The prevalence of equine odontoclastic tooth resorption and hypercementosis and the role of interincisal angulation in disease severity in a representative cohort of horses in Switzerland

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Prävalenz der Equinen odontoklastischen Zahnresorption und Hyperzementose in einer repräsentativen Kohorte von Pferden in der Schweiz und die Bedeutung der Interinzisalwinkelungmessung zur Beurteilung des Schweregrades der Erkrankung

Die Equine odontoklastische Zahnresorption und Hyperzementose (EOTRH) ist eine zunehmend diagnostizierte degenerative Zahnerkrankung bei älteren Pferden. Das Hauptziel dieser retrospektiven Studie bestand darin, die Prävalenz von EOTRH bei Pferden zu bestimmen, die von 2004 bis 2017 für zahnärztliche Eingriffe in die Pferdeklinik der Universität Zürich vorgestellt wurden. Ein sekundäres Ziel bestand darin, die Interinzisalwinkelung bei Pferde mit EOTRH auf zweidimensionalen Röntgenaufnahmen zu messen, um festzustellen, ob der Interinzisalwinkel mit dem Alter und dem Schweregrad der Erkrankung zusammenhängt.

Röntgenaufnahmen wurden auf das Vorliegen einer Lyse und/oder Hyperzementose untersucht und die Anzahl und Position der betroffenen Zähne bestimmt. Jeder Zahn wurde auch anhand des von Rehrl et al. (2018) eingeführten modifizierten Klassifizierungssystems bewertet, wobei Grad 0 keine radiologischen Pathologien anzeigt und Grad 3 schwere Pathologien bezeichnet. Der Gesamtschweregrad wurde durch den Zahn mit den schwerwiegendsten Läsionen definiert. Der Interinzisalwinkel wurde bei Pferden bestimmt, die über geeignete Röntgenaufnahmen verfügten. Die Krankenakten von 838 Zahnpatienten wurden ausgewertet und 85 (10,1 %) wiesen klinische Hinweise auf EOTRH auf. Der mittlere Interinzisalwinkel betrug 136,06° bei Pferden mit leichter bis mittelschwerer EOTRH und 135,10° (SD = 11,90°) bei schwer betroffenen Patienten. Zusammenfassend lässt sich sagen, dass die Winkelmessungen auf lateralen Röntgenaufnahmen sehr gut reproduzier-

Summary

Equine odontoclastic tooth resorption and hypercementosis (EOTRH) is an increasingly diagnosed degenerative dental disease in aged horses. The primary aim of this retrospective study was to determine the prevalence of EOTRH in horses admitted to the Equine Hospital, University of Zurich, for dental procedures from 2004 to 2017. A secondary goal was to measure and compare interincisal angles on two-dimensional radiographs of horses with EOTRH to determine whether the interincisal angle is associated with age and severity of the disease.

Radiographs were assessed for the presence of lysis and/or hypercementosis, and the number and position of the teeth affected were determined. Each tooth was also evaluated using the modified classification system introduced by Rehrl et al. (2018), in which stage 0 indicates no radiographic abnormalities and stage 3 denotes severe abnormalities. The overall stage was defined by the tooth with the most severe lesions. The interincisal angle was determined in horses that had suitable radiographs. The medical records of 838 horses admitted for dental procedures were evaluated, and 85 (10,1 %) had clinical evidence of EOTRH. The mean interincisal angle was 136,06° in horses with mild to moderate EOTRH and 135,10° (SD = 11,90°) in severely affected patients. In conclusion, the angle measurements on lateral radiographs were highly reproducible. However, the interincisal angle was not associated with age or the severity of EOTRH. The interincisal angle and the disease pattern were not correlated.

Keywords: Equine, EOTRH, hypercementosis, tooth resorption, interincisal angle

bar waren. Der Interinzisalwinkel war jedoch nicht mit dem Alter oder der Schwere der EOTRH assoziiert. Der Interinzisalwinkel und das Krankheitsbild korrelierten nicht.

Schlüsselwörter: Pferd, EOTRH, Hyperzementose, Zahnresorption, Interinzisalwinkel

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Introduction

Equine odontoclastic tooth resorption and hypercementosis (EOTRH) is a progressive dental disease characterised by tooth resorption and/or excessive build-up of irregular cementum.[25] Clinical signs include pain, gingival inflammation, periodontal attachment destruction, disruption of alveolar bone, tooth fractures and tooth loss.[3,8] The prevalence of EOTRH is high, ranging from 88,2 to 93,7 %, and the disease predominantly affects incisors and canine teeth.[9,20] Although EOTRH is seen most often in horses older than 15 years, moderate to severe radiographic changes have also been reported in younger horses.[9,20,25]

The exact aetiology of the disease is unknown but appears to be multifactorial.[25] Mechanical stress with subsequent destruction of the periodontal ligament (PDL) has been proposed as the initiating factor.[25] The increasingly horizontal orientation of the incisors in aging horses is presumed to place additional stress on the PDL.[25] Earley et al. (2013) observed a decrease in the incisor angle in horses with EOTRH, whereas other authors described an increase. [8,19,24]Another hypothesis states that local irritation and trauma associated with occlusion leads to a build-up of necrotic tissue favouring microbial growth and the development of EOTRH.[22] Secondary involvement of *Treponema* spp. and/or *Tannerella* spp. in horses with EOTRH was described by Sykora et al. in 2014.[27] These red complex bacteria have been shown to be involved in periodontal disease in humans and dogs.[4,26] Other studies describe endocrine disorders, periodontal disease and an alfalfa-based diet without pasture as risk factors for the development of EOTRH.[17] Equine metabolic syndrome (EMS) and pituitary pars intermedia dysfunction (PPID) have been shown to predispose healthy horses to the development of EOTRH.[17,18]

Clinical signs alone are not sufficient for definitive diagnosis of EOTRH and thus, intraoral radiographs are required. Radiographs show tooth resorption and destruction of dental hard tissue and periodontium with cemental thickening causing bulbous enlargement of the tooth root in horses with hypercementosis.[18,24]

The interincisal angle is commonly measured in human cephalometric studies for the analysis of maxillofacial deformities and orthodontic problems.[29] In adult horses, detailed angulation measurements have only involved the occlusal angle of the incisors.[12] Domanska-Kruppa et al. (2019) measured the interincisal angle of the upper and lower incisors in Warmblood foals with and without overjet. The results did not differ between the two groups, but unfortunately detailed information concerning the results of the measurements were not included.[6] To our knowledge, the interincisal angulation of the front teeth of healthy horses has not been reported. The angles formed by the upper and lower incisors are not well described in the literature and appear to be based on personal observations without proper measurements. Schrock et al. (2013) reported that the front teeth appear to be positioned in a straight line in young horses and the angulation becomes more acute (less than 90 °) in older horses.[16,23] Richardson et al. (1997) and Martin et al. (1999) published similar observations without going into further detail.[14,21] Muylle et al. (1996) reported an interincisal angle of 180 ° in horses up to 10 years of age and an obtuse angle (between 90 ° and 180 °) in horses more than 10 years old, but the presence of dental disease was not described.[16] The angle was approximately 100 ° in 17-year-old horses and 90 ° in horses 19 years or older with the exception of one horse in which the angle was acute. Arnbjerg et al. (2014) also noted that horses with a more acute incisor angle hat a greater cementum disposition; however, they didn't perform any measurement.[1] Sykora et al. (2014) reported that horses with EOTRH had an abnormally steep incisor angle.[27] This is to be interpreted as higher angles as normal for the patient's age.

The aim of this retrospective study was to determine the prevalence of EOTRH in a group of horses admitted to the Equine Hospital of the University of Zurich for dental procedures. A secondary goal was to measure and compare interincisal angles on two-dimensional radiographs of horses with EOTRH. Our first hypothesis was that the prevalence of EOTRH in horses admitted to our hospital is similar to that described in other studies. We also hypothesised that the interincisal angle is a variable that can be used to assess the severity of EOTRH.

Materials and methods

The medical records of equine patients admitted to the Equine Hospital, University of Zurich, between 2004 and 2017 were screened for certain key words describing the anatomic region of interest (anatomic region: teeth). The matching clinical records of these dental patients were then filtered for their diagnosis. Records including the key words

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«routine dental examination», «EOTRH», «hypercementosis», «resorption», «lysis», «tooth extraction», «incisive», «canini», «cementoma», «tooth fracture», «periodontal disease», «dental disorder», «loose tooth», «alveolar bone lysis» and «osteitis» (n=838). For these patients the written medical records were reviewed/verified to filter for definite EOTRH patients. Horses were included in the study when the results of the physical oral and radiographic examinations were consistent with a diagnosis of EOTRH of the incisors, canines and/or the cheek teeth.

Data extracted from the medical records included age, breed, gender and the results of clinical and radiographic examinations. Some horses had repeated admissions with several clinical datasets. Horses were divided into the following groups: Warmbloods, Icelandic horses, ponies, cobs (Haflinger, Freiberger and Welsh), Thoroughbreds and draft horses. Horses were also divided into two groups based on age: 8 to 20 years (Group 1) and older than 20 years (Group 2) similar to Rehrl et al. (2018).[20] The medical records were analysed for clinical signs assessed/recorded by the referring veterinarian or the evaluation at the Equine Hospital. The radiographic projections used for evaluation included: intraoral dorsoventral oblique (0°/+45°) views, intraoral ventrodorsal oblique (0°/-60°) views, lateral extraoral views of the canine teeth (100°/-30° and 100°/+30° with open mouth) and other lateral views (90°/0°). A radiograph was suitable for assessment if it was diagnostically acceptable (had a sufficient image quality to answer the clinical question). Each radiograph was assessed to determine the EOTRH pattern (lysis and/or hypercementosis) and the number of teeth affected. Teeth were also individually staged from 0 (no radiographic abnormalities) to 3 (severe radiographic abnormalities; Table 1) using the modified classification system introduced by Rehrl et al. (2018).[20] The overall severity of EOTRH was based on the tooth with the most severe lesions. For disease staging and determination of the EOTRH pattern we only took the first assessment with complete intraoral radiographs in consideration. In some patients though radiographs for further analysis were not available.

Table 1: Radiographic scoring system for staging Equine odontoclastic tooth resorption and hypercementosis (EOTRH) (Rehrl et al., 2018).[20]

Stage of EOTRH		Radiographic findings
Severe	**3**	Loss of tooth shape/intra-alveolar aspect of tooth is wider than the clinical crown/tooth fracture. Obvious irregular/rough surface
Moderate	**2**	Tooth shape largely preserved/intra-alveolar aspect of tooth is not wider than the clinical crown/obvious blunting of root tip. Irregular/rough surface
Mild	**1**	Tooth shape preserved/slightly blunted root tip. Irregular/rough surface
Normal	**0**	No abnormal radiographic findings

Figure 1: Latero-lateral 90°/0° – radiographic projection of the premaxilla and incisival mandibular bone of a 21-year-old Friesian stallion with tooth resorption showing the measurement lines for determining the interincisal angle.

The lateral radiographic views (90°/0°) were used to measure the interincisal angle, which was defined as the angle between the long axes of the central maxillary and mandibular incisors. The line of each axis was drawn along the incisal third of the rostral surface of the incisors (Figure 1). When several radiographs were available, the one with the least visible distortion was selected for further analysis and measurements. Using a digital ruler, the interincisal angle was determined and measured by one author (P.I.); each radiograph was measured three times and the mean of the measurements was used.

The interpretation of the digital radiographic images was done using the medical imaging software OsiriX Open Source™ 5.0.2, OsiriX Foundation, Geneva, Switzerland. Two-tailed t-tests for independent samples were done for comparison of the two groups, and breed and sex distributions were analysed using a chi-square test. A P value of <0,05 was considered significant. All analyses were done in the R programming language (version 3.6.2) (R Core Team, 2019).

Results

The mean age of all horses admitted to the Equine Hospital, University of Zurich, for dental procedures from 2004 to 2017 (n = 838) was 13,2 years (range 1 month to 41 years). A total of 85 horses (10,1 %) met the EOTRH inclusion criteria (Figure 2). Their mean age was 21,2 years (range 8

to 32 years); 36 horses were in group 1 (≤ 20 years) and 49 in group 2 (≥ 20 years). Eleven (12,9 %) of the EOTRH patients were stallions, 62 (72,9 %) were geldings and 12 (14,1 %) were mares. In the same time frame of our study period (2004–2017), a total of 22810 equine patients were presented to the same Equine Hospital. Among these, 9,4 % were stallions, 48,0 % geldings and 42,6 % mares. Consequently, in the present study, geldings had a higher prevalence of EOTRH than stallions and mares (X^2 (1, N = 838) = 15,6, p = <0,001). There were 57 Warmblood horses (67,1 %), 13 Icelandic horses (15,3 %), 7 cobs, 5 ponies and 3 Thoroughbreds. Draft horse did not meet the EOTRH inclusion criteria. The distribution of breeds in the EOTRH and non-EOTRH groups differed (p=0,014); Icelandic horses comprised 15,3 % (n=13) of all horses with EOTRH (n=85), but made up only 5,7 % (n=43) of the non-EOTRH population (n=753).

According to the medical records, physical and oral examinations revealed tooth fractures or missing teeth without any history of trauma, difficulty in biting into solid food such as apples or carrots, sensitivity to the bit, salivation, painful incisors, gingivitis, gingival hyperplasia, gingival recession, fistulas, enlargements of dental structures and tooth mobility.[17] Some of the medical records did not contain all the necessary information, such as whether a missing tooth had been previously removed by a veterinarian or it had fallen out on its own. In addition, a complete series of radiographs, consisting of one lateral (90 °/0 °) and two intraoral views, was not available for each horse. Figure 2 shows that radiographic and dataset assessments were carried out in a total of 85 horses. Sixty-six horses were assessed once and 19 were evaluated 2 to 6 times.

In the available radiographs assessed once per patient (n=85), EOTRH was severe in 54 (74 %), moderate in 18 (24,7 %) and mild in one horse (1,3 %). Twelve horses could not be assessed due to lack of radiographs of the incisors (Figure 2).

In single assessments per patient (n=85), hypercementosis alone was diagnosed in one patient (1,4 %), tooth resorption in 30 (41,1 %) and hypercementosis and tooth resorption in 42 (57,5 %, Figure 3). In 12 of the 85 cases, disease staging could not be determined. The type of lesion changed from tooth resorption alone to tooth resorption and hypercementosis in two horses during the course of evaluation at our clinic. One 14-year-old Shetland pony also had hypercementosis of the maxillary premolars.

Disease staging could be determined in 31 of the 36 horses of age group 1: EOTRH was mild in one (3,2 %), moderate in 12 (38,7 %) and severe in 18 (58,1 %). In age group 2, disease staging could be done in 42 of the 49 horses: EOTRH was moderate in six (14,3 %) and severe in 36 (85,7 %). The severity of EOTRH was higher in horses of group 2 (p = 0,02) (Figure 4).

The third incisors were the most frequently affected teeth (Table 2) and had the highest percentage of grade 3 lesions (52,4 to 57,6,0 %). Most of the 104 (69,0 %) and 204 teeth (72,4 %) did not have EOTRH lesions. Teeth 304 and 404 had more grade 1 and grade 2 EOTRH lesions than teeth 104 and 204.

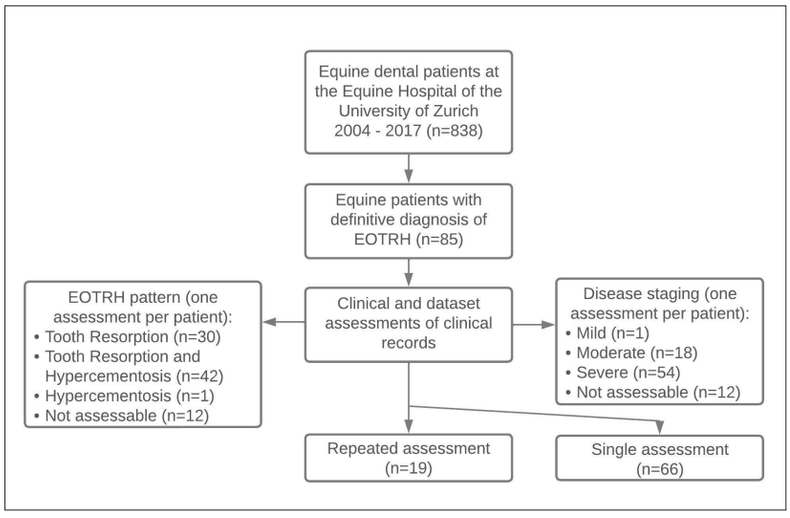

Figure 2: Flowchart describing the study population of 838 patients admitted for dental procedures, 85 had a definitive diagnosis of equine odontoclastic tooth resorption and hypercementosis (EOTRH).

Table 2: Total number of teeth affected by Equine odontoclastic tooth resorption and hypercementosis (EOTRH) and the severity of disease. Values may not add to 100 % due to rounding.

Incisor / Canine tooth				
(Triadan position)	**Grade 0**	**Grade 1**	**Grade 2**	**Grade 3**
101	5,80 % (4/69)	30,43 % (21/69)	39,13 % (27/69)	24,64 % (17/69)
102	4,35 % (3/69)	18,84 % (13/69)	43,48 % (30/69)	33,33 % (23/69)
103	4,55 % (3/66)	6,00 % (4/66)	31,81 % (21/66)	57,58 % (38/66)
104	68,97 % (40/58)	13,80 % (8/58)	12,07 % (7/58)	5,17 % (3/58)
201	7,14 % (5/70)	42,86 % (30/70)	31,43 % (22/70)	18,57 % (13/70)
202	4,41 % (3/68)	26,47 % (18/68)	41,18 % (28/68)	27,94 % (19/68)
203	3,17 % (2/63)	6,35 % (4/63)	38,10 % (24/63)	52,38 % (33/63)
204	72,41 % (42/58)	8,62 % (5/58)	17,24 % (10/58)	1,72 % (1/58)
301	10,96 % (8/73)	26,03 % (19/73)	35,62 % (26/73)	27,40 % (20/73)
302	8,33 % (6/72)	20,83 % (15/72)	34,72 % (25/72)	36,11 % (26/72)
303	7,14 % (5/70)	11,43 % (8/70)	27,14 % (19/70)	54,29 % (38/70)
304	30,65 % (19/62)	27,42 % (17/62)	27,42 % (17/62)	14,52 % (9/62)
401	13,70 % (10/73)	24,66 % (18/73)	36,99 % (27/73)	24,66 % (18/73)
402	11,27 % (8/71)	19,72 % (14/71)	36,62 % (26/71)	32,39 % (23/71)
403	7,04 % (5/71)	12,68 % (9/71)	26,76 % (19/71)	53,52 % (38/71)
404	31,74 % (20/63)	33,33 % (21/63)	26,98 % (17/63)	7,94 % (5/63)

Relationships between radiographic disease staging, age and the interincisal angle

Angle measurements were obtained from eight horses with mild to moderate EOTRH (grade 1 and 2 based on Rehrl et al., 2018) and 25 horses with severe EOTRH (grade 3). The mean central interincisal angle was 136,06° (SD = 13,05°) in horses with mild to moderate EOTRH and 135,10° (SD = 11,90°) in severely affected horses. The interincisal angles of the two groups did not differ (p = 0,847). The angles ranged from 122,14 to 164,36° (mean 139,99°, SD=13,30°) in age group 1 and from 115,80 to 154,36° (mean 131,14°, SD=10,87°) in age group 2 (Figure 5).

Relationship between disease pattern and interincisal angle

Data from 16 horses with tooth resorption alone and 17 horses with tooth resorption and hypercementosis were available for analysis. One horse with only hypercementosis was excluded. In two horses, in which the pattern of EOTRH had changed between assessments, the findings of the first assessment were used. In all other horses with multiple assessments, the angle measured in the initial assessment was used. The mean angle in horses with resorption alone was 134,14° (n = 16, SD = 11,66°) and the mean angle of horses with tooth resorption and hypercementosis was 135,11° (n = 17, SD = 13,47°) (Table 3); this difference was not significant (p = 0,827) (Figure 6).

Table 3: Descriptive characteristics about the patients with angle measurements performed (HTR = Hypercementosis and Tooth Resorption, TR = Tooth Resorption).

Case No	Age Group	Age	Sex	Breed	Stage Overall	EOTRH Pattern	(HTR, TR) Angle Measurements (Mean ± SD)
1	2	28	gelding	warmblood	3	HTR	123,15 ± 1,60
2	2	26	gelding	warmblood	3	HTR	128,16 ± 0,16
3	1	14	gelding	warmblood	3	TR	132,25 ± 1,78
4	1	20	stallion	warmblood	2	HTR	134,59 ± 0,80
5	2	22	gelding	warmblood	3	HTR	115,80 ± 0,68
6	2	22	mare	warmblood	3	HTR	138,84 ± 0,56
7	2	23	gelding	warmblood	3	HTR	131,33 ± 2,35
8	1	14	gelding	warmblood	3	HTR	145,69 ± 0,40
9	2	21	stallion	warmblood	3	TR	118,13 ± 0,95
10	2	22	gelding	icelandic horse	3	HTR	137,62 ± 0,77
11	1	10	stallion	icelandic horse	2	TR	147, 29 ± 0,99
12	2	24	gelding	warmblood	2	TR	129,97 ± 1,00
13	2	21	mare	warmblood	3	TR	124,38 ± 0,35
14	1	17	gelding	icelandic horse	1	TR	129,01 ± 2,02
15	2	26	gelding	thoroughbred	3	TR	145,03 ± 0,83
16	1	19	gelding	warmblood	3	TR	143,00 ± 1,56
17	1	18	gelding	warmblood	3	TR	143,95 ± 1,45
18	1	17	gelding	icelandic horse	2	TR	152,16 ± 0,62
19	2	29	mare	warmblood	3	HTR	129,88 ± 0,22
20	1	15	gelding	warmblood	2	TR	122,62 ± 0,64
21	2	24	gelding	warmblood	3	HTR	129,47 ± 1,23
22	1	20	gelding	warmblood	3	HTR	122,14 ± 3,97
23	1	18	gelding	warmblood	3	TR	128,88 ± 0,69
24	1	19	stallion	warmblood	3	TR	122,47 ± 1,08
25	1	19	gelding	warmblood	3	HTR	160,14 ± 1,39
26	2	21	gelding	warmblood	3	TR	134,42 ± 1,33
27	2	22	gelding	warmblood	2	HTR	120,05 ± 1,24
28	2	21	gelding	warmblood	3	HTR	146,76 ± 0,92
29	1	19	gelding	cob	3	HTR	164,36 ± 2,58
30	1	16	gelding	warmblood	3	HTR	126,78 ± 0,41
31	1	8	gelding	icelandic horse	2	TR	152,84 ± 1,27
32	2	24	gelding	warmblood	3	TR	119,89 ± 0,35
33	2	22	gelding	warmblood	3	HTR	142,16 ± 1,88

Discussion

The prevalence of EOTRH in our study population was markedly lower (10,1 %) than in two other studies, which reported a radiological prevalence of 88,2 % and 93,7 %.[9,20] The first hypothesis was therefore rejected. Our study population (838 equines) had a markedly lower mean age than the one described by Rehrl et al. (2018), which is one possible explanation for the difference in prevalence.[20] Another possible explanation for the difference in prevalence is that the selection of our cases was based on clinical records and certain keywords, whereas other studies based a diagnosis of EOTRH solely on radiographic lesions.[9,20] Henry et al. (2017) even excluded horses with obvious or reported disease of the incisors. As a result, with our retrospective case selection, many cases with radiological changes but no clinical signs may have been omitted from a definitive diagnosis. Thus, mild and even moderate radiographic lesions may represent normal age-related changes without clinical significance. It is therefore imperative that a definitive diagnosis be based on clinical findings and patient history, and not solely on radiography. Our results are in agreement with those of Dixon et al. (1999), in which 11 % of 400 clinical dental cases had disorders of the incisors.[5] The mean age of the 838 horses admitted to the Equine Hospital, University of Zurich, from 2004 and 2017 for dental procedures was 13,2 years. This was similar to the mean age (12,6 years) of the Swiss horse population determined in 2016.[2]

Controversy exists as to whether breed and sex are predisposing factors in the development of EOTRH. The study by Rehrl et al. showed no apparent breed predilection in her radiological prevalence study, whereas Vlaminck et al., who was looking at horses without specific inclusion criteria, reported that EOTRH was more widespread in Icelandic horses (13,1 %) than in Warmbloods (4,7 %).[20,28] In the present study, EOTRH was seen mostly in Warmblood horses (67,1 %) and geldings (72,9 %). The distribution of the breeds was significantly different between EOTRH and non-EOTRH patients (p=0,014). The most noticeable finding was that 15,3 % (n=13) of all EOTRH patients (n=85) were Icelandic horses, while only 5,7 % (n=43) were Icelandic horses in the non-EOTRH population (n=753).

In 2016, the AGROSCOPE Agricultural Research Centre reported that the Swiss horse population consisted of 51,4 % mares and 48,6 % male horses, 90 % of which were geldings, and Icelandic horses made up 4 % of all breeds. Moreover, in the same time frame of our study period (2004–2017), among all equine patients presented to the same Hospital (n = 22810), 9,4 % were stallions, 48,0 % geldings and 42,6 % mares. Thus, our study showed a high predisposition for EOTRH in geldings and Icelandic horses similar to other studies.[2,13,18,24,28]

Equine odontoclastic tooth resorption and hypercementosis is a progressive disease that commonly affects the incisor and canine teeth and rarely the cheek teeth.[13,20] This finding agreed with our results, which showed that the highest percentage of grade 3 disease occurred in the third incisors. Moore et al. described two cases in which all of the cheek teeth had EOTRH.[15] One pony in our study group had maxillary hypercementosis but only the premolars were involved.

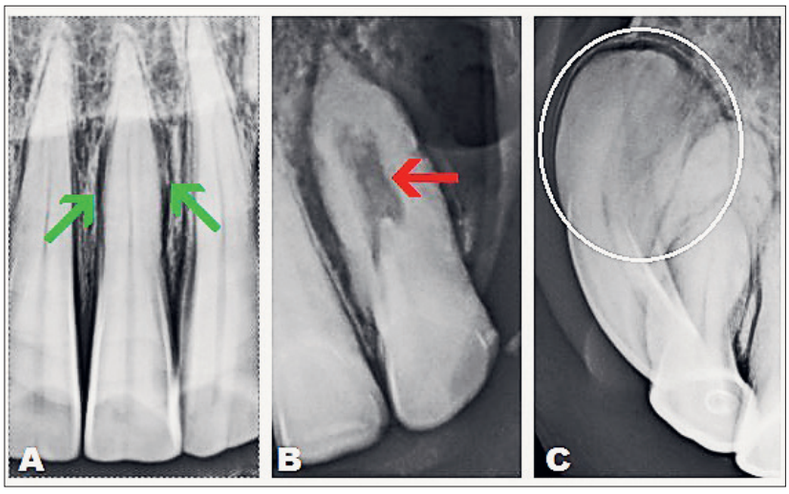

Figure 3: Intraoral radiographs showing various Equine odontoclastic tooth resorption and hypercementosis (EOTRH) lesions in equine incisors. A) mandibula (0°/-60°): widening of the periodontal ligament space (green arrows); B) maxilla (0°/+45°) severe tooth resorption: maxilla (0°/+45°) (red arrow); C) maxilla (0°/45°) severe hypercementosis (circle).

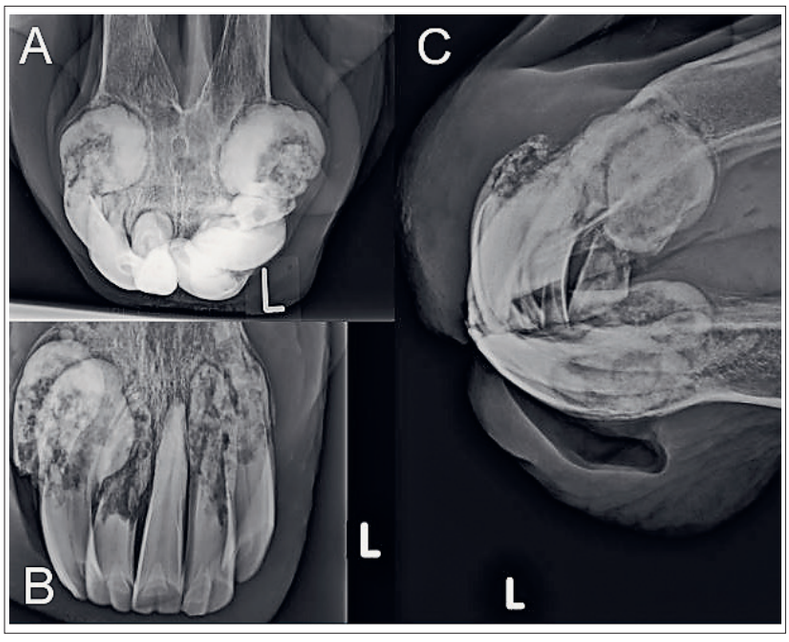

Figure 4: Intraoral (A maxilla and B mandibula) and lateral (C) radiographs of a 22-year-old Warmblood mare (Group 2). The mean interincisal angle was 138.84° (SD = 0.56°). Except for tooth 301, all incisors had grade 3 Equine odontoclastic tooth resorption and hypercementosis (EOTRH).

The central interincisal angle was not correlated with age or the stage of EOTRH, and thus was not a reliable indicator of disease severity. Our second hypothesis was therefore rejected. Although the pattern of EOTRH varied, significant differences in the incisive angle, which was an average of 134,14° to 135,11°, were not found. It was assumed that the incisive angle varies with the individual oral status of the horse, the onset of the disease and factors such as feeding, dental care and possibly genetics. It is important to consider that the accuracy of measurements was likely affected by the quality of the radiographs. A reliable measurement of individual opposite tooth pairs is not possible with a two-dimensional radiograph and thus we compared the measurements of the anterior contour line, which corresponds to the angle of the central incisors (101, 201, 301, 401). All measurements were made by one assessor to avoid interobserver variation.

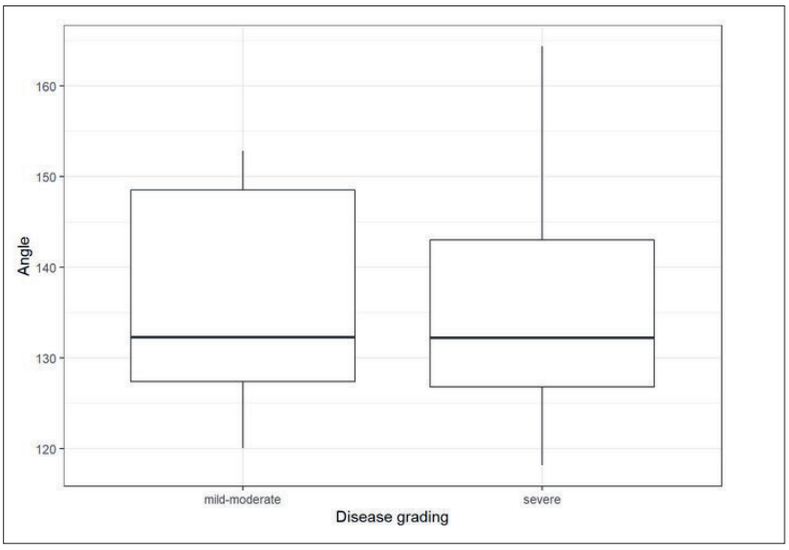

Figure 5: Box-and-whisker plots of the interincisal angle in eight horses with mild to moderate EOTRH and 25 horses with severe Equine odontoclastic tooth resorption and hypercementosis (EOTRH). The horizontal lines of the box-and-whisker plots represent, from bottom to top, the first quartile, the median and the third quartile, and the whiskers extend to the minimum and maximum values within 1.5 interquartile ranges.

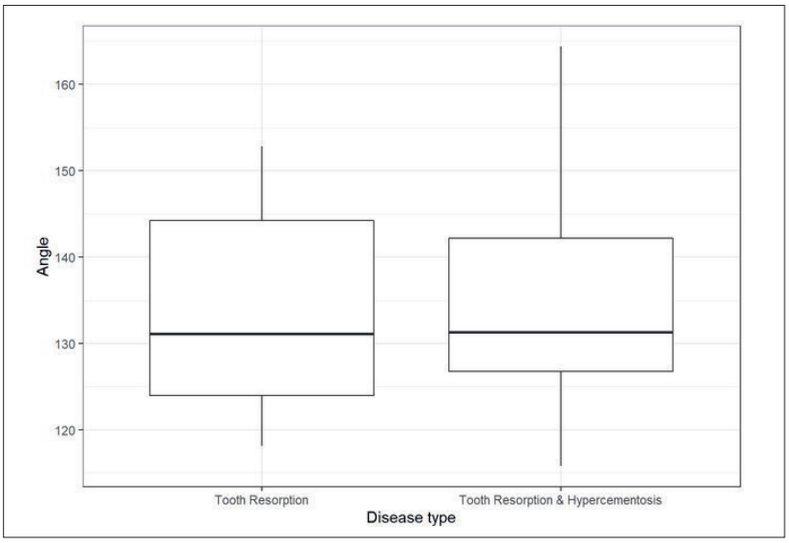

Figure 6: Box-and-whisker plots of the interincisal angle in 16 horses with tooth resorption alone and in 17 horses with tooth resorption and hypercementosis. The horizontal lines of the box-and-whisker plots represent, from bottom to top, the first quartile, the median and the third quartile, and the whiskers extend to the minimum and maximum values within 1.5 interquartile ranges.

Three-dimensional imaging allows for more precise measurements than two-dimensional lateral cephalometric radiographs and is the method of choice for determining interincisal angles. It is also optimal for obtaining accurate angulation measurements of the second and third incisor pairs in EOTRH patients. Nevertheless, our measurements showed that the angle of the anterior contour line was reproducible with an error of only a few degrees compared with three-dimensional cephalometric computed tomography (CT). In fact, in one study, CT showed that in healthy horses (mean age 9,2 years), the mean central interincisal angle was 132,7° for the right side and 132,6° degrees for the left side.[9] These values were similar to the interincisal angle (132,76°) determined for group 1. It, therefore, appears that angulation measurements do not differ between EOTRH patients and healthy horses ≤ 20 years of age. Further prospective studies are needed to corroborate this finding. In addition, angles of individual tooth pairs should be compared with non-EOTRH patients to determine whether EOTRH leads to a noticeable variation in the interincisal angle. However, this comparison could be problematic because according to Rehrl et al., it is difficult to find horses older than 14 years that do not have EOTRH.[20]

The main limitation of our study was the small number of horses with EOTRH that had lateral radiographs even though 838 horses were admitted for dental procedures. In addition, the retrospective nature of the study may have resulted in a selection bias. Another limitation was the lack of comparison of the interincisal angle in horses with EOTRH and healthy horses. Our number of follow-up cases was small, which prevented the determination of possible angulation changes during the course of the disease. However, data about incisor angulation are scarce, and our study determined angulation values in the largest number of horses with EOTRH to date.

In conclusion, the prevalence of horses with clinical and radiographic signs of EOTRH in our group of horses was relatively low in this compared to Rehrl et al. and Henry et al.[9,20] Determination of the interincisal angle was easy to achieve and may be a useful tool for better understanding the aetiology of EOTRH. The severity of EOTRH and the disease pattern were not associated with the interincisal angle. Studies using a larger number of horses with EOTRH that undergo follow-up examinations for several years are needed.

Prévalence de la résorption dentaire odontoclastique et de l'hypercémentose équine et rôle de l'angulation inter-incisive dans la sévérité de la maladie dans une cohorte représentative de chevaux en Suisse

La résorption et l'hypercémentose odontoclastique des dents chez le cheval (EOTRH) est une maladie dentaire dégénérative de plus en plus diagnostiquée chez les animaux âgés. L'objectif principal de cette étude rétrospective était de déterminer la prévalence de l'EOTRH chez les chevaux admis à l'Hôpital équin de l'Université de Zurich pour des interventions dentaires entre 2014 et 2017. Un objectif secondaire était de mesurer et de comparer les angles inter-incisifs sur des radiographies bidimensionnelles de chevaux atteints d'EOTRH afin de déterminer si cet angle est associé à l'âge et à la gravité de la maladie.

Les radiographies ont été évaluées pour la présence de lyse et/ou d'hypercémentose, et le nombre et la position des dents affectées ont été déterminés. Chaque dent a également été évaluée à l'aide du système de classification modifié introduit par Rehrl et al. (2018), dans lequel le stade 0 indique l'absence d'anomalies radiographiques et le stade 3 indique des anomalies graves. Le stade global a été défini par la dent présentant les lésions les plus sévères. L'angle inter-incisif a été déterminé chez les chevaux qui avaient des radiographies appropriées. Les dossiers médicaux de 838 chevaux admis pour des interventions dentaires ont été évalués et 85 (10,1 %) présentaient des signes cliniques d'EOTRH. L'angle inter-incisif moyen était de 136,06° chez les chevaux présentant une EOTRH légère à modérée et de 135,10° (écart-type = 11,90°) chez les patients gravement atteints. En conclusion, les mesures d'angle sur les radiographies latérales étaient très reproductibles. Cependant, l'angle inter-incisif n'était pas associé à l'âge ou à la sévérité de l'EOTRH. L'angle inter-incisif et le profil de la maladie n'étaient pas corrélés.

Mots clés: Cheval, EOTRH, hypercémentose, résorption dentaire, angle inter-incisif.

Prevalenza del riassorbimento odontoclastico dentale e dell'ipercementosi e il ruolo dell'angolazione interincisale nella valutazione della gravità della malattia in una coorte rappresentativa di cavalli in Svizzera

L'EOTRH, il riassorbimento odontoclastico dentale e l'ipercementosi equina, **è** una malattia dentale degenerativa diagnosticata sempre più frequentemente nei cavalli anziani. Lo scopo principale di questo studio retrospettivo era di determinare la prevalenza dell'EOTRH nei cavalli ammessi per procedure dentali presso la Pferdeklinik (clinica per gli equini) dell'Università di Zurigo dal 2014 al 2017. Un obiettivo secondario era di misurare e confrontare gli angoli interincisali sulle radiografie bidimensionali dei cavalli affetti da EOTRH per determinare se l'angolazione interincisale è associata all'età dell'animale e alla gravità della malattia.

Le radiografie sono state valutate per la presenza di lisi e/o di ipercementosi e sono stati determinati il numero e la posizione dei denti interessati. Ogni dente è stato valutato anche utilizzando il sistema di classificazione modificato introdotto da Rehrl et al. (2018), in cui lo stadio 0 indica l'assenza di anomalie radiografiche e lo stadio 3 indica gravi anomalie. La gravità complessiva **è stat**a definita dal dente con le lesioni più gravi. L'angolazione interincisale è stata determinata nei cavalli che avevano radiografie idonee. Si sono esaminate le cartelle cliniche di 838 cavalli ammessi per procedure dentali, e 85 (10,1%) presentavano evidenze cliniche di EOTRH. La media dell'angolazione interincisale era di 136,06° nei cavalli con EOTRH lieve o moderato e di 135,10° (SD = 11,90°) nei pazienti gravemente affetti. In conclusione, le misurazioni degli angoli sulle radiografie laterali erano altamente riproducibili. Tuttavia, l'angolazione interincisale non era associata all'età o alla gravità dell'EOTRH. L'angolazione interincisale e il profilo della malattia non erano correlati.

Parole chiave: Equino, EOTRH, ipercementosi, riassorbimento dentale, angolo interincisale.

The prevalence of equine odontoclastic tooth resorption and hypercementosis and the role of interincisal angulation in disease severity in a representative cohort of horses in Switzerland

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