Original Article

Early Headgear Effects on the Eruption Pattern of the Maxillary Canines

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ABSTRACT

Objective: To test the null hypothesis that early headgear (HG) treatment has no effect on the eruption pattern of the maxillary canines in the early mixed dentition.

Materials and Methods: Sixty-eight children (40 boys and 28 girls) with a Class II tendency in occlusion and moderate crowding of the dental arches were randomized into two groups. HG treatment was initiated immediately in the first group. In the second group only minor interceptive procedures were performed during the first follow-up period of 2 years. Orthopantomograms were taken at the baseline, three times at 1-year intervals, and after growth at the age of 16. Eruption geometry was performed. The space from the maxillary first molar to the lateral incisor was measured on the dental casts.

Results: The inclination of the maxillary canine in relation to the midline appeared to be significantly more vertically oriented on the right side in the HG group 1 and 2 years after starting the HG therapy ($P = .0098$ and $P = .0003$, respectively). The inclination in relation to the lateral incisors was smaller in the HG group bilaterally after 1 year and 2 years of HG treatment, and on the right side after 3 years of treatment.

Conclusion: The hypothesis is rejected. Early HG treatment significantly affects the inclination of the maxillary canine during eruption. The strongest influence was seen after 2 years of HG use, more prominently in the right-side canine. (*Angle Orthod.* 2009;79:540–545.)

KEY WORDS: Maxillary canine; Orthodontic treatment; Headgear; Crowding; Radiogrammetry

INTRODUCTION

Ectopic eruption of maxillary canines is the most common eruption problem after third molar impaction.[1,2] The prevalence of ectopic eruption has been reported to be 0.9% to 2% in children not previously selected for orthodontic treatment,[3,4] the frequency being higher in girls than in boys. The displacement of the crypt, long path of eruption, short-rooted or absent upper lateral incisor, crowding, retention of the primary deciduous canine, and genetic factors have been suggested as causative factors of eruption disturbances.[5,6] The ectopic maxillary canine is located palatally to the dental arch in about 85% and buccally in only about 15% of the cases.[7] It has been reported that buccal displacement is most frequently associated with crowding,[8] whereas most palatal canine displacements occur in dentitions without crowding.[8–11] In addition, palatal displacement occurs frequently in families and is often associated with dental anomalies.[6,12–14]

During normal development, the crown of the maxillary canine lies buccally between the root of the lateral incisor and the crown of the first bicuspid. In a Nordic study, the age at the emergence of a maxillary canine was reported to be 10.8 years in girls (SD = 1.30, range = 7.5–15.5) and 11.6 years in boys (SD = 1.17, range = 9.5–15.5).[15] Clinically, impaction and other types of ectopic eruption of the maxillary canines is a significant clinical problem. The ectopic eruption of the maxillary canines has been reported to be associated with impaction and root resorption of lateral incisors, with higher prevalence seen in females.[16] The eruption of the canine may occur abnormally, being associated with transposition in the dental arch.[17] It has been shown that extraction of the primary canines has a favorable effect on a palatally erupting permanent canine if the extraction is performed at the right

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time.[18] According to Ericson and Kurol,[19] the canine cusp erupting medially to the long axis of the lateral incisor and the canine in the mesial angle of eruption to the midline exceeding 25° is a possible cause for resorption of the lateral incisors.

Cervical headgear (HG) is one of the most common ways to treat Class II malocclusion. The HG has a distalizing effect on the maxillary first molars, and one of the main purposes of its use is to create additional space in the maxillary dental arch. Space is also gained by a significant expansion if the HG is used to expand the dental arch.[20] Many studies on the eruption pattern of the maxillary canine have been published. However, there are no reports on HG use and its effect on canine eruption in cases of crowding. We have shown earlier that it is possible to create more space in the maxillary area in the transversal dimension by using an expanded HG.[20,21]

The purpose of this longitudinal randomized investigation was to study the effects of HG treatment on the eruption pattern of maxillary canines in the early mixed dentition in the case of moderate crowding, with an 8-year follow-up.

MATERIALS AND METHODS

Subjects and Treatments

For the investigation, 240 seven-year-old children were screened. Inclusion criteria were the need for orthodontic treatment due to moderate crowding and a Class II tendency. The crowding was clinically diagnosed as moderate, based on the degree of space deficiency in the anterior regions of the dental arches. Of the children screened, 71 met the inclusion criteria; 3 refused to be enrolled in the study. The total study group comprised 68 children (40 boys and 28 girls) aged 7.6 years (SD = 0.3). The study group has previously been described in detail.[20,21]

The children were randomly divided into two groups of equal size, matched according to gender. This was undertaken by one author using random numbers. To conceal the allocation, the practitioners who were responsible for the treatment were not given information concerning the aim or rationale of the study.

In the first group, HG treatment was initiated immediately. The maxillary first molars were banded and a cervical HG was used, but no other appliances were used. The outer bows of the HG were bent 10° upwards in relation to the inner bow. The inner bow was expanded and was constantly held 10 mm wider than the dental arch. A force of 7–10 N was applied and the subjects were instructed to wear the HG during sleep, for 8–10 hours.

In the control group, only minor interceptive procedures were performed during the follow-up period. The criterion for providing interceptive treatment in the control group was to achieve improved alignment of the anterior teeth during the early mixed dentition. The interceptive procedures in the controls were extraction of the upper primary canines in 38% and lower primary canines in 35% of the subjects to ease the eruption of the lateral incisors. In addition, interdental stripping was carried out in 19% of the subjects in the control group.

After a 1-year follow-up period (T1), the mean active treatment time in the HG group was 8 months, and after 2 years (T2) it was 16.2 months. Treatment procedures in the control group included any necessary interceptive procedures during the period T0 (baseline) through T2. There was no difference in the treatment protocol for the duration between T2 and the final examination (T4), which was made at 8 years after the initial follow-up period. Total follow-up period was until the subjects reached the age of 16 years.

Radiographic Analysis

Standard orthopantomograms were taken at T0, T1, T2, T3, and T4. The orthopantomograms were digitized by using the Epson Perfection 3200 Photo scanner (Epson America Inc, Long Beach, Calif) with a resolution of 300 dots per inch. The angles and the canine position were measured according to the method of Ericson and Kurol,[19] using the Scion Image software (release Beta 4.0.2; Scion Corporation, Frederick, Md). The angle between the mid-axis of the maxillary canines and the midline (angle α) was measured bilaterally, as was the angle between the mid-axis of the canine and the mid-axis of the lateral incisor (angle β; Figure 1). The canine crown position in relation to the other teeth was also determined by dividing the upper incisor area into five sectors (Figure 2). The radiographic analyses were performed by one of the investigators. The intraobserver error was defined from repeated measurements performed measuring 20 orthopantomograms within 1 week.

Dental Cast Analysis

The distance from the distal contact point of the maxillary canine to the mesial contact point of the maxillary first molar was measured bilaterally from the dental casts using a digital sliding caliper. The dental cast analysis was performed by one of the authors.

Statistical Analysis

The normality of the sample was assessed before the analyses, and as there were only minor deviations, the use of parametric tests was preferred. The SPSS statistical package (version 14.00; SPSS Inc, Chicago, Ill) was used for the analyses. Independent samples *t*-

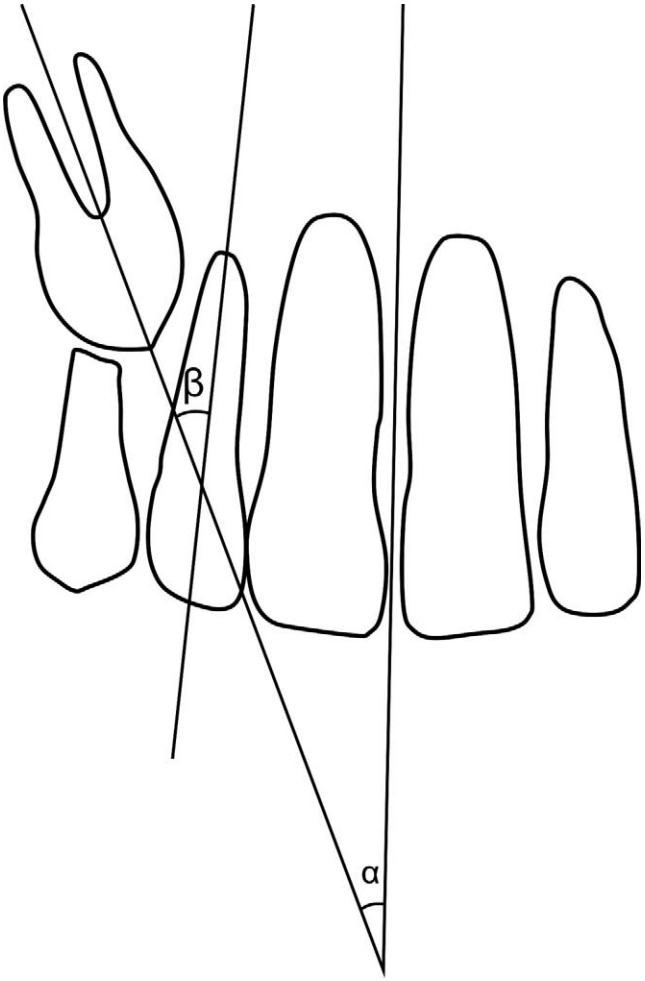

Figure 1. The angular measurements used in the study. α indicates the angle between the midline in dentition and the axis of the canine; β, the angle between the axis of the canine and the axis of the lateral incisor.

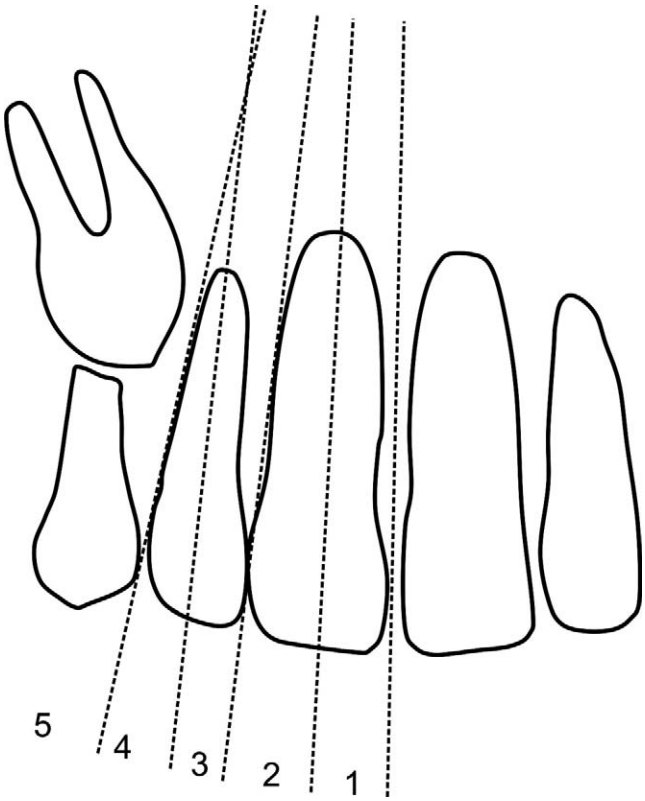

Figure 2. Sector 5 indicates the area lateral to the lateral incisors; sector 4, the area between the axis of the elateral incisor and the line tangential to the distal side of the tooth; sector 3, the area between the distal side of the mesial incisors and the axis of the lateral incisors; sector 2, the area between the axis of the mesial incisor and the line tangenting to the distal side of the tooth; sector 1, the area between the midline in dentition and the axis of the maxillary mesial incisor.

test was used to evaluate the difference between the treatments at the same time point. The Pearson correlation coefficient was calculated between the change of the inclination angle of the maxillary canine and the space on the dental arch. The intraobserver error of the method in radiographic analysis was measured using intraclass correlation (ICC).

RESULTS

The repeated measurements in radiographic analysis were compared using intraclass correlation. The correlation ranged from 0.996 to 0.999.

The Inclination and Position of the Maxillary Canine

The inclination of the maxillary canine in relation to the midline (angle α) was significantly more vertically positioned on the right side (6.8°; SD = 6.84) in the HG group at T1 compared to the control group (12.1°; SD = 8.51; $P = .0098$). At T2, the inclination of the maxillary canine in relation to the midline was also significantly more vertically positioned on the right side (1.5°; SD = 6.70) in the HG group compared to the control group (9.1°; SD = 7.77; $P = .0003$; Figures 3a,b and 4a,b). On the left side the difference between the groups was not significant (Table 1). At later time points (T3, T4), no significant difference between the groups was found in the inclination of the canine in relation to the midline (Table 1).

The canine angulation in relation to the lateral incisors (angle β) was smaller in the HG group bilaterally at T1 when compared to the control group. On the right side, angle β was 11.1° (SD = 8.93) in the HG group and 21.9° (SD = 8.28) in the controls ($P < .0001$). The corresponding values on the left side were 16.5° (SD = 9.95) in the HG group and 21.5° (SD = 8.23) in the control group ($P = .0348$). At T2, the inclination of the canine in relation to the lateral incisor was significantly smaller in the HG group compared to the control. On the right side, the angle was 7.1° (SD =

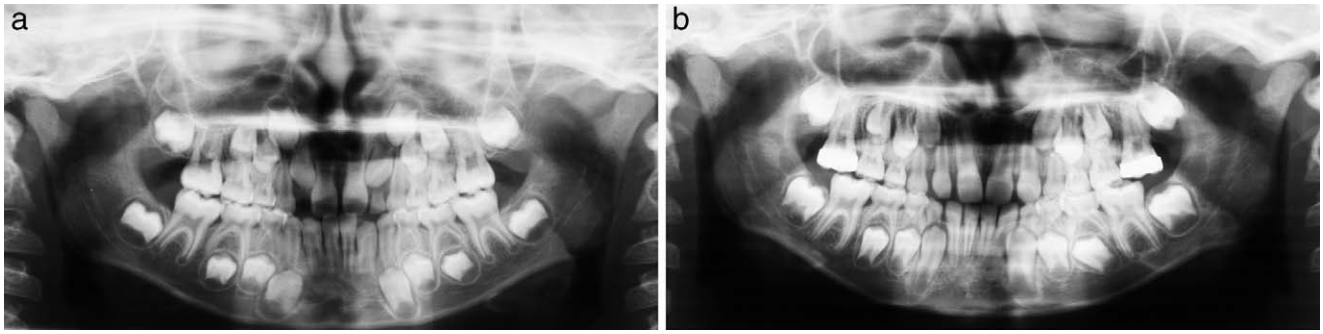

Figure 3. Orthopantomograms of a patient treated with a cervical HG, taken at the baseline (a) and after 2-year follow-up (b).

6.81) in the HG group and 20.0° (SD = 7.73) in the control group ($P < .0001$), and on the left side the angle was 14.00° (SD = 8.88) in the HG group and 21.0° (SD = 7.55) in the control ($P = .0021$). The difference was significant at T3 on the right side, the angles being 7.1° (SD = 8.12) in the HG group and 15.0° (SD = 9.58) in the control group ($P = .0059$). There was no significant difference between the groups at T3 on the left side or at T4 (Table 1).

When the position of the crown of the maxillary canine was examined in relation to the incisors, the values between the control group and the HG group did not differ significantly. The values ranged in both groups between sectors 3 and 5, and cases with a more medial canine position (sectors 1 and 2) were not found in this study.

Space in the Dental Arch

The space from the distal contact point of the maxillary canine to the mesial contact point of the maxillary first molar was significantly larger at T1–T3 and after growth (T4) bilaterally in the HG group compared to the control group ($P < .02$). The mean increase in the HG group from T0 to T2 was 0.48 mm (SD = 2.06) on the right side and 0.66 mm (SD = 1.51) on the left side. The corresponding values in the control group were −1.45 mm (SD = 2.10) and −1.21 mm (SD = 1.89), the difference between the HG and control group being statistically significant ($P = .011$ and $P = .000$, respectively). When the space change in the sagittal dimension dental arch between the time points T0 and T1 and T0 and T2 was correlated with the change of the inclination angle of the canine, no significant correlation was found (Table 2).

DISCUSSION

When the intra-examiner measurement error was analyzed, it was observed that repeatability was good for most of the measurements. In orthopantomograms, wrong positioning of the head may result in some distortion due to imaging geometry, but to avoid projection error, metric measurements were not used here.

In the present longitudinal randomized study, the inclination angle of the erupting canine was found to decrease more quickly in the HG group compared to the control group. The largest effect was seen at T2 on the right side. This finding provides new information on the eruption pattern of the maxillary canine. Most of the previous studies on HG treatment have dealt with its effects on craniofacial development,[22–24] whereas studies concerning dental effects have mostly focused on maxillary molars and incisors.[24,25] In addition, cervical HG treatment has mostly been combined with functional appliances, extractions, bite plates, or other appliances.[26–29] In this study, the patients had moderate crowding in the anterior regions. Because the screening of the patients

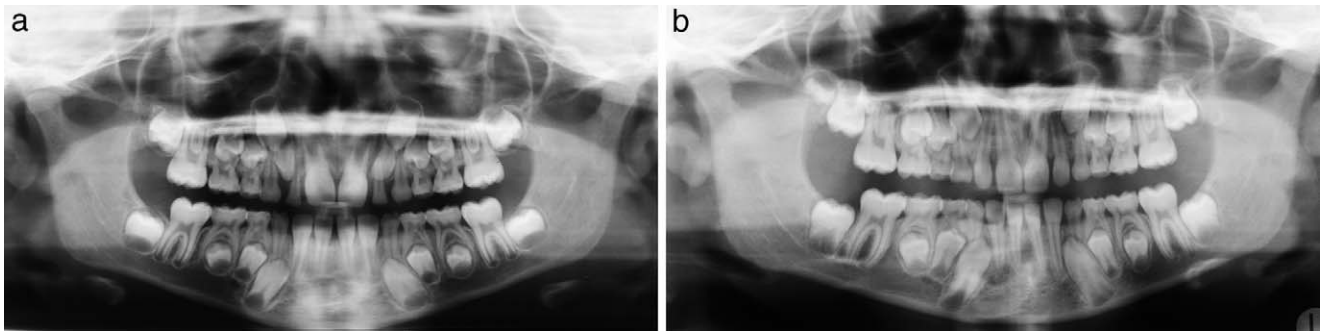

Figure 4. Orthopantomograms of a patient from the control group, taken at the baseline (a) and after 2-year follow-up (b).

Table 1. The Values of α and β Angles Describing Maxillary Canine Inclination at Different Time Points[a]

	Right					Left				
	HG		Controls			HG		Controls		
	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	*P*
Angle α										
T0	8.1	7.38	11.5	9.35	.1045	11.1	9.06	12.1	8.40	.6367
T1	6.8	6.84	12.1	8.51	.0098**	11.2	7.51	11.3	6.53	.9362
T2	1.5	6.70	9.1	7.77	.0003***	5.2	8.77	9.1	6.56	.0617
T3	1.9	7.31	3.5	8.12	.4998	4.6	9.75	4.7	9.49	.9845
T4	−1.7	3.72	−3.3	4.40	.1848	−2.7	3.90	−4.2	4.40	.2303
Angle β										
T0	7.7	14.42	14.7	11.49	.0438	13.9	15.71	15.5	12.10	.6633
T1	11.1	8.93	21.9	8.28	.0000***	16.5	9.95	21.5	8.23	.0348*
T2	7.1	6.81	20.0	7.73	.0000***	14.0	8.88	21.0	7.55	.0021**
T3	7.1	8.12	15.0	9.58	.0059**	12.5	8.17	15.9	9.98	.2277
T4	1.0	3.40	1.5	3.43	.6598	1.6	3.90	1.4	3.79	.8028

[a] HG indicates headgear group; angle α, the angle between the mid-axis of the maxillary canines and the midline; and angle β, the angle between the mid-axis of the canine and the mid-axis of the lateral incisor; T0, baseline; T1, 1-year follow-up; T2, 2-year follow-up; T3, 3-year follow-up; T4, 8-year follow-up; N = 68.
* = P < .05, ** = P < .01, *** = P > .001.

was performed during the early mixed dentition, a clinical diagnosis of canine area crowding was not possible at that point. It is likely, however, that canine area crowding was frequent in the patients. This can also be concluded from the fact that a high number of premolar extractions was carried out in the control group, without the use of HG.[20,21]

Disturbance in canine eruption is a major clinical problem, and later treatment is in many cases extensive and requires a long treatment time. If the disturbance of canine eruption is diagnosed at an early stage, primary canine extraction has been suggested as a method of treatment in cases of palatally erupting canines.[18] In cases of buccally erupting canines or crowding, the elimination of the space deficiency is important. In this study, the method of Ericson and Kurol[19] was used to measure the inclination of the canine, and it proved to be very suitable. The use of orthopantomograms appears to be reliable especially in angular measurements, whereas calibration is problematic in linear measurements.

It is a common finding that asymmetries are frequent in dentitions and dental arches.[30] Therefore, it is interesting that in the present study the influence of HG on the canine seems to be greater on the right side. The reason for this is obscure, but the finding may partly be explained by occlusal side differences.[31]

We have shown earlier with the same study material[20] that with expanded HG it is possible to create more space in the upper canine area in the transversal dimension, but here we were interested in knowing the possible correlation of the canine angulation with the increased space in the premolar area. In this study, the additional space created was not related to the inclination of the canine. One thing that could affect the vertical eruption pattern of the canine is the labial tilting of the maxillary incisors after HG use, previously shown in the present group, where we have shown that the maxillary incisors were significantly more labially tilted in the HG group even after 1 year of HG use.

It is known that early cervical HG is valuable in the treatment of subjects with moderate crowding, but

Table 2. The Space From the Distal Contact Point of the Maxillary Canine to the Mesial Contact Point of the Maxillary First Molar, Measured From the Dental Casts[a]

	Right					Left				
	HG		Controls			HG		Controls		
	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	*P*
T0	23.25	1.27	23.11	1.06	.630	22.99	1.03	22.79	1.50	.529
T1	23.90	1.82	21.84	2.25	.003**	24.21	0.96	21.71	2.14	.000****
T2	23.88	2.28	21.81	2.35	.001***	23.88	1.86	21.64	2.33	.000***
T3	23.46	2.48	21.71	2.58	.007**	23.48	1.83	21.53	2.75	.001***
T4	22.81	0.99	20.57	2.95	.001***	22.98	1.20	20.48	3.12	.001***

[a] HG indicates headgear group; T0, baseline; T1, 1-year follow-up; T2, 2-year follow-up; T3, 3-year follow-up; T4, 8-year follow-up; N = 68.
* = P < .05, ** = P < .01, *** = P > .001.

based on the results of this study, it also has a strong influence on the eruption pattern of the maxillary canines. However, further studies are needed to understand the mechanism. It could be assumed that in subjects predisposed to ectopically erupting maxillary canines and crowding, HG treatment can be used to eliminate space deficiency, and it might also have preventive potential for canine impaction.

CONCLUSIONS

- Early HG treatment affects the inclination of the maxillary canine during eruption.
- The canine eruption pattern was significantly more vertical after HG use.
- The strongest influence was seen in the right side canines after 2 years of HG use.

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