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Palatally Impacted Canines – Factors Affecting Treatment Duration

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Abstract : *A relationship between the duration of orthodontic treatment and the exact position of palatally impacted canines before treatment was studied in panoramic radiographs (OPG).*

Material and Method: *Sixty-seven palatally impacted canines were measured in 54 OPGs prior to treatment. The measured parameters were: vertical distance of the canine crown tip to the occlusal plane, inclination of palatally impacted canines to the vertical reference line and horizontal zones. The treatment time was measured from the open eruption technique of the canine till alignment of the canine.*

Conclusions: *A middle correlation was found between the inclination of impacted maxillary permanent canine to the vertical reference line in OPG and the treatment duration. The greater the inclination, the longer the treatment. The relationship between the distance of the canine cusp from the occlusal plane in OPG and the treatment duration was not proved. Horizontal position of the canine in OPG is a factor that significantly affected the treatment duration.*

Keywords: *canine inclination, duration of orthodontic treatment, horizontal zone, impacted canine, OPG*

I. Introduction

Impaction of upper canines is second only to that of the third molars. Approximately 2% of the population is affected. Most often the impaction is palatal and unilateral. Vestibular impaction is reported only in 7-16% of patients with the anomaly [1]. The disturbances in the development and eruption of canines may result in serious problems related to functional architecture and aesthetics of the dentition [2].

Treatment of impacted canine teeth is associated with a risk of various complications which may adversely affect the overall therapeutic outcome [3]. The prognosis of aligning the impacted tooth into the dental arch depends on the initial position of the canine and anatomical situation. Further, it depends on the relationship of the dental arches, the shape and size of the upper dental arch before treatment, the desired occlusion after the therapy, and the patient's age [4]. The canine inclination, the distance of the canine from its desired place in the dental arch, or pathological changes in impacted canines were also reported as important factors for the treatment result [5].

Horizontal canine position in OPG is considered to be an important factor affecting the treatment duration [6]. To determine horizontal position of palatally impacted canines, the classification in zones is a common practice. The zone borderlines are represented by long axes of teeth or the lines running between adjacent teeth [6, 7, 8, 9]. The position of the canine crown tip mesially to the long axis of the lateral incisor suggests a higher risk of later canine retention [10], resorptions caused by the canine [6], and longer treatment time.

II. Aim

The aim of the study was to find out whether a correlation exists between the position of palatally impacted canines and treatment duration.

III. Material And Method

The study included 54 patients who successfully underwent orthodontic treatment for palatally impacted canines at the Institute of Dentistry and Oral Sciences in Olomouc. There were 12 males (22.2%) and 42 females (77.8%). The average age of the patients at the beginning of treatment was 16.5 ± 3.3 years (range, 11 to 29 years). In 41 patients only one canine was impacted, in 13 both, so a total of 67 palatally impacted canines were measured. All the patients received treatment with a fixed appliance in the upper arch, most of them in both arches. In all patients after the initial orthodontic alignment, an open eruption technique was performed.

All 54 panoramic radiographs (OPGs) were taken using the same equipment under the same conditions. Individual metric parameters were measured in OPGs obtained before treatment.

The following parameters were evaluated in each patient:

1) Treatment time

Duration of treatment of the impacted canine was established as the period of time between commencement of an active traction till the canine was aligned and ligated at least to the .018“ stainless steel wire. The accuracy of measurement was 0.5 month.

2) The inclination of the canine long axis

The inclination of the canine long axis to the vertical reference line in OPG was measured by a method developed by Stewart [11]. The long axis of the impacted canine divided the vertical reference line into halves. This line cuts the angle between the long axes of the upper permanent incisors (Fig.1). The inclination of the canine long axis was measured with an accuracy of 0.5°.

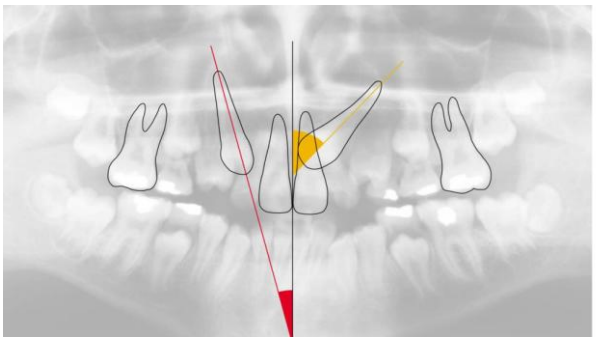

Fig. 1: inclination of the longitudinal axis of the canine to the vertical reference line in OPG

3) Vertical distance between the canine crown tip and occlusal plane (mm) on OPG.

The line of the occlusal plane was drawn (Fig. 2). The line of the occlusal plane of the upper dental arch ran through the incisal point of the upper incisor and mesial cusp of the maxillary first molar. From the canine crown tip the perpendicular line to the occlusal plane was construed. The distance of the canine crown tip was measured perpendicularly to the occlusal plane with an accuracy of 0.5 mm. According to the values measured, the individual impacted canines were subclassified into three vertical categories according to Vermette et al. [12]:

Class I - below 12 mm
Class II - 12-15 mm
Class III - over 15 mm

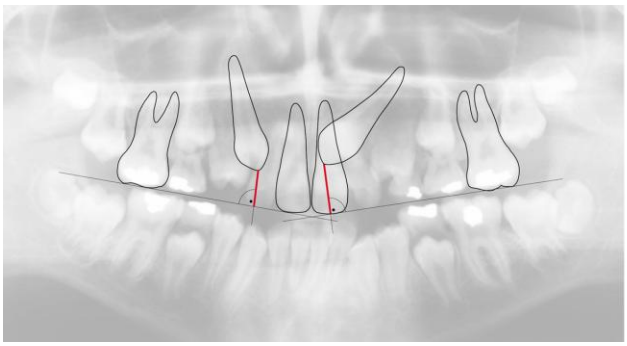

Fig. 2: vertical distance of the canine crown tip from the plane of occlusion in OPG.

4) Horizontal mesiodistal position of canines

The contours of the maxillary incisors and canines were drawn as well as the long axis of the lateral incisors and the line dissecting the distance between the crowns and roots of the lateral incisors and central incisors. Horizontal anterioposterior position of canines was determined with regard to the adjacent teeth and the position in the so-called zones according to McSherry [7] (Fig. 3). The canine position was assessed according to the projection of the canine crown tip into a given zone. The zone of each individual canine was determined as the most mesial zone into which the canine crown tip was projected.

Zone I - distally to the long axis of the maxillary lateral incisor.
Zone II - between the long axis of the lateral incisor and the line running between the central and lateral incisors.
Zone III - more mesially to the line dividing the angle between the central and lateral incisors.

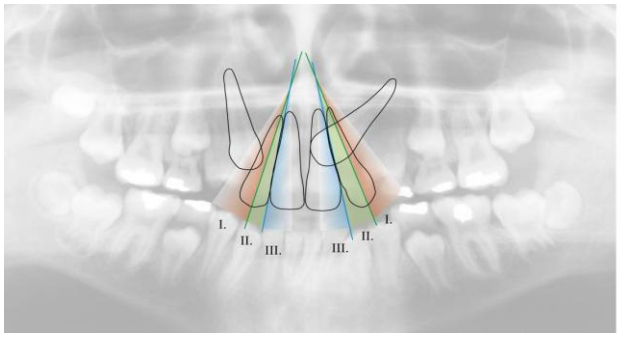

Fig. 3: horizontal position of canine - location in zones according to McSherry [7]

IV. Results

The mean treatment duration of 67 impacted canines, i.e. the orthodontic therapy between the open eruption technique and the beginning of an active traction and the alignment of the canine in the arch of the fixed appliance, was 17.1 ± 7.6 months (range, 4 to 36 months); median = 16 months. The mean distance of the impacted canine from the occlusal plane in OPG was 14.0 ± 3.2 mm (range, 7 to 21 mm).

The mean inclination of the canine long axis to the vertical reference line in OPGs was 36.0° ± 4.6° (range, 2° to 68°).

Table 1: Position of the impacted canine before treatment in OPG

		Mean	S.D.	Min.	Max.	Range
OPG	Vertic. to OL [mm] [a]	14	3.2	7	21	14
(N= 67)	Inclin. to VRL [°] [b]	36	14.6	2	68	66
	Treat. time [months]	17.1	7.6	4	36	32

[a] canine cusp distance to occlusal plane on OPG
[b] canine inclination to vertical reference line on OPG

The mean value of association between the inclination of the impacted canine to the vertical reference line in OPG before treatment and the treatment duration was determined with Pearson coefficient of linear correlation r. The calculated value of Pearson correlation coefficient was r = 0.487. (Fig. 4)

Table 2: Correlation between duration of treatment and the position of impacted canine before treatment in OPG

	Pearson correlation	coef. correl. r	p-value	sign.	coef. determin. r^2
OPG	Inclin. to OL [°] [a]	0.487	0	***	24%
(N= 67)	Vertic. to OL [mm] [b]	0.164	0.185	ns	3%

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ns = $p > 0.05$; Pearson's correlation
[a] canine inclination to occlusal plane on OPG
[b] canine cusp distance to occlusal line on OPG

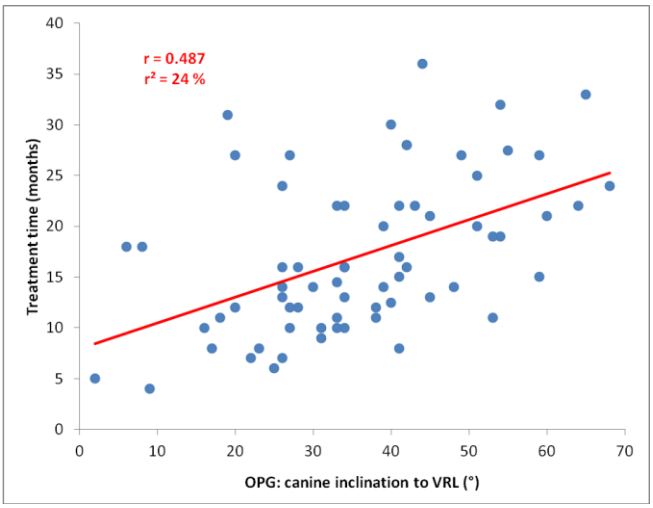

Fig. 4: correlation of inclination of the longitudinal axis of the canine to the vertical reference line (VRL) in OPG with duration of treatment

The relationship between treatment duration and vertical distance between the cusp of the impacted permanent canine and the occlusal plane was tested.

Pearson correlation analysis did not prove any dependence between the distance of the canine cusp from the occlusal plane in OPG prior to treatment and the length of therapy. The value of Pearson correlation coefficient was r = 0.164. (Table 2, Fig. 5)

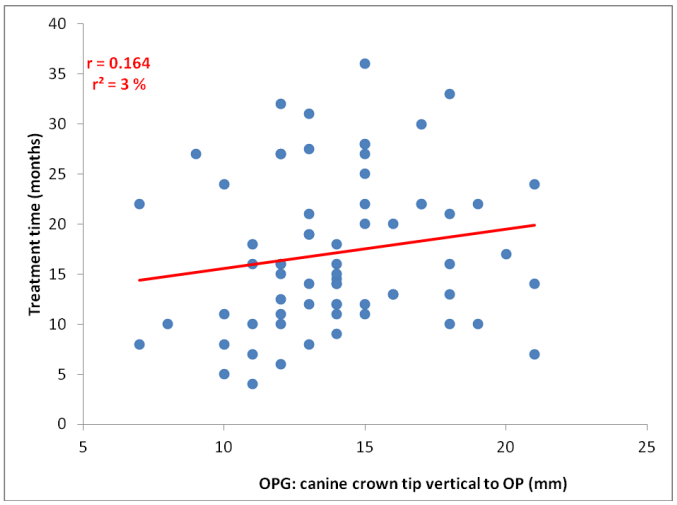

Fig. 5: correlation of vertical distance of the canine crown tip from the plane of occlusion (OP) in OPG with duration of treatment

When the horizontal position of the canine did not overlap the long axis of the maxillary lateral incisor (zone I), the mean length of treatment was 11.1 ± 6.8 months. If the canine crown tip was located between the lateral incisor long axis and the line running between the central and lateral incisors (zone II), the mean length of treatment was 16.5 ± 6.6 months. In zone III, where the canine crown tip was located more mesially than the line running between the central and lateral incisors, the mean length of treatment was 21.9 ± 6.5 months (Fig. 6).

Table 3: Treatment times in horizontal zones I, II, III.

Horizontal zone	N	Mean	Std. deviation
I.	15	11.1	6.8
II.	30	16.5	6.6
III.	22	21.9	6.5

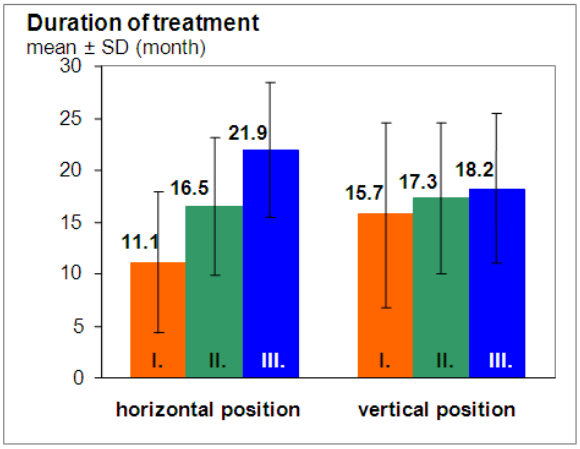

Fig. 6: treatment duration in vertical classes I, II, III and horizontal zones I, II, III.

The mean length of treatment in vertical positions in zone I (below 12 mm) was 15.7 ± 8.9 months, in zone II (12-15 mm) it was 17.3 ± 7.3 months, and in zone III (over 15 mm) it took 18.2 ± 7.2 months (Fig. 6).

Table 4: Treatment times in vertical class I, II, III.

Vertical class	N	Mean	Std. deviation
I.	18	15.7	8.9
II.	30	17.3	7.3
III.	19	18.2	7.2

To evaluate the joint impact of the canine distance from the occlusal plane and the canine horizontal position in zones, measured in OPGs, and the duration of treatment, we used the two-factor analysis of variance. It showed a significant dependence of the treatment duration on the canine horizontal location. However, the relationship between the length of treatment and vertical position of the canine, or on the combined vertical and horizontal position, was not proved.

The following multiple comparison with LSD technique (Least Significant Difference) showed a significantly different duration of treatment for different horizontal locations of the canine. The longest treatment period (21.9 ± 6.5 months) was recorded for the horizontal zone III, the shortest time (11.1 ± 6.8 months) was associated with zone I. (Fig. 6).

One-factor ANOVA with the factor of canine location (combined vertical and horizontal position) and the following multiple LSD comparison showed a significantly longer time of treatment for the positions vertical class III, horizontal zone II and vertical class III, horizontal zone III (in comparison with the positions vertical class I, horizontal zone I, vertical class I, horizontal zone III and vertical class II, horizontal zone II).

V. Discussion

We showed a middle correlation between the degree of canine inclination to the vertical reference line in OPG taken before treatment and the treatment duration. The greater the canine inclination, the longer the therapy. Canine inclination to the midline over 30° worsens the prognosis [5]. This view is supported by McSherry [7].

Kurol suggests that the less vertical position of an impacted canine, the shorter the period of therapy is to be expected [6]. In their study Štefková and Kamínek [13] stated that the vertical distance of the crown cusp from the occlusal plane was the only parameter related to treatment duration. The greater the vertical distance from the occlusal plane, the longer the time required for canine alignment. In our study the relationship between the distance of the canine cusp from the occlusal plane in OPGs before treatment and the treatment duration was not proved.

According to our results, horizontal location of the canine in OPG is a factor that significantly affected the treatment duration. The same results were reported by Fleming et al. [14] and McSherry [7], both concluding that the closer the impacted canine to the midline, the least chance for a correct alignment. This is also supported by Zuccati [15] who demonstrated a relationship between the need for more treatment visits when the position of the canine was more mesial.

Stewart et al. [11] state that the closer the impacted canine is to the zone near the midline, the greater is the distance of the canine crown tip from the occlusal plane, and thus the greater its inclination and the longer the length of treatment. Our study failed to confirm this assumption. The longest mean treatment periods were almost identical, i.e. 22 months, and were found in the horizontal zone III. However, the length of treatment did

not increase with the increasing distance of the canine from the occlusal plane. The result may be due to the use of different biomechanics, in cases where the palatally impacted canine was located more mesially. Active traction cannot be directed to a place in the dental arch as it may result in resorption of roots of the incisors located in the direction of the traction. First, it is necessary to upright the canine and distance it from the roots of the lateral incisors, thus preventing their resorption. Elastic traction to the transpalatal arch is used most frequently. Once the canine has been distanced and upright, the traction may be directed towards the arch. The duration of treatment is noticeably prolonged due to the necessary avoidance of lateral incisors roots.

Higher vertical class of the canine crown tip distance from the occlusal plane led to a longer mean treatment duration by 5.4 months (between Class I and Class II), and by 3.5 months (between Class II and Class III). In horizontal zone I, the vertical distance significantly affected the treatment duration, because of the canine being located in its place in the dental arch, however, in different vertical positions within the bone. The canine inclination is another factor that may affect the length of treatment in this position.

In horizontal zones II and III, the vertical distance affected the treatment duration much less, as during the canine upright it is possible to add force also in the extrusive direction. In zone II, the length of treatment even decreases with the increasing vertical distance. This may be due to easier distancing of the canine from the lateral incisor root in greater distance from the occlusal plane. When located closer to the occlusal plane, it is necessary to add root torsion (in order to obtain the correct position) after distancing it from the lateral incisor and alignment into the arch. The additional upright of the aligned canine may result in substantial prolongation of treatment duration.

VI. Conclusions

1. A middle correlation was found between the inclination of the impacted maxillary permanent canine to the vertical reference line in OPG and the treatment duration. The greater the inclination, the longer the treatment.
2. The relationship between the distance of the canine cusp from the occlusal plane in OPG and the treatment duration was not shown.
3. Horizontal position of the canine in OPG is a factor that significantly affected the treatment duration.

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