Behavioral Signs Associated With Equine Cheek Tooth Findings

Laukkanen, Tuuli

2023-01-12

Laukkanen , T , Karma , L , Virtala , A-M , Mykkänen , A , Pehkonen , J , Rossi , H , Tuomola , K & Raekallio , M 2023 , ' Behavioral Signs Associated With Equine Cheek Tooth Findings ' , Journal of Equine Veterinary Science , vol. 121 , 104198 . https://doi.org/10.1016/j.jevs.2022.104198

http://hdl.handle.net/10138/356013
https://doi.org/10.1016/j.jevs.2022.104198

Journal of Equine Veterinary Science 121 (2023) 104198

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Original Research

Behavioral Signs Associated With Equine Cheek Tooth Findings

Tuuli Laukkanen[a], Leena Karma[b], Anna-Maija Virtala[c], Anna Mykkänen[a,*], Jaana Pehkonen[d], Heini Rossi[a], Kati Tuomola[a], Marja Raekallio[a]

[a] Department of Equine and Small Animal Medicine, Faculty of Veterinary Medicine, University of Helsinki, Helsinki, Finland
[b] Porvoo Equine Clinic, Askola, Finland
[c] Department of Veterinary Biosciences, Faculty of Veterinary Medicine, University of Helsinki, Helsinki, Finland
[d] Hippomedi Equine Clinic, Piikkiö, Finland

ARTICLE INFO

Article history:
Received 6 September 2022
Received in revised form 16 December 2022
Accepted 19 December 2022
Available online 23 December 2022

Keywords:
Behavior
Dental pain
Dentistry
Horses
Molar

ABSTRACT

Equine dental diseases are often underdiagnosed and their signs inadequately reported. Many horse owners have difficulties in recognizing pain-related behavioral signs and in associating them with dental pain. Our objective was to determine what type and degree of dental findings may cause behavioral signs associated with dental pain. In this cross-sectional study, dental examination was performed on 183 adult horses and cheek tooth findings were scored. Owners filled in an internet-based questionnaire including 35 questions concerning eating behavior, bit behavior, and general behavior of the horse. Descriptive statistics and logistic regression analyses were performed. Broadened or darkened fissures [odds ratio (OR) 2.4, 95% confidence interval (CI) 1.04–5.7), complicated fractures (OR 2.3, CI 1.01–5.2) and secondary dentine defects of at least the second degree (OR 3.1, CI 1.2–7.7) were associated with the expression of at least five behavioral signs in the univariable binomial logistic regression analyses. Horses with at least one of these potentially painful cheek tooth findings expressed more signs related to eating behavior, bit behavior, and general behavior than did the other horses. The results suggest that cheek tooth findings indicated by this study as being potentially painful, i.e. broadened or darkened fissures, complicated fractures and secondary dentine defects of at least the second degree, may require intervention, particularly if the horse expresses any behavioral signs that might be related to dental pain.

1. Introduction

Equine odontology has received little attention in the veterinary literature. Many horses may have undiagnosed painful dental diseases, such as pulpar exposure and diastema [1], which are common especially in older horses [2,3]. Chronic dental disease may be a welfare problem and a common reason for undesirable behaviors [2].

Studies related to equine dental diseases have mainly concentrated on various pathologies. Even though signs related to dental findings have been described, such as altered eating and abnormal bit behavior [1,4–8], no studies focusing on the behavioral signs related to various dental findings have been conducted. To the authors' knowledge, Pehkonen et al (2019) published the first study demonstrating that certain behavioral signs may be associated with dental pain in horses [9]. Signs of dental diseases vary according to the pathology, although the majority of horses had shown no behavioral signs despite numerous dental changes [3,10]. The behavioral signs of dental diseases are not specific and can be confused with signs caused by pain in other organ systems. Many horse owners do not recognize pain-related behavioral signs and do not associate them with dental pain [10]. Furthermore, the absence of clear signs, such as eating difficulties, bit problems and weight loss, do not exclude the possibility of dental changes causing pain or discomfort [10].

The aim of our study was to survey owners to identify in their horses behavioral signs possibly related to common cheek tooth findings and to compare the findings with a veterinary dental examination. Our hypothesis was that each cheek tooth finding has a degree of severity which is likely to cause behavioral signs associated with dental pain. This knowledge may help veterinarians evaluate what degree of a finding is potentially painful.

Conflict of interest statement: None of the authors has financial or personal relationships that could inappropriately influence or bias the content of the paper.

Animal welfare/ethical statement: The study complied with all relevant national regulations and institutional policies for the care and use of animals (University of Helsinki Viikki Campus Research Ethics Committee, 4/2017).

* Corresponding author at: Anna Mykkänen, Department of Equine and Small Animal Medicine, Faculty of Veterinary Medicine, University of Helsinki, Viikintie 49, P.O. Box 57, 00014 Helsinki, Finland

E-mail address: anna.mykkanen@helsinki.fi (A. Mykkänen).

https://doi.org/10.1016/j.jevs.2022.104198

2. Materials and Methods

2.1. Data Collection

The data for this cross-sectional study were collected in 2017 to 2019 using a questionnaire survey and a simultaneous first or second opinion clinical dental examination performed by a veterinarian. The study complied with all relevant national regulations and institutional policies for the care and use of animals (University of Helsinki Viikki Campus Research Ethics Committee, 4/2017).

The horses and ponies in this study came from two private equine clinics and from one ambulatory veterinary practice, with examinations performed by four veterinarians experienced in equine dentistry. Only animals over 5 years of age at the time of examination and without front teeth pathologies that had owner consent and all data available were included. Exclusion criteria were the owner reporting a potentially painful comorbidity and the animal not using a bit.

The clinical examination included a general examination, palpation of the head, and an assessment of breath odor. All the animals were sedated prior to the dental examination, which was performed with an intraoral endoscope or mirror. Radiological diagnoses were not included because the ambulatory practice did not perform radiological examinations, and they were only performed at the clinics if deemed necessary. The types of dental findings and their grading are described in Table 1.

The owners answered an internet-based questionnaire during the animal's dental examination or soon after it prior to knowing the results of the current examination. The questionnaire was written in Finnish, i.e., the respondents' native language. In addition to the animal's basic information, it contained a total of 35 questions regarding eating behavior, bit behavior, and other behavioral patterns of the equid (see Appendix A: Supplementary material), modified from Pehkonen et al (2019) [9]. Response options were "yes" and "no." It was possible to add more behavioral signs in an open text box at the end of each question group. Owner consent was ensured at the end of the questionnaire. The data were automatically transferred to a spreadsheet.

2.2. Data Analysis

Blank answers in the questionnaire related to behavioral signs were interpreted as a sign not having been observed, rather than as missing data. The presence or absence of defined behavioral signs was used to divide the horses into Sign groups: Sign group 1 included horses with no behavioral signs or up to one sign related to bit behavior. One bit behavioral sign was allowed, as that was the median number of bit-related signs in an earlier study after removal of a periapically infected cheek tooth [9]. Horses with at least five behavioral signs belonged to Sign group 3, and the rest of the horses belonged to Sign group 2. Five behavioral signs were chosen as the cut-off because 85% of the horses in our previous study had less than five signs, and none of them had more than six behavioral signs after the removal of a periapically infected cheek tooth [9].

Univariable logistic regression analyses were performed to calculate the odds of each cheek tooth finding in horses belonging to Sign group 3 compared to Sign group 1. Statistically significant odds ratios were considered to indicate potentially painful degrees of cheek tooth findings. Based on these significant odds ratios, the horses were divided into two groups: the ones with no potentially painful cheek tooth findings were place into Finding group A and those ones with at least one potentially painful cheek tooth finding into Finding group B.

To obtain proportions of each sign in each behavioral sign entity (eating and drinking, bit, general, miscellaneous), we calculated 95% confidence intervals (CI) with the Wilson method [11] using Epitools[1] to detect differences between the Finding groups. The Mann–Whitney *U* test was used to calculate the *P* value of the difference between the median numbers of signs between these two Finding groups in each sign entity. To pinpoint signs that differentiate Sign groups, we calculated proportions and their 95% CIs for each sign in each behavioral sign entity.

Finally, the entire study population was used to test the association of each finding to having at least five behavioral signs (Sign group 3) compared to the rest after adjusting for animal characteristics available (age group, sex, breed). Univariable logistic regressions were performed. Descriptions and statistical analyses were conducted with IBM SPSS Statistics for Windows, Version 25.0 (Released 2017, Armonk, NY, USA).

3. Results

The owners of 265 animals filled in the questionnaire. Sixty-three animals were excluded due to a potentially painful comorbidity and 19 were not using a bit. The final material comprised 183 animals (74 mares, 103 geldings, and 6 stallions). Their breeds were Warmbloods (81), Finnhorses (32), ponies (31), Standardbreds (13), Icelandic horses (4), Thoroughbreds (2), and other breeds (20). The horses were used for riding (162), harness racing (11), and ten animals were reportedly used for other purposes (pleasure horses, carriage driving and animal-assisted therapy). Horse age ranged from 5 to 28 years (median 12). The examination was performed with an endoscope in 104 horses and with a mirror in 79 horses. Six horses had received pain medication during the previous week.

At least one finding in one cheek tooth or more was detected in 95% of the horses. A total of 76% had infundibular and 65% had peripheral caries. Fissures were reported in 69%, diastemas in 38%, secondary dentine defects in 32% and fractures in 27% of the horses (Table 1). Two horses had retained deciduous teeth. Enamel overgrowths, mucous membrane damage and malocclusions were not included in the data. The more detailed distribution of the cheek tooth findings is presented in Supplementary material (see Appendix A: Supplementary material). Nine horses had no dental findings (two in Sign group 1, five in Sign group 2, and two in Sign group 3). The preliminary logistic regression analysis results for horses in Sign groups 1 and 3 are presented in Table 1. A secondary dentine defect of the first degree had a significant positive effect on the odds of a horse exhibiting at least five behavioral signs in the logistic regression analysis, but nearly all horses with this finding also exhibited other more severe cheek tooth findings. Therefore, a secondary dentine defect of at least the second degree was presented in supplementary material (see Appendix A: Supplementary material) and used in the further analyses.

Univariable binomial logistic regressions performed for all the horses showed that a broadened or darkened fissure, a complicated fracture and a secondary dentine defect of at least the second degree had a significant positive effect on the odds of a horse exhibiting at least five behavioral signs (Table 1). These cheek tooth findings were considered potentially painful when dividing the horses into two Finding groups. Horses in Finding group A (no potentially painful cheek tooth findings) expressed less signs related to eating behavior, bit behavior, and general behavior than did horses in Finding group B (at least one potentially painful finding). The proportions and their confidence intervals for each behavioral sign are presented in Table 2. More detailed descriptive data of these Sign groups are presented in supplementary material (see Appendix A: Supplementary material).

Geldings or stallions (compared to mares) and other breeds (compared to ponies and Icelandic horses) were positively associated with exhibiting at least five behavioral signs (Table 3).

Table 1
Cheek tooth findings from 183 horses.

Finding	Degree	Total *n*	%	Sign Groups 1 and 3 *n*	*P*	OR (95% CI)
PC	No PC	64		34		Reference
	1.1	29	15.8	12	0.725	1.27 (0.34–4.74)
	1.2	50	27.3	24	0.410	0.63 (0.21–1.88)
	2	35	19.1	16	0.110	2.79 (0.79–9.78)
	3	5	2.7	2		
	Total PC	119	65.0	54	0.316	
ICH	No ICH	44		28		Reference
	1	81	44.3	35	0.284	0.58 (0.21–1.58)
	2	31	16.9	13	0.659	0.74 (0.20–2.78)
	3	26	14.2	12	0.782	1.21 (0.31–4.76)
	4	1	0.5	0		
	5	0	0.0	0		
	Total ICH	139	76.0	60	0.624	
Fissure	No fissure	55		31		Reference
	Thin	98	53.6	45	0.520	0.74 (0.29–1.87)
	Broadened/darkened	29	15.8	12	0.019	13.36 (1.53–116.5)
	Total fissure	127	69.4	57	0.029	
Fracture	No fracture	133		62		Reference
	UCCF; URCF	14	7.7	6	0.592	1.58 (0.29–8.49)
	CCCF/CRCF	16	8.7	12	0.030	4.75 (1.17–19.30)
	CCCF/CRCF, runs through pulp chambers	17	9.3	8	0.069	4.75 (0.88–25.48)
	Total fracture	47	27.3	26	0.063	
Secondary dentine defect	No defect	125		57		Reference
	1	35	19.1	19	0.036	3.17 (1.08–9.33)
	2	15	8.2	10	0.017	7.40 (1.43–38.23)
	3	8	4.4	2		
	Total secondary dentine defect	58	31.7	31	0.034	
Diastema	No diastema	114		60		Reference
	PD 0	35	19.1	14	0.482	1.52 (0.47–4.93)
	PD 1	29	15.8	12	0.751	0.82 (0.23–2.86)
	PD 2	2	1.1	1		
	PD 3	2	1.1	1		
	PD 1, 2 or 3 and loose tooth	1	0.5	0		
	Total diastema	69	37.7	28	0.952	

PC = peripheral caries. PC grades: 1.1 small cemental caries; 1.2 caries of peripheral cement exposing enamel; 2 caries of cementum and enamel; 3 caries of cementum, enamel and dentine.
ICH = infundibular caries. ICH grades: 1 cemental caries; 2 cemental and enamel caries; 3 cemental, enamel and dentinal caries; 4 loss of dental structural integrity; 5 results in tooth loss.
UCCF = uncomplicated clinical crown fracture, no pulpar involvement.
URCF = uncomplicated reserve crown fracture, no pulpar involvement, fracture line below gingival margin.
CCCF = complicated clinical crown fracture, secondary dentine involvement, fracture line above gingival margin.
CRCF = complicated clinical crown fracture. Secondary dentine involvement. Fracture line below gingival margin.
PD = periodontal disease. PD grades according to probing depth: PD0 none, PD1 5–9 mm; PD2 10–14 mm; PD3 >15 mm.
Secondary dentine defect grades according to probing depth: 1 none; 2 < 3 mm; 3 > 3 mm.
Univariable logistic regression analyses were performed to calculate the odds for each cheek tooth finding in horses belonging to Sign group 3 (n = 42, horses exhibiting at least five behavioral signs) compared to Sign group 1 (n = 46, no behavioral signs or at most one sign related to bit behavior). Odds ratios (OR) and their 95% confidence intervals (CI) are not reported for degrees detected in less than five horses.

4. Discussion

In our study, five or more behavioral signs reported by the owner were associated with broadened or darkened fissures, complicated fractures or secondary dentine defects of at least the second degree. Moreover, horses with at least one potentially painful cheek tooth finding expressed a significantly higher number of signs in all categories (eating and drinking behavior, bit behavior and general behavior) than horses without such findings. The signs asked in the questionnaire were not specific for dental pain although they have been associated with periapical cheek tooth infection and other equine dental problems [1,4–6,9]. Many of these behavioral patterns have also been related to other painful conditions [7,12–17]. Therefore, other possible causes of pain and discomfort cannot be ruled out, even though horses with reported comorbidities were excluded from the study.

Behavioral signs related to eating, particularly eating hay, were typical in horses with potentially painful cheek tooth findings. This suggests that various dental problems, such as broadened or darkened fissures, complicated fractures, or a secondary dentine defect of at least the second degree, may cause discomfort or pain while chewing. This result agrees with an earlier study, where periapical cheek tooth infection was demonstrated to cause such pain, as the number of signs related to eating behavior significantly decreased after removal of the infected tooth [9].

In our present study, potentially painful dental findings were associated with horse behavior when exercising while wearing a bit. Using a bit also induced pain in horses with periapical cheek tooth infection, as the number of such behavioral patterns decreased after the infected tooth had been removed [9]. On the other hand, Moine et al (2017) could not demonstrate any influence of performance dentistry on equine rideability assessed by rider scoring [18]. Moreover, Cook and Kibler (2019) demonstrated that riding a horse without the bit reduced the number of various behavioral patterns, suggesting that a bit may cause discomfort or pain [19]. However, they did not reveal whether bit-related oral pain originated from the teeth or some other part of the mouth [19]. Soft tissue injuries related to bit use are common [20–22], and they are also likely to induce discomfort or pain. Many other issues may additionally cause pain-related behavior during exercise. Even though horses with known orthopedic problems were excluded from the present study, it is possible that the data con-

Table 2
The numbers, proportions and their confidence intervals (CIs) of behavioral and miscellaneous signs reported by the owners of 183 horses.

Signs Related to Eating and Drinking Behavior	Finding Group A (n = 99)	Proportion (CI) %	Finding Group B (n = 84)	Proportion (CI) %
Adjusts hay in mouth	5	5.1 (2.2–11.3)	16	19.1 (12.1–28.7)
Eats hay slowly	18	18.2 (11.8–26.9)	24	28.6 (20.0–39.0)
Drops hay from mouth	3	3.0 (1.0–8.5)	14	16.7 (10.2–26.1)
Pausing while eating hay	10	10.1 (5.6–17.6)	23	27.4 (19.0–37.8)
Food pocketing	4	4.0 (1.6–9.9)	9	10.7 (5.7–19.1)
Quidding (drops "hayballs")	10	10.1 (5.6–17.6)	11	13.1 (7.5–22.0)
Turns head while eating hay	6	6.1 (2.8–12.6)	11	13.1 (7.5–22.0)
Drops grain from mouth	10	10.1 (5.6–17.6)	13	15.5 (9.3–24.7)
Dips hay in water	12	12.1 (7.1–20.0)	20	23.8 (16.0–33.9)
Avoids drinking cold water	8	8.1 (4.2–15.1)	11	13.1 (7.5–22.0)
Total number of signs per horse; median (min-max)	0 (0–8)		1 (0–8)	$P < 0.001$
Bit behavior signs				
Evades the bit; grabs/is above/runs through the bit	26	26.3 (18.6–35.7)	33	39.3 (29.5–50.0)
Asymmetry between left and right rein contact[a]	31	31.3 (23.0–41.0)	38	45.2 (35.0–55.9)
Headshaking[a]	10	10.1 (5.6–17.6)	20	23.8 (16.0–33.9)
Opens mouth[a]	27	27.3 (19.5–36.8)	35	41.7 (31.7–52.4)
Resists bridling	7	7.1 (3.5–13.9)	14	16.7 (10.2–26.1)
Lolling tongue[a]	12	12.1 (7.1–20.0)	8	9.5 (4.9–17.7)
Total number of signs per horse; median (min-max)	1 (0–6)		1.5 (0–6)	$P = 0.047$
General behavioral signs				
Withdrawn or intense stare	1	1.0 (0.2–5.5)	7	8.3 (4.1–16.2)
Asocial towards people	4	4.0 (1.6–9.9)	4	4.8 (1.9–11.6)
Asocial towards other horses	6	6.1 (2.8–12.6)	5	6.0 (2.3–13.2)
Aggressive behavior	3	3.0 (1.0–8.5)	3	3.6 (1.2–10.0)
Head shy	7	7.1 (3.5–13.9)	14	16.7 (10.2–26.1)
Not interested in surroundings	10	10.1 (5.6–17.6)	9	10.7 (5.7–19.1)
Self-mutilation of head	2	2.0 (0.6–7.1)	1	1.2 (0.2–6.4)
Head shaking	4	4.0 (1.6–9.9)	8	9.5 (4.9–17.7)
Total number of signs per horse; median (min–max)	0 (0–2)		0 (0–5)	$P = 0.008$
Total number of behavioral signs per horse median (min–max)	2 (0–12)		3 (0–16)	$P < 0.001$
Miscellaneous signs				
Halitosis	10	10.1 (5.6–17.6)	13	15.5 (9.3–24.7)
Poor performance	3	3.0 (1.0–8.5)	8	9.5 (4.9–17.7)
Fecal strands of forage/whole-grain particles	8	8.1 (4.2–15.1)	6	7.1 (3.3–14.7)
Impaction colic	4	4.0 (1.6–9.9)	7	8.3 (4.1–16.2)
Losing weight	4	4.0 (1.6–9.9)	12	14.3 (8.4–23.3)
Total number of signs per horse; median (min–max)	0 (0–5)		1 (0–4)	$P = 0.001$

Finding group A consists of horses with no potentially painful cheek tooth findings and Finding group B contains horses with at least one potentially painful finding.
[a] When ridden or driven with a bit.

Table 3
Univariable logistic regression results when studying the effect of signalment and cheek tooth findings on having at least five behavioral signs (vs. less or none) and using cut-offs adapted from Table 1 (n = 183).

Variable	B	Walds's P Value	OR (95% CI)
Age group in years		0.063	NA
5–8			Reference
9–12	1.458	0.063	4.3 (0.9–20.0)
13–16	2.094	0.009	8.1 (1.7–39.2)
At least 17	1.480	0.069	4.4 (0.9–21.7)
Gelding or stallion vs. mare	0.823	0.035	2.3 (1.1–4.9)
Other breeds vs. ponies and Icelandic horses	1.143	0.041	3.1 (1.05–9.4)
PC degree 2 and 3 vs. lower	0.638	0.108	1.9 (0.9–4.1)
ICH at least third degree vs. lower	0.191	0.691	1.2 (0.5–3.1)
Broadened or darkened fissure vs. no	0.886	0.040	2.4 (1.04–5.7)
Complicated fracture vs. no	0.827	0.047	2.3 (1.01–5.2)
Secondary dentine defect at least second degree vs. no	1.124	0.016	3.1 (1.2–7.7)
Diastema at least PD1 vs. no	0.397	0.417	0.7 (0.3–1.8)

NA, not applicable; PC, peripheral caries; ICH, infundibular caries.

tained some lame horses. Undiagnosed lameness is common in horses [23], and musculoskeletal pain may cause exercise-related misbehaviors [24] similar to the ones reported in our present study. In addition, gastrointestinal problems, such as gastric ulcers [25] and large colon sand accumulation [26] may affect horse behavior during exercise. Nevertheless, although exercise-related behavioral signs are not specific to dental problems, they should be kept in mind as possible sources of pain when examining a horse expressing behaviors interpreted as misbehavior during exercise.

Chronic pain can be misinterpreted as "bad behavior" of the horse [13]. This may also have been the case in some horses in our present study, as the total number of general behavioral signs was significantly higher in horses with potentially painful dental findings (P = 0.008), although the expression of any particular undesirable behavioral pattern did not differ significantly between the Finding groups.

Pain behavior is known to be affected by breed, as with other individual characteristics [27]. For example, Shetland ponies have

been bred for demanding conditions and show less distinctive pain behavior than Thoroughbreds [27]. In our current study, the Icelandic horse, which is a pony-sized seemingly stoic breed, was merged in the same group as the ponies. As expected, the pony group showed less behavioral signs compared to other horse breeds, emphasizing the need to react even to subtle changes in behavior in ponies with dental findings.

The owners did not receive information on our dental examination findings before filling in the questionnaire. However, some horses had a history of previous dental disease, which may have caused bias in the owner responses. Moreover, owners may only spend a limited time period with their horses during the day, and for example abnormal eating and drinking behavior may therefore be easily overlooked. For the same reasons, bit-related signs may be easier to detect and, may therefore be emphasized in our data. Furthermore, the owners may lack the ability to identify subtle signs of pain. Recognition of these signs may be improved by educating the owners. For example, chronic pain in dogs can be more reliably assessed by prior owner education and by assisting the owner when filling in the questionnaire [28]. Interestingly, some owners are reluctant to report behaviors interpreted as misbehavior, which may also affect the questionnaire results [29].

A limitation of our data was the low number of horses without cheek tooth findings. Furthermore, most horses had several findings, many of them affecting several teeth. Therefore, further statistical analyses, such as multivariable regression, could not be performed to analyze the effect of each specific finding. Some cheek tooth findings in our data, such as diastemas and severe degrees of peripheral and infundibular caries, were too few to be analyzed statistically. Enamel overgrowths, lesions in the oral mucosa or malocclusions were not reported. Furthermore, the previous dental histories of the horses were not reported, and some of the horses had been floated recently and subsequently referred to a dental examination. Conclusions regarding the effect of these dental changes could therefore not be assessed. Dental radiographs were not available for all horses, as they were only taken if a pathology affecting the bony structures was suspected. Therefore, it is possible that some horses considered healthy had a dental disease, such as a tooth root abscess of hematogenous origin that remained undetected. The study population also included horses that had received non-steroidal anti-inflammatories during the week before examination. However, this was not expected to bias our results, as the owners were asked to assess signs of pain over a longer time period.

5. Conclusions

The study indicated that at least broadened or darkened fissures, complicated fractures and secondary dentine defects of at least the second degree were associated with a high number of behavioral signs, and thus these dental findings were considered to be potentially painful. Correspondingly, horses with many behavioral signs reported by the owner were more likely to have at least one of these potentially painful dental problems. Our results suggest that these dental findings may require intervention, particularly if the horse expresses any behavioral signs related to cheek tooth pain.

Acknowledgments

We warmly thank the horse owners for their participation in the study.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jevs.2022.104198.

References

[1] Dixon PM, Dacre I. A review of equine dental disorders. Vet J 2005;169:165–87.
[2] Baker GJ. Some aspects of equine dental disease. Equine Vet J 1970;2:105–10.
[3] Nicholls VM, Townsend N. Dental disease in aged horses and its management. Vet Clin North Am Equine Pract 2016;32:215–27.
[4] Dixon PM, Tremaine WH, Pickles K, Kuhns L, Hawe C, et al. Equine dental disease part 4: a long-term study of 400 cases: apical infections of cheek teeth. Equine Vet J 2000;32:182–94.
[5] Dixon PM, Barakzai SZ, Collins NM, Yates J. Equine idiopathic cheek teeth fractures: part 3: a hospital-based survey of 68 referred horses (1999-2005). Equine Vet J 2007;39:327–32.
[6] Ashley FH, Waterman-Pearson AE, Whay HR. Behavioural assessment of pain in horses and donkeys: application to clinical practice and future studies. Equine Vet J 2005;37:565–75.
[7] van Loon JP, van Dierendonck MC. Monitoring equine head-related pain with the equine Utrecht university scale for facial assessment of pain (EQUUS-FAP). Vet J 2017;220:88–90.
[8] Coneglian MM, Borges TD, Weber SH, Bertagnon HG, Michelotto PV. Use of the horse grimace scale to identify and quantify pain due to dental disorders in horses. Appl Anim Behav Sci 2020;225:104970.
[9] Pehkonen J, Karma L, Raekallio M. Behavioral signs associated with equine periapical infection in cheek teeth. J Equine Vet Sci 2019;77:144–50.
[10] Brkljaca Bottegaro N, Kos J, Smolec O, Vnuk D, Maticic D, et al. Pathological findings in premolar and molar teeth in 100 horses during routine clinical examinations. Vet Arh 2012;82:143–53.
[11] Brown LD, Cat TT, DasGupta A. Interval estimation for a proportion. Stat Sci 2001;16:101–33.
[12] McDonnell SM. Practical review of self-mutilation in horses. Anim Reprod Sci 2008;107:219–28.
[13] Fureix C, Menguy H, Hausberger M. Partners with bad temper: reject or cure? A study of chronic pain and aggression in horses. PLoS One 2010;5:e12434.
[14] Jonckheer-Sheehy VS, Delesalle CJ, van den Belt AJM, van den Boom R. Bad behavior or a physical problem? Rearing in a Dutch warmblood mare. J Vet Behav 2012;7:380–5.
[15] Gleerup KB, Forkman B, Lindegaard C, Andersen PH. An equine pain face. Vet Anaesth Analg 2015;42:103–14.
[16] van Loon JP, van Dierendonck MC. Monitoring acute equine visceral pain with the equine Utrecht university scale for composite pain assessment (EQUUS-COMPASS) and the equine Utrecht university scale for facial assessment of pain (EQUUS-FAP): a scale-construction study. Vet J 2015;206:356–64.
[17] Dyson S, Berger JM, Ellis AD, Mullard J. Can the presence of musculoskeletal pain be determined from the facial expressions of ridden horses (FEReq)? J Vet Behav 2017;19:78–89.
[18] Moine S, Flammer SA, de Jesus Maia-Nussbaumer P, Klopfenstein Bregger MD, Gerber V. Evaluation of the effects of performance dentistry on equine rideability: a randomized, blinded, controlled trial. Vet Q 2017;37:195–9.
[19] Cook WR, Kibler M. Behavioural assessment of pain in 66 horses, with and without a bit equine. Vet Educ 2019;31:551–60.
[20] Tell A, Egenvall A, Lundström T, Wattle O. The prevalence of oral ulceration in Swedish horses when ridden with bit and bridle and when unridden. Vet J 2008;178:405–10.
[21] Tuomola K, Mäki-Kihniä N, Kujala-Wirth M, Mykkänen A, Valros A. Oral lesions in the bit area in Finnish trotters after a race: lesion evaluation, scoring, and occurrence. Front Vet Sci 2019;12.
[22] Tuomola K, Mäki-Kihniä N, Valros A, Mykkänen A, Kujala-Wirth M. Bit-related lesions in event horses after a cross-country test. Front Vet Sci 2021;8.
[23] Rhodin M, Egenvall A, Haubro Andersen P, Pfau T. Head and pelvic movement asymmetries at trot in riding horses in training and perceived as free from lameness by the owner. PLoS One 2017;12:e0176253.
[24] Dyson S, Berger JM, Ellis AD, Mullard J. Development of an ethogram for a pain scoring system in ridden horses and its application to determine the presence of musculoskeletal pain. J Vet Behav 2018;23:47–57.
[25] Murray MJ, Grodinsky C, Anderson CW, Radue PF, Schmidt GR. Gastric ulcers in horses: a comparison of endoscopic findings in horses with and without clinical signs. Equine Vet J 1989;7:68–72.
[26] Niinistö KE, Määttä MA, Ruohoniemi MO, Paulaniemi M, Raekallio MR. Owner-reported clinical signs and management-related factors in horses radiographed for intestinal sand accumulation. J Equine Vet Sci 2018;80:10–15.
[27] Taylor PM, Pascoe PJ, Mama KR. Diagnosing and treating pain in the horse. Vet Clin North Am Equine Pract 2002;18:1–19.
[28] Hielm-Björkman AK, Kuusela E, Liman A, Markkola Saarto E, et al. Evaluation of methods for assessment of pain associated with chronic osteoarthritis in dogs. J Am Vet Med 2003;222:1552–8.
[29] Lesimple C, Hausberger M. How accurate are we at assessing others' well-being? The example of welfare assessment in horses. Front Psychol 2015;5.