



## MORPHOMETRIC CHARACTERISTICS OF THE FIRST PREMOLAR (WOLF TOOTH) IN HORSES, WITH SPECIAL REFERENCE TO ITS CLINICAL IMPORTANCE

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### Summary

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Wolf tooth is a common term used to describe the first premolar, a functionless remnant from modern horse's ancestors. This study was performed to reveal possible relationships between morphometric characteristics of wolf tooth and its clinical importance in animal's health. A total of 158 wolf teeth were extracted from 83 horses from 1.5 to 15 years of age during a period of one year and divided into two groups based on the age of the animals: Group 1, up to 3 years old and group 2, over 3 years old. Crown length, root length, neck width and crown/root ratio of the teeth were measured using a Vernier caliper. Crown length, root length and neck width decreased significantly in group 2, while the crown/root ratio was considerably increased. Crown length exhibited a significant correlation ( $P < 0.05$ ) with root length in group 1, while this correlation was stronger ( $P < 0.01$ ) in group 2. Crown length was significantly correlated with neck width ( $P < 0.01$ ) in both groups, but there was no significant correlation between root length and neck width in both groups. Also, crown length and root length were negatively and significantly related ( $P < 0.01$ ) with age in both studied groups and became shorter. The results revealed that the crown of the wolf tooth could be a more reliable indicator for estimation of the root length in horses over 3 years of age than in those under 3 years and that in younger horses this criterion had a lower potential to predict the root length.

**Key words:** first premolar, horse, morphometry, wolf tooth

### INTRODUCTION

The earliest equid, *Hyracotherium*, has a dental formula of three incisors, one canine, four premolars, and three molars (3 : 1 : 4 : 3) on each side of upper and lower jaws. The canine is large and sexu-

ally dimorphic (Gingerich, 1981). The premolars are primitive in structure, and roughly triangular in shape, whereas the molars are relatively square and have a greater surface area for trituration. Mor-

phological features of the modern horse's teeth reflect adaptations to ecologic changes (Soana *et al.*, 1999). During the Eocene, fossil horses are characterised by progressive 'molarization' of the premolars, resulting in a functional dental battery consisting of six principal teeth (P2/p2 through M3/m3) for mastication of foodstuffs (Easley, 2011). The first premolar progressively became smaller and is now small, cone shaped, and usually situated just rostrally to the first well-developed cheek teeth. Thus, the first premolar is a functionless remnant from ancestors of the modern horse (Jones, 1972; MacFadden, 2005). Like most other mammalian families with little evolutionary variation in the dental formula, other than the variable presence of the first premolar, equids are relatively constant in the dental formula throughout their phylogeny (Sisson & Grossman, 1975; Sach & Habel, 1976). Wolf tooth is a common term used to describe the first premolar. This tooth is a simple brachydont, usually erupting between 6–12 months of age (Easley, 2004; Dixon, 2005).

One or both of the upper first premolars, and less commonly, the lower first premolar, can be present with a reported incidence of between 13% and 32% by different authors. These percentages in fact may be underestimated because many young horses may lose their wolf teeth when they shed their deciduous first cheek teeth (Dixon, 2002). Johnson (2010) mentioned that at least one wolf tooth erupts in 40%–80% of domestic horses.

If wolf teeth are very large, particularly if displaced rostrally, medially or laterally, horses may experience oral pain as a result of bit working against them and forcing cheek mucosa into the sharp point of teeth (Dixon, 2005; Linkous, 2005). Behaviours associated with oral discom-

fort caused by wolf tooth include biting problems, head tossing, and head shaking (Lowder, 2006). Additionally, their presence precludes creation of 'bit seats' (shaping of rostral aspects of the 1<sup>st</sup> CT). However, erupted upper wolf teeth may be present in mature horses that are being ridden successfully with a bit and have no history of oral discomfort (Dixon, 2005; Scrutchfield, 2006). Thus, there are contrary opinions about wolf teeth extraction or leaving them. In studies that have been conducted on dental disorders, involvement of wolf tooth has been reported at various level (Dixon *et al.*, 1999; Buttegaro *et al.*, 2012). Due to the high prevalence of presence of wolf tooth in horse population and its potential side effects to induce biting problems, studies on this topic are important. On the other hand, as far as we know, there is no information about morphologic changes of wolf tooth characteristics parallel to aging. Thus, this study was conducted to find answers for the following questions; 1) Are there any correlations between morphometric features of the wolf tooth such as length of the crown and root at different ages; 2) Is it possible to predict the size of the root according to the exposed crown; 3) What is the possible impact on equine health.

## MATERIALS AND METHODS

During a period of time from May 2013 to March 2014, a total of 83 horses (ranging in age from 1.5 to 15 years) were examined for wolf teeth condition upon their owners requests and underwent teeth extraction. Briefly, after initial examination, horses were sedated with xylazine (0.25 to 0.5 mg/kg, IV). After five minutes, the mouth was rinsed with water and the head was supported at an appropriate height using a dental halter and a full-mouth den-

tal speculum was used to provide optimum visualisation. For local anaesthesia, approximately 1.5 to 2 mL of mepivacaine hydrochloride solution (2%; Carbocaine-V, Pfizer Animal Health) was injected submucosally between the gingiva and palatine mucosa on the palatal side of the wolf tooth. Moreover, 1 to 2 mL of local anaesthetic solution was injected submucosally on the buccal side of the wolf tooth at the junction of the gingival and cheek mucosa. Then, the gingival tissue and periodontal attachments were elevated from the root and crown and the loosened tooth was removed with forceps. All teeth were extracted without any kinds of fractures. In 75 cases, the extraction was done bilaterally and in 8 cases unilaterally. Totally, 158 wolf teeth were obtained. The teeth were divided into two distinct groups based on the age of the animals: group 1 comprising horses <3 years old and group 2: >3 years old. Teeth were subjected to morphometric measurements. The determined parameters (crown length, root length, width at neck and crown/root ratio of the teeth) were measured using a Vernier caliper (200 mm; Mitutoyo Corp., Kawasaki, Japan; resolution 0.05 mm, graduation 0.05 mm, accuracy  $\pm 0.05$  mm).

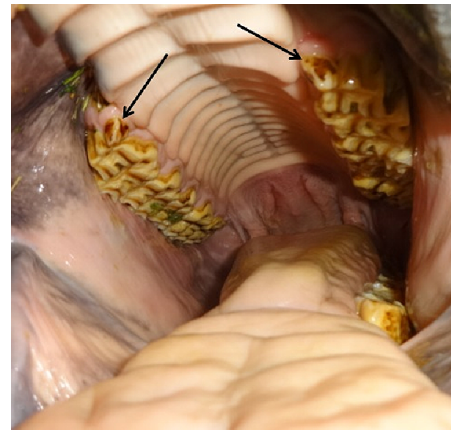
All parameters were measured three times and the mean values were recorded.

#### *Statistical analysis*

The statistical software SPSS v. 19.0 for Windows (SPSS Corp., Chicago, IL) was used to compute the means and standard deviation (SD) of all parameters. The independent sample *t* test and Mann-Whitney test were used to compare the groups. The correlations between studied measurements and fixed effects of age on them were determined. *P* values of <0.01 and <0.05 were regarded as statistically significant.

## RESULTS

Except for one case, all obtained teeth in this study were upper wolf teeth (Fig. 1). Fig. 2 shows a wide variety of size and shape of occlusal surface of wolf teeth in different age groups.



**Fig. 1.** Maxillary dental arcades. Upper wolf teeth (arrows) are just rostral to each row of the upper cheek teeth.

Minimum, maximum and mean $\pm$ SD for the measured morphometric parameters are presented in Table 1. Comparison of the mean values of variables in studied groups revealed significant decrease ( $P<0.05$ ) of crown length, root length and neck width in the group > 3 years of age. Subsequently, the crown/root ratio was significantly higher ( $P<0.05$ ) compared to the group > 3 years of age (Table 1).

In horses up to 3 years old, crown length was significantly correlated ( $P<0.05$ ) with root length, while this correlation in horses older than 3 years of age was more significant ( $P<0.01$ ) (0.29 and 0.54 respectively) (Table 2). Crown length was significantly correlated with neck width ( $P<0.01$ ) and crown/root ratio ( $P<0.05$ ) in both groups. However, there was no significant correlation between neck width



**Fig. 2.** Wolf teeth in a wide variety of size and shape of occlusal surface in horses up to 3 years of age (upper row) and over 3 years of age (lower row).

**Table 1.** Morphometric parameters of the wolf tooth (mm) in horses < 3 years of age (Group 1) and horses > 3 years of age (Group 2). Data are presented as mean±SD

Measured parameters	Group 1 (n=55)			Group 2 (n=30)		
	Max	Min	Mean±SD	Max	Min	Mean±SD
Crown length	10.6	5.6	7.83 ± 1.32*	8.2	3.3	5.84 ± 1.46
Root length	22.0	7.4	14.66 ± 3.75*	10.7	3.5	7.31 ± 1.90
Neck width	11.5	4.9	7.60 ± 1.48	9.4	3.4	6.15 ± 1.49
Crown/root ratio	0.99	0.33	0.57 ± 0.17*	1.24	0.48	0.83 ± 0.20

significantly different at  $P < 0.05$  between groups.

**Table 2.** Spearman correlation coefficients between studied morphometric parameters<sup>1</sup> in horses < 3 years of age (Group 1, above the diagonal) and horses > 3 years of age (Group 2, below the diagonal)

	Crown length	Root length	Neck width	Crown/root ratio	Age
Crown length		0.29*	0.38**	0.34*	-0.42**
Root length	0.54**		0.18	-0.75**	-0.83**
Neck width	0.78**	0.31		0.18	-0.24
Crown/root ratio	0.43*	-0.44**	0.42		0.53**
Age	-0.76**	-0.79**	-0.61**	0.04	

\*  $P < 0.05$ ; \*\*  $P < 0.01$ .

and root length in both groups. Also, crown length and root length exhibited significant negative correlation ( $P < 0.01$ ) with age in both studied groups (-0.42 and -0.83, -0.76 and -0.79 respectively).

The crown/root ratio and age were significantly related ( $P < 0.01$ ) in the group under 3 years of age, but not in the older group of horses ( $P > 0.05$ ).

## DISCUSSION

During eruption of the adjacent permanent second premolar, approximately at 30–36 months of age, the root of wolf teeth began to be resorbed (Sisson & Grossman, 1975). Wolf teeth have a root of variable length up to 30 mm (Dixon, 2005; Dixon & Dacre, 2005). In our study, the longest root (22 mm) was seen in a 20-month-old horse from group 1, while in group 2 the longest root (10.7 mm) belonged to a 48-month-old horse. According to the obtained results, crown length had a significant correlation with root length in all ages and this correlation was stronger and more significant in animals aged over 3 years ( $P < 0.01$ ). In contrast to our finding, Easley *et al.* (2011) mentioned that the size and shape of the crown were not necessarily a reflection of the size or shape of the root.

On the other hand, crown and root length in both groups had negative significant correlation with age ( $P < 0.01$ ) and became shorter, but their ratio (crown/root ratio) showed a significant correlation (0.53,  $P < 0.01$ ) with ages up to 3 years and no correlation (0.04,  $P > 0.05$ ) with ages over 3 years. This absence of significant correlation between crown/root ratio and age over 3 years may be attributed to the proximity of the values of the roots in this group.

There was no significant correlation between neck width and root length in both groups while the correlation between neck width and crown length in all ages was significant ( $P < 0.01$ ). As a result, for root length estimation, different criteria should be considered with regard to age. In horses over 3 years of age, the crown of the wolf tooth could be a more reliable indicator than in animals below 3 years of age. In younger horses these criteria are less reliable to predict the root length.

Mandibular wolf teeth are uncommon (Nickel *et al.*, 1979) and in this study also, only one case of lower wolf tooth was seen. The occlusal surface of the wolf teeth in this study had various shapes (Fig. 2) in agreement to literature reports (Easley *et al.*, 2011).

The role of wolf teeth in causing biting discomfort and the decision whether to extract them or not are still controversial (Lane, 1994; Gaughn, 1998). Due to their placement in the interdental space right in front of the second premolar, wolf teeth can easily cause problems in ridden horses by interfering with the bit and cause pain and major training problems (Johnson, 2010). Normally placed but enlarged wolf teeth may cause oral pain and buccal laceration due to bit contact, especially when the bit or the noseband force the cheeks onto occasional sharp protuberances of the wolf teeth (Dixon & Dacre, 2005; Johnson, 2010). Furthermore, loose wolf teeth may shift under bit pressure and irritate the gum (Dyce *et al.*, 1987). Therefore, their presence is blamed for many behavioural problems (Dixon & Dacre, 2005), such as, for example, notable unsteadiness in the mouth and the head itself during riding. Consequently, many experts advise to extract wolf teeth in horses that carry a bit.

However, it should be pointed that wolf teeth extraction is not necessarily an innocuous procedure, as all or part of their crown can be hidden beneath soft tissue and their crowns can be large and deeply embedded (Dixon & Dacre, 2005). Consequently, their extraction can cause damage to the hard palate and the enclosing soft tissues. Although normal sized and positioned wolf teeth have been found in older riding horses competing at a very high level, that have no history of biting problems. Maybe the decision whether to

extract wolf tooth or not should be made based upon their size and placement and whether they are loose or not, in order to avoid the above mentioned, possible complications.

Fractures of wolf teeth's roots and remaining part of them after extraction can lead to permanent, painful, local swellings, which cause biting problems that may not have been present before. For this reason, understanding length and anatomical characters of root is of clinical importance for practitioners.

In conclusion, it should be considered that the length of crown could be an approximately reliable indicator to predict the root length in horses older than 3 years. However, in younger animals, the size of crown had a lower potential to predict the root length. This finding will be useful for practitioners to design an appropriate plan for wolf tooth extraction.

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