION

In conclusion, dental problems negatively influence the general welfare of the horses and can affect other regions of the body as demonstrated by the pain scoring and the number of reactive acupoints. Additionally, acupoints ‘dental point’, ST-7, TH- 17 and TH-16 could be included in clinical examination as indicative of dental disorders and in assessing the results of dental treatment. It is suggested that other studies be conducted to further confirm our findings.

FUNDING SOURCE

This work was supported in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finaced code 001.

ACKNOWLEDGEMENT

The authors thank the veterinarians and owners of the horses involved in the study.

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