Original Article

Does Rapid Maxillary Expansion Affect the Eruption of Upper Third Molars?

Oral Sökücü[a]; Fırat Öztürk[b]; Hasan Babacan[a]; Ali Altuğ Bıçakçı[a]

ABSTRACT

Objective: To test the hypothesis that there is no difference in the movement of the upper third molars between rapid maxillary expansion (RME) and non-RME patients.

Materials and Methods: This study was performed on 30 patients divided into two groups. The study group included 20 patients who had maxillary narrowness and bilateral maxillary third molars and who had undergone RME application. The control group of 10 patients had a bilateral crossbite, had bilateral maxillary third molars, and did not receive orthodontic treatment. The records included lateral and frontal cephalometric films and maxillary plaster models. In the study group, records were taken before expansion (T1), after expansion (T2), and at the retention period (T3). T2 records were not taken in the control group because this period was too short to observe any changes. Friedman tests were used to observe within groups, and the Mann-Whitney *U*-test was used to see the differences between groups on films and casts.

Results: Frontal films showed that vertical eruption occurred after the retention period in the RME cases. Cephalometric films revealed that the angular eruption occurred immediately after expansion. However, the results were not significant with respect to the control group.

Conclusion: The hypothesis was rejected. Rapid maxillary expansion affects maxillary third molar movement during and after the RME procedure. RME may indicate upper third molar eruption, but the final position of third molar was not different compared to the normal growth pattern.

KEY WORDS: Upper third molar; RME; Third molar eruption

INTRODUCTION

Rapid maxillary expansion (RME) is an extremely useful procedure in real and relative maxillary transverse deficiency cases. RME is accomplished by applying a laterally directed force against the teeth, palatal mucosa, or both, resulting in a widening of the midpalatal suture.[1,2]

Although the main object of RME is to correct maxillary arch narrowness, its effects are not limited to the upper jaw. The maxilla is associated with 10 bones in the face and head.[3] Therefore, skeletal and dental effects of RME have been investigated using radiologic, histologic, and various other techniques.[4–8] RME has also been reported to cause improvements in breathing, to correct dental crossbite and crowding, and to restore conductive hearing loss due to middle ear loss and Eustacian tube problems.[3]

The third molar impaction rate is higher than for any other tooth in modern populations. The average age for the eruption of the upper third molar is 20 years, although eruption may continue in some patients until age 25. During normal development, the third molar begins in a horizontal angulation, but the angulation changes from horizontal to mesioangular to vertical as the tooth develops and the jaw grows. Failure of rotation from mesioangular to the vertical direction is the most common cause of the tooth's remaining impacted. The second major factor is that the mesiodistal dimension of the teeth vs the length of the jaw is such that there is inadequate room in the alveolar process anterior to the anterior border of the tuber to allow the tooth to erupt into position.[9]

The purpose of this study was to compare the movement of the upper third molars on RME and non-RME patients using lateral and frontal cephalograms.

[a] Assistant Professor, Department of Orthodontics, University of Cumhuriyet, Sivas, Turkey.

[b] Research Assistant, Department of Orthodontics, University of Cumhuriyet, Sivas, Turkey.

Corresponding author: Dr Oral Sökücü, Cumhuriyet Üniversitesi, Dişhekimliği Fakültesi, Ortodonti AD, 58140 Sivas, Türkiye
(e-mail: almanoral@hotmail.com)

Accepted: May 2007. Submitted: March 2007.

Table 1. The Distribution of Average Ages

	n	Mean Age	SD
Study group	20	15.30	2.68
Control group	10	15.70	1.16

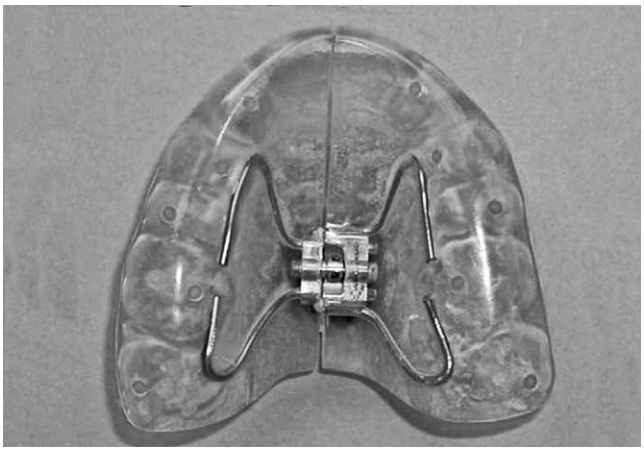

Figure 1. Acrylic-bonded rapid maxillary expansion (RME) appliance.

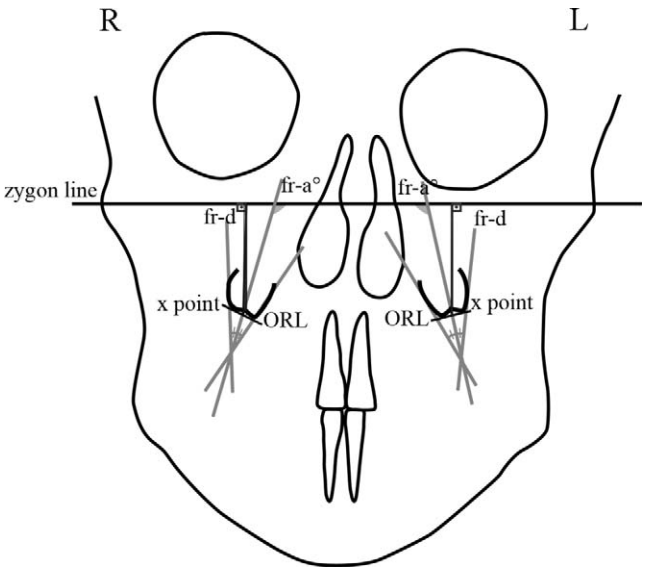

Figure 2. Frontal cephalometric measurements. Zygon line indicates the line that joins the left and right arcus zygomaticus points; ORL, occlusal reference line tangent to the buccal and palatal cup tips of the upper third molar; fr-a°, the angle measured between the zygon Line and crown long axis of the third molar; X point, the intersection of the ORL and crown long axis of the upper third molar; fr-d, the vertical line distance measured from the X point to the zygon line.

MATERIALS AND METHODS

The study samples were divided into two groups. The first group (RME group) included 20 subjects (13 girls and 7 boys; mean age, 15.3 years). The second group (control group) included 10 subjects (6 girls and 4 boys; mean age, 15.7 years). Table 1 shows the distribution and average ages of both groups.

The RME group consisted of patients who presented with a posterior crossbite and had bilateral third molars. A control group was selected from the patients waiting for orthodontic treatment in the Department of Orthodontics, Faculty of Dentistry, University of Cumhuriyet. These patients had bilateral crossbites and bilateral third molars. The patients of this group were informed about this study and consented to both cephalometric and lateral films before beginning their treatment. The study protocol was approved by the local ethics committee (July 2003).

An acrylic, fully bonded tooth and tissue-borne RME appliance containing a Hyrax screw (GAC International, Islandia, NY) was positioned parallel to the second premolars and used to correct the posterior crossbite in the RME group (Figure 1). A modified splint type of RME appliance with full occlusal coverage was selected to provide control of the vertical dimensional changes that occur in growing patients during maxillary expansion.[10] The expansion appliance was activated one-quarter turn daily.

The records included lateral and frontal cephalometric films and upper plaster models. All pretreatment records were taken at the start of treatment (T1), and posttreatment records (T2) were taken after achieving successful expansion on molar region. We did not take T2 records for the control group because the period was too short to observe any change during this period. The retention records were taken after appliance removal (T3) at the end of 8 months. During the retention period, Essix appliances were used, and the patients did not receive any fixed orthodontic therapy.

All the films were taken on the same radiographic unit (Planmeca-Proline 2002 CC, Helsinki, Finland). The radiographs were evaluated using a standardized technique of tracing the images on acetate paper.

MEASUREMENTS

Frontal Cephalometric Film Parameters

The zygon line on the frontal cephalogram was used as a reference line.[11] Zygon is the line that joins the left and right arcus zygomaticus points (Figure 2).

Fr-a°. The frontal change of the third molar formed by the angle of the long axis of the third molar and the zygon line (Figure 2). The long axis of the upper third molar was determined following two-thirds of buccal and palatal crown. The bisector of this angle was used as a long axis of the upper third molar. We recorded the right and left upper third molars independently.

Fr-d. The second parameter on the frontal film was used to observe the eruption distance of the third molar. We drew the occlusal reference line (ORL) tangent to the buccal and palatal cusp tips of the upper third

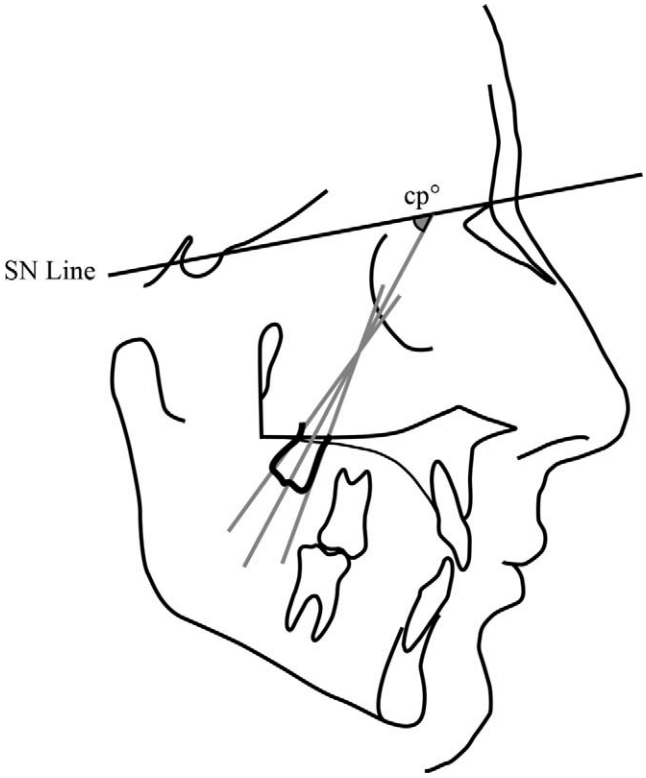

Figure 3. Lateral cephalometric measurements: cp°, the angle measured between the long axis of the third molar and the sella nasion line.

molar. The intersection of the ORL and the long axis of the crown of the upper third molar was named the X point. The vertical distance line from the X point to the zygon line gave the eruption distance of the upper third molar. The right and left third molars were recorded independently (Figure 2).

Lateral Cephalometric Film Parameters

Cp°. The sagittal change of the third molar was formed by the angle of the long axis of the third molar and sella nasion line. When the third molars were double, we used the median value (Figure 3).

Cast Analyses

Study casts were taken before treatment and after the retention period to analyze changes in intermolar and intercanine width. Direct measurements of maxillary casts were taken to the nearest 0.1 mm with vernier calipers. On the cast of the upper dental arch, the distance between the tips of the distopalatal cusps of the permanent first molars was measured. The width of the anterior part of the dental arch was measured using the occlusal reference points on canines (Figure 4).

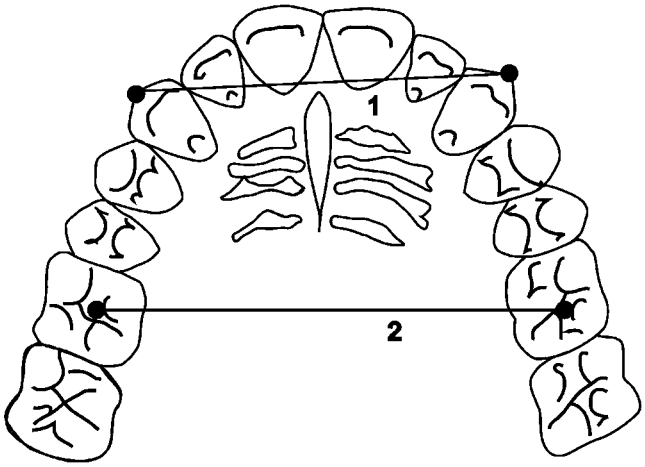

Figure 4. Cast dental analyses: 1, upper intercanine width; 2, upper intermolar width.

Table 2. Intercanine and Intermolar Width Changes of the Groups (mm)

	Intercanine Width Change		Intermolar Width Change		
	$\bar{x}$	SD	$\bar{x}$	SD	*P*
Study group	3.48	1.06	4.28	1.93	.001*
Control group	0.45	0.30	0.55	0.50	NS[a]

[a] NS indicates nonsignificant.
* $P < .05$.

Statistical Analyses

For error measurements, before-and-after treatment lateral and frontal films and dental casts of 10 randomly selected patients were used. All film measurements were recorded independently twice on two separate occasions within a 1-week interval.[12] The method errors ranged from 0.15° and 0.18° for casts and from 0.25 mm to 0.83 mm for both films. The results were calculated using the software SPSS for Windows (release 13.00; SPSS Inc, Chicago, Ill). Friedman tests were used to observe within groups, and the significant differences were evaluated by the Wilcoxon test. The Mann-Whitney *U*-test was used to see the differences between groups on films and casts.

RESULTS

There were no significant differences between the ages of participants in the study and control groups ($P > .05$; Table 1). The intercanine and intermolar width changes showed significant differences in both groups ($P < .05$; Table 2).

Frontal Film Parameters Among the Groups (Fr-a°, Fr-d)

Fr-a°. There were no significant angular changes between the T1, T2, and T3 measurements on the

Table 3. The Frontal Film Changes and Comparisons of Study and Control Group Values Between and Within the Groups

	Study Group, $\bar{x} \pm SD$	Control group, $\bar{x} \pm SD$	Result
Right angle (fr-a°)			
T1	98.00 ± 9.07	101.10 ± 6.52	$P = .504$, NS[a]
T2	99.94 ± 9.27		
T3	97.15 ± 7.29	98.10 ± 4.90	
Result	$\chi^2 = 2.30$, $P = .316$, NS	$P = .159$, NS	
Left angle (fr-a°)			
T1	98.89 ± 10.13	103.20 ± 8.57	$P = .009$*
T2	102.73 ± 8.68		
T3	101.78 ± 8.37	97.80 ± 5.84	
Result	$\chi^2 = 4.40$, $P = .111$, NS	$P = .074$, NS	
Right distance (fr-d), mm			
T1	27.30 ± 4.49	27.70 ± 3.77	$P = .447$, NS
T2	26.97 ± 5.38		
T3	30.26 ± 5.68	27.50 ± 3.56	
Result	$\chi^2 = 14.72$, $P = .001$*	$P = .212$, NS	
Left distance (fr-d), mm			
T1	27.26 ± 4.78	25.20 ± 3.51	$P = .447$, NS
T2	26.31 ± 5.55		
T3	29.94 ± 5.78	27.40 ± 4.64	
Result	$\chi^2 = 12.09$, $P = .002$*	$P = .313$, NS	

[a] NS indicates nonsignificant.
* $P < .05$.

Table 4. The Cephalometric Film Changes and Comparisons of Study and Control Group Values Between and Within the Groups

Cephalometric (cp)	Study Group	Control Group	Result
T1	51.73 ± 13.07	48.35 ± 9.87	
T2	54.84 ± 13.43		P = .565, NS[a]
T3	55.42 ± 12.54	52.85 ± 6.72	
	$\chi^2 = 10.77$, $P = .005$*	$P = .052$, NS	

[a] NS indicates nonsignificant.
* $P < .05$.

right and left sides of the upper third molar in the study group ($P > .05$). The control group did not show any angle changes between the T1 and T3 measurements (Table 3).

Fr-d. The distance change in the study group was significant. Both on the right and left sides, the distances were significant differences between the pretreatment and retention period (T1–T3) and posttreatment and retention period (T2–T3; $P < .05$). There was no significant change between pretreatment and posttreatment (T1–T2; $P > .05$).

The control group did not show any distance changes between the T1 and T3 time points ($P > .05$; Table 3).

Cephalometric Film Parameters (cp°)

There were significant differences on the angular changes between T1, T2, and T3 in the study group ($P < .05$). The angle changes were significant between the pretreatment and posttreatment (T1–T2) and pretreatment and retention period (T1–T3) in the study group ($P < .05$). There was no significant change between the posttreatment and retention period (T2–T3; $P > .05$; Table 4). There was no significant difference between the pretreatment and retention period (T1–T3) in the control group ($P > .05$).

Frontal and Cephalometric Film Between Groups (T1–T3)

The study group showed significant differences from the control group on only the frontal film (fr-a°) in the left angle parameter ($P < .05$). The fr-a° on the left side had significantly increased. The cephalometric film parameters did not show any differences between both groups.

DISCUSSION

It has been noted that RME promotes an increase in the transverse dimensions and in the perimeter of the upper dental arch with a real gain of bone at the level of the midpalatal suture.[1,2]

The impaction of the upper third molars probably is influenced additionally by space considerations. Theories explaining the most common cause of tooth impaction include inadequate space between the second molar and the ascending tuber, limited or adverse skeletal growth, and increased crown size in impacted vs normally erupted teeth.[9]

Staggers[13] noted that patients usually can tolerate the loss of four premolars, but they may not be as receptive to the loss of four additional teeth. As a result, eight perfectly good teeth are lost during orthodontic treatment. Therefore, causes of third molar impaction and predictions of third molar eruption become important.[14,15] Richardson[15] investigated cephalometric methods for the prediction of third molar impaction, but the results of the study were inconclusive.

The effect of orthodontic treatment on the third molar is still controversial. Mostly, the extraction of premolars was used as a criterion of an erupting third molar.[16–19] Kim et al[16] found a significant reduction in the rate of impaction of the third molars in both jaws in extraction patients compared with nonextraction patients.

Saysel et al[18] showed an improvement in third molar angulations relative to the occlusal plane in the first premolar extraction group. Richardson's[19] study supported this study and remarked that factors other than change in third molar space influenced the eruption of third molars. On the other hand, Staggers[13] stated that premolar extractions do not improve third molar angulations any differently than nonextraction treatment does.

In this study, the frontal cephalometric films revealed that there were no angular differences in the third molar teeth in RME cases and non-RME cases. In the same cases, the vertical eruption distances of the third molars were significantly higher than the control group 8 months later ($P < .05$). RME may induce the vertical eruption of the third molar a few months later. The left and right third molar teeth gave the same responses to RME. The left side in the control group had a movement similar to that of the study group, but this was not observed on both sides, and the results were not significantly different in the control group.

Lateral cephalometric films showed that third molar teeth uprighted in the RME group. We point out that the statistical difference appears immediately after the RME procedure (T1–T2). Expansion increases the area of intercanine and intermolar width, and this causes uprighting of the third molar. It is known that growth of the jaw causes changes in position from horizontal to mesioangular and finally to vertical. In our study, after RME application, the upper third molar teeth were uprighted immediately and then began to erupt vertically in the retention period. The upper third molar teeth may respond to the expansion as growth of the jaws. Following upper third molar teeth on the lateral cephalometric films, there was not any difference in the study group (T2–T3). The control group's cephalometric results did not show any difference in 8 months, but they had a similar movement-like uprighting as the study group.

When we compare the distance and angular differences between groups on the frontal film, only the angle of left side (Fr-a°) showed more angular change than the control group in approximately 8 months. The right side had similar movement, but the results were not statistically significant. Expansion in the transverse dimension may cause horizontal movements of the third molar. The upper third molar of the control group had a tendency to stay vertical contrary to the expansion group.

The sagittal changes in the third molar did not show any differences with the control group on cephalometric films. Third molar angulations may be affected immediately after expansion. The third molar reacted by uprighting until the expansion procedure ended. In the retention period, the uprighting of the third molar had similar movements to the control group. The uprighting of the third molar was accelerated with the expansion procedure, but the sagittal movement was under physiological limits. We need further long-term investigation with control groups to observe the influence of RME on third molar teeth.

CONCLUSIONS

- The upper third molar was influenced by expansion.
- Eruption of the third molar accelerated after RME but did not show a difference with normal growth pattern subjects in the end.

REFERENCES

1. Isaacson RJ, Ingram AH. Forces produced by rapid maxillary expansion I: forces present during treatment. *Angle Orthod.* 1964;34:256–260.
2. Doruk C, Biçakçi AA, Basciftci FA, Agar U. A comparison of the effects of rapid maxillary expansion and fan-type rapid maxillary expansion on dentofacial structures. *Angle Orthod.* 2004;74:184–194.
3. Ceylan İ, Oktay H, Demirci M. The effect of rapid maxillary expansion on conductive hearing loss. *Angle Orthod.* 1996; 66:301–308.
4. Timms DJ. A study of basal movement with rapid maxillary expansion. *Am J Orthod.* 1980;77:500–507.
5. Velazquez P, Benito E, Bravo LA. Rapid maxillary expansion: a study of the long-term effects. *Am J Orthod Dentofacial Orthop.* 1996;109:361–367.
6. Adkins MD, Nanda RS, Currier GF. Arch perimeter changes on rapid palatal expansion. *Am J Orthod Dentofacial Orthop.* 1990;97:194–199.
7. Hershey HG, Stewart BL, Warren DW. Changes in nasal

airway resistance associated with rapid maxillary expansion. *Am J Orthod.* 1976;69:274–284.
8. Laptook T. Conductive hearing loss and rapid maxillary expansion. *Am J Orthod.* 1981;80:325–331.
9. Peterson LJ, Ellis E, Hupp JR, Tucker MR. *Contemporary Oral and Maxillofacial Surgery.* St. Louis, Mo: Mosby-Year Book; 1998.
10. Alpern MC, Yurosko JJ. Rapid maxillary expansion in adults with and without surgery. *Angle Orthod.* 1987;57:245–263.
11. Rickets RM. Foundation for cephalometric communication. *Am J Orthod.* 1960;46:330–357.
12. Dahlberg G. *Statistical Methods for Medical and Biological Students.* London, UK: George Unwin Ltd; 1940.
13. Staggers JA, Germane N, Fortson WM. A comparison of the effects of first premolar extractions on third molar angulation. *Angle Orthod.* 1991;62:135–138.
14. Bishara SE, Andreasen G. Third molars: a review. *Am J Orthod.* 1983;83:131–137.
15. Richardson ME. The etiology and prediction of mandibular third molar impaction. *Angle Orthod.* 1977;47:165–172.
16. Kim TW, Artun J, Behbehani F, Artese F. Prevelance of third molar impaction in orthodontic patients treated nonextraction and with extraction of 4 premolars. *Am J Orthod Dentofacial Orthop.* 2003;123:138–145.
17. Biçakçi AA, Sökücü O, Babacan H, Kosger H. Mesial migration effect on root morphology of mandibular third molars. *Angle Orthod.* 2007;77:73–76.
18. Saysel MY, Meral GD, Kocadereli İ, Taşar F. The effects of the first premolar extractions on third molar angulations. *Angle Orthod.* 2005;75:719–722.
19. Ricardson ME. The effect of mandibular first premolar extraction on third molar space. *Angle Orthod.* 1986;59:291–294.