RESEARCH

Effect of Rapid Maxillary Expansion and Face Mask Application on Mesiodistal Axial Inclination and Apex Flexion of Maxillary Canine Teeth

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Selcuk Dent J, 2022; 9: 88-92 (Doi: 10.15311/selcukdentj.840856)

Başvuru Tarihi: 14 Aralık 2020
Yayına Kabul Tarihi: 21 Haziran 2021

ABSTRACT

Effect of Rapid Maxillary Expansion and Face Mask Application on Mesiodistal Axial Inclination and Apex Flexion of Maxillary Canine Teeth

Background: The aim of this study was to evaluate the effects of rapid maxillary expansion (RME) and face mask application (FMA) on the mesiodistal axial inclination and the apex flexion of the maxillary canine tooth in mixed dentition.

Methods: In this study, seventy-six panoramic radiographs from 38 individuals were used. In the study group, there were 19 patients who treated with RME and FMA and panoramic x-rays obtained before (T0) treatment and after (T1) RME and FMA. The control group comprised 19 patients who no previous orthodontic treatment and panoramic x-rays obtained before (T0) and after (T1) maxillary canine tooth eruption. The inclination and flexion of maxillary canine were measured on these radiographs. A Wilcoxon test was used for intragroup comparisons of T0 and T1 measurements and a Mann Whitney U test was used for intergroup comparisons of T1 differences from T0 and flexion values. The significance level was set at $p < 0.05$.

Results: No statistically significant differences existed between the T0 and T1 values of the mesiodistal axial inclination of the maxillary canine tooth in the study group. However, a statistically significant decrease was found in the control group ($p < 0.05$). No statistically significant differences existed between the study and control groups for mesiodistal axial inclination or apex flexion of the maxillary canine tooth.

Conclusion: In patients with mixed dentition, RME and FMA did not have a significant effect on the mesiodistal axial inclination and the apex flexion of the maxillary canine tooth.

KEYWORDS

Rapid maxillary expansion, facemask application, mesiodistal inclination, apex flexion, maxillary canine tooth

ÖZ

Hızlı üst çene genişletmesi ve yüz maskesi uygulamasının üst kanin dişlerin meziodistal inklinasyonu ve kök ucu fleksiyonu üzerine etkileri

Amaç: Bu çalışmanın amacı, karışık dişlenme döneminde hızlı üst çene genişletmesi (HÜÇG) ve yüz maskesi (YM) uygulamasının üst kanin dişin meziodistal eksen eğimi ve kök ucu fleksiyonu üzerine etkilerini değerlendirmektir.

Gereç ve Yöntemler: Bu çalışmada 38 bireyden alınan 76 panoramik radyograf kullanıldı. Çalışma grubunda, HÜÇG ve YM ile tedavi edilen 19 hasta ve HÜÇG ve YM tedavisinden önce (T0) ve sonra (T1) alınan panoramik radyograflar vardı. Kontrol grubu ise daha önce tedavi uygulanmamış 19 hasta ve maksiller kanin dişlerin sürmesinden önce (T0) ve sonra (T1) alınan panoramic radyograflardan oluştu. Maksiller kanin dişin inklinasyonu ve fleksiyonu bu radyograflar üzerinde ölçüldü. T0 ve T1 ölçümlerinin grup içi karşılaştırmaları için Wilcoxon testi ve T1 ve T0 farkları ve fleksiyon değerlerinin gruplar arası karşılaştırmaları için Mann Whitney U testi kullanıldı. Anlamlılık düzeyi $p < 0.05$ olarak belirlendi.

Bulgular: Çalışma grubunda, maksiller kanin dişin mezyodistal aksiyal inklinasyonu için T0 ve T1 değerleri arasında istatistiksel olarak önemli farklılıklar yoktu. Bununla birlikte, kontrol grubunda istatistiksel olarak anlamlı azalma bulundu ($p < 0.05$). Çalışma ve kontrol grupları arasında, maksiller kanin dişin mezyodistal inklinasyonu ya da kök ucu fleksiyonu için istatistiksel olarak olarak anlamlı bir fark yoktu.

Sonuç: Karışık dişlenme dönemindeki hastalarda, HÜÇG ve YM uygulamasının üst kanin dişin mezyodistal eksen eğimi ve kök ucu fleksiyonu üzerinde önemli bir etkisi olmadı.

ANAHTAR KELİMELER

Hızlı üst çene genişletmesi, yüz maskesi, mezyodistal eğim, kök ucu fleksiyonu, üst kanin diş

INTRODUCTION

Treatment of a class III malocclusion by rapid maxillary expansion (RME) and face mask application (FMA) causes a mixture of skeletal and dental changes that improve the soft tissue profile.[1,2] This treatment has been more effective in patients with mixed dentition, especially in the early mixed dentition period.[3] During early mixed dentition, the maxillary canine tooth continues to erupt within the bone by inclining mesially. After approximately 9 years of age, the tooth gradually straightens until it erupts above the gingival margin. It is difficult to foresee inclination at a specific age, because there are individual differences in the degree of canine inclination at specific points during eruption.[4] In the mixed dentition period, class III malocclusion treatment with RME and FMA may also cause a change on the mesiodistal axial inclination of the maxillary canine, as it will exert a protrusive force on the maxilla and on maxillary dentition. This protrusive force may cause bending of the apical third of the developing

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maxillary canine root. The flexion of one third of the apical side of the maxillary canine root between 10° and 50° from the long axis of the maxillary canine has been described by root curvature.[5] Studies on the mesiodistal axial inclination and the apex flexion of maxillary canine tooth are available.[4,5] However, no studies exist on the effects of RME and FMA on the mesiodistal axial inclination and the apex flexion of the maxillary canine tooth. Therefore, this study evaluated the effects of RME and FMA on the mesiodistal axial inclination and the root flexion of the maxillary canine tooth in mixed dentition.

MATERIALS AND METHODS

The protocol of this retrospective study was reviewed and approved by the ethics review board of the Ondokuz Mayıs University (resolution number 2017/22). The sample size of this study was calculated as 19 individuals to achieve 95% confidence and 84.9% test power, using the study by Parenti et al.[6] as a reference. Seventy-six panoramic radiographs from 38 individuals were used from the radiology archive of the Faculty of Dentistry Orthodontics Clinic at the Ondokuz Mayıs University.

The following inclusion criteria were applied for the study group: mixed dentition with unerupted maxillary canine teeth; treatment with RME and FMA; and panoramic x-rays obtained before treatment and after RME and FMA. The following inclusion criteria were applied for the control group: no previous orthodontic treatment and panoramic x-rays obtained before and after maxillary canine tooth eruption. The exclusion criteria were the presence of supernumerary teeth, missing teeth, pathological formations, craniofacial malformations or traumatic injuries.

The study group comprised 38 radiographs of 19 patients (10 female patients, nine male patients) who had a mean age of 12 years and 4 months and who were treated with RME and FMA. The control group comprised 38 radiographs of 19 patients (12 male patients, seven female patients) who had an average age of 11 years and 1 month and who were examined orthodontically.

In the study group, radiographs were separated into groups: before treatment (T0) and after RME and FMA (T1). Radiographs for the control group were also separated into groups: before (T0) and after (T1) maxillary canine tooth eruption. The horizontal reference plane was created between the right and left suborbitary points. The vertical reference plane was created as the perpendicular line drawn from the spinal nasalis anterior to the horizontal reference plane. The mesiodistal axial inclination of the maxillary canine tooth was measured as the internal angle between the long axis of the maxillary canine tooth and the vertical reference plane (Figure 1).

Figure 1.

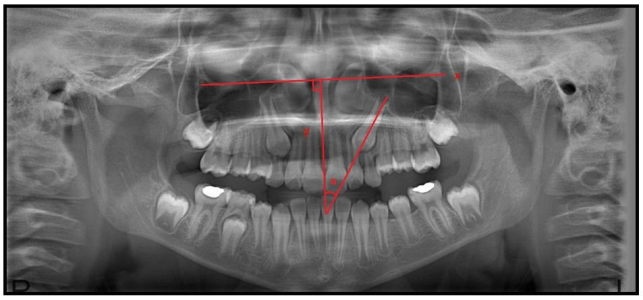

Figure 1

x, Horizontal referance plane, straight line passing through the right and left suborbitary points. y, Vertical referance plane, the perpendicular line drawn from the spina nasalis anterior to the horizontal reference plane. a, The internal angle between vertical referance plane and long axis of maxillary canine.

The apex flexion of the maxillary canine tooth was calculated by measuring the distal angle between the long axis of the maxillary canine and its apex **(Figure 2)**.

Figure 2.

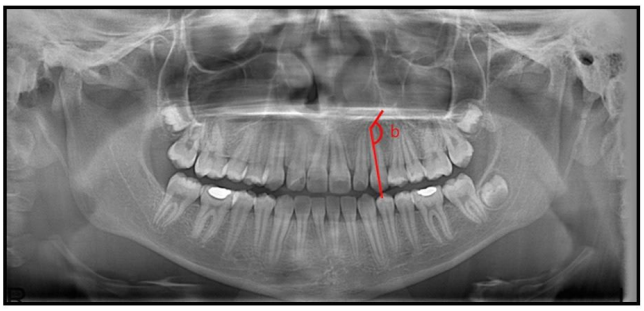

Figure 2

b, apex flexion of maxillary canine tooth, the distal angle between the long axis of the maxillary canine and its apex.

Apex flexion of the maxillary canine tooth was measured on panoramic radiographs taken at the T1 stage in both groups. The radiograph measurements were made by the same investigator (S.A.) using Dolphin Imaging 11.7 (Patterson Dental Supply, Inc., St. Paul, Minnesota, USA).

STATISTICAL ANALYSIS

Data were analysed with IBM SPSS V26, and a Shapiro-Wilk test was used to analyse the data for normal distribution (Table 1).

Table 1.

Tests of normality of T0, T1, T1-T0 and flexion measurements.

Group		Shapiro-Wilk		
		Statistic	df	Sig.
T0	Study	.821	19	.002
	Control	.821	19	.002
T1	Study	.860	19	.010
	Control	.645	19	.000
T1-T0	Study	.937	19	.231
	Control	.821	19	.002
Flexion	Study	.917	19	.102
	Control	.785	19	.001

A Wilcoxon test was used for intragroup comparisons of T0 and T1 measurements of the mesiodistal axial inclination of the maxillary canine, and a Mann-Whitney U test was used for intergroup comparisons of T1 differences from T0 and flexion values. Results are presented as the median (minimum-maximum), and the significance level was set at $p < 0.05$.

RESULTS

No statistically significant differences existed between the T0 and T1 values of the mesiodistal axial inclination of the maxillary canine tooth in the study group. However, a statistically significant decrease was found in the control group ($p < 0.05$). Intragroup comparisons are shown in Table 2.

Table 2.

Intragroup comparisons of T0 and T1mesiodistal inclination measurements.

MEASUREMENT	GROUP	MEASUREMENT Median (Min-Max)		P
		T0 (dg)	T1 (dg)	
MESIODISTAL INCLINATION OF MAXILLARY CANINE TOOTH	STUDY	6.5 (1.2 - 30)	6 (0.8 – 19.4)	0.748
	CONTROL	5.2 (1.2 – 29.8)	3 (0.1 – 26.3)	0.031*

** Statistically significant difference (P < 0.05).*

No statistically significant differences existed between the study and control groups for mesiodistal axial inclination or apex flexion of the maxillary canine tooth. Intergroup comparisons are shown in Tables 3 and 4.

Table 3.

Intergroup comparisons of T1-T0 differences.

MEASUREMENT	GROUP	MEASUREMENT T1-T0 (dg) Median (Min-Max)	P
INCLINATION OF MAXILLARY CANINE TOOTH	STUDY	-0.5 (-29.2 – 13.30)	0.271
	CONTROL	-2.4 (-24.5 – 3.6)	

dg: Degree

Table 4.

Intergroup comparison of apex flexion of maxillary canine tooth.

MEASUREMENT	GROUP	MEASUREMENT	P
APEX FLEXION OF MAXILLARY CANINE TOOTH	STUDY	178 (138.7 – 208.4)	0.583
	CONTROL	180 (141.7 – 196.6)	

dg: Degree

DISCUSSION

The data set of this study was obtained from angular measurements made on panoramic x-rays. The angle between the vertical reference plane and the long axis of the maxillary canine was used to evaluate the mesiodistal axial inclination of the maxillary canine tooth. Suborbital and spina nasalis anterior points were used to create reference planes in this study. These points were preferred because they are found in localizations that are not affected by changes in dental and alveolar structures during the examination period. Thus, the reliability of the angles measured in the T0 and T1 stages was high. In the orthodontics literature, the internal angle is created by the vertical line of the maxillary canine and the middle of the central incisors.[7–9] The external angle is constructed by the vertical line of the maxillary canine and a horizontal line withdrawing from both suborbitary points.[4] The internal angle was created by the vertical line of the maxillary canine and a bicondylar line withdrawing from the most superior points of both condyles.[10,11] The external angle was created by the vertical line of the maxillary canine and a horizontal line withdrawing from the mesiobuccal cusp tip of the right and left maxillary first molars.[12] In this study, the axial inclination of the maxillary canine tooth changed in the distal direction in both groups. This change was statistically significant in

the untreated control group, but no significant change was observed in the study group. This result was explained by the protruding effect of FMA on the maxilla and maxillary dentition because the teeth driving into the alveolar bone act in the mesial direction with an extraoral force. Thus, the amount of distal movement of the maxillary canine tooth that continues throughout the eruption is reduced. Similar to the results we obtained in the control group, Coulter and Richardson[13] reported that, in the anteroposterior plane, maxillary canines move in a posterior direction between 7 and 12 years of age and at a reduced level between the ages of 12 and 13 years. In support of our view, Williams et al.[14] reported that maxillary incisors tipped labially in children who were treated using maxillary expansion and maxillary protraction. Ki[15] showed that orthodontic force affects not only the periodontal ligament of the teeth to which the force is applied but also that of more distant teeth. According to Caprioglio et al,[16] rapid maxillary expansion affects the canine position significantly and positively. In our study, however, FMA was provided after RME. Therefore, the uprighting effect of RME was not observed. The change in the axial inclination of the maxillary canine tooth was not significant between the groups. This result showed that the mesial effect of RME and FMA treatment on the maxillary canine tooth was not enough to change the distal angulation of the canine tooth during eruption.

In this study, the bending of the apical third of the developing maxillary canine was defined as flexion. This study showed no significant difference in this value between the study and control groups. In the study group, RME and FMA had a mesial effect on the axial inclination of the maxillary canine tooth, but the shape of the root apex of this tooth did not differ significantly from that of the control group. This result was consistent with the similar changes in the axial inclination of the maxillary canine tooth between the groups. The flexion results may be explained by the similar amount of movement in the coronal and apical parts of the tooth. According to Standerwick,[17] the more coronal parts of the tooth are in a more plastic region that exhibits more tooth movement; conversely, a tooth root that is developing in a less plastic region exhibits a reduced rate of tooth movement.

Limitations of this study are the lack of a standardized treatment protocol resulting from the retrospective nature of the study and the inclusion of only panoramic radiographs for measurements. It is only possible to make two-dimensional measurements on panoramic radiographs. Future studies should use a standardized treatment procedure and should include three-dimensional imaging methods.

CONCLUSIONS

This study showed that, in patients with mixed dentition, RME and FMA did not have a significant effect on the mesiodistal axial inclination and the apex flexion of the maxillary canine tooth.

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