

EVALUATION OF THE EFFECTS OF HEADGEAR TRACTION ON MAXILLARY THIRD MOLAR ANGULATION

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ABSTRACT

Background and Aim: To assess the changes in the angulation of maxillary third molar during orthodontic treatment in subjects having distalization of maxillary first molar with cervical headgear.

Subjects and Methods: In this retrospective study, the sample consisted of 40 subjects (22 males and 18 females) with a mean age of 11.9 ± 0.8 years. In pre-treatment (T1) and post-treatment (T2), panoramic radiographs as the horizontal reference lines, the occlusal, and the orbital planes were used to measure and compare changes in the position of the developing maxillary third molars. The angulations of the right and left maxillary third molars were compared with the vertical axis of the adjacent second molars and in relation to the occlusal and orbital planes before and at the end of orthodontic treatment.

Results: Compared with pre-treatment measurements, the average maxillary second and third molar angulations after orthodontic treatment with distalization by using the cervical headgear did not differ significantly ($p > 0.05$).

Conclusion: The effect of maxillary first molar distalization on the angulation of the maxillary third molar appears to be minimal before the eruption of the maxillary second molar.

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HEADGEARIN ÜST ÜÇÜNCÜ MOLAR DIŞLERİN ANGULASYONU ÜZERİNDEKİ ETKİLERİNİN DEĞERLENDİRİLMESİ

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ÖZ

Amaç: Servikal headgear uygulaması ile maksiller birinci molar distalizasyonu yapılan bireylerde ortodontik tedavinin maksiller üçüncü molar angulasyonunda oluşturduğu değişiklikleri değerlendirmektir.

Bireyler ve Yöntem : Bu retrospektif çalışmaya, ortalama yaşı $11,9 \pm 0,8$ yıl olan 40 birey (22 erkek, 18 kız) dahil edildi. Tedavi öncesi (T1) ve tedavi sonrası (T2) panoramik radyograflarda gelişmekte olan üçüncü molarların pozisyonundaki değişiklikleri ölçmek ve karşılaştırmak için horizontal referans düzlemleri olarak oklüzal düzlem ve orbital düzlem kullanıldı. Sağ ve sol maksiller üçüncü molarların angulasyonları tedavi öncesi ve sonrasında komşu ikinci moların vertikal eksenine ile ve oklüzal ve orbital düzlemlerle yaptığı açıya göre karşılaştırıldı.

Bulgular: Tedavi öncesi ölçümlerle karşılaştırıldığında, ortalama maksiller ikinci ve üçüncü molar angulasyonları servikal headgear ile distalizasyon yapılan ortodontik tedaviden sonra anlamlı farklılık göstermedi ($p > 0.05$).

Sonuç: Maksiller birinci molar distalizasyonunun maksiller üçüncü molar angulasyonuna etkisi maksiller ikinci moların erüpsiyonundan önce minimal olarak görünmektedir.

Sorumlu Yazar

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INTRODUCTION

Maxillary molar distalization, a common treatment modality used to correct Class II malocclusion, is particularly indicated when maxillary skeletal or dentoalveolar protrusion is present.¹ Several methods and devices can be used for maxillary molar distalization through extra- or intraoral forces.²⁻⁵ The oldest and most common of these methods is the application of extraoral headgear forces on maxillary molar teeth⁶. Significant distalization of the upper posterior teeth develops in patients with headgear, but moving first molars back requires space behind them.⁷ Investigations have concluded that the position of the second molar, when distalizing the first molar, is important.⁸⁻¹⁰ A clinical study supported that the achievement of first molar distalization varies according to the stage of development of the second and third molars.¹¹ Eventually, if distalization of both molars was performed, germectomy of the third molar would be recommended. Conversely, only a few studies have inferred that first molar distalization has no effect on the second molars.^{7,12,13}

Although the effects of first molar distalization on the second molar's position and angulation have been examined in detail, the relationship between the molar distalization in Class II malocclusion subjects and the angular changes in the maxillary third molars has been investigated in limited number of studies focused on intraoral molar distalization^{5,14}, or two premolar extractions.¹⁵ Therefore, the present study investigated the null hypothesis that no difference exists in the angulation of maxillary third molars of Class II subjects treated by maxillary molar distalization with cervical headgear.

SUBJECTS AND METHODS

Pre-treatment (T1) and post-treatment (T2) cephalometric and panoramic radiographs of 40 patients (18 females and 22 males), with a mean age of 11.9 ± 0.8 years and who had been treated with cervical headgear and fixed orthodontic appliances at the Department of Orthodontics at Hacettepe University, were retrospectively analyzed. The inclusion criteria for selecting the patients were Angle Class I or Class II skeletal and Angle full-cusp Class II dental relationship. All of the patients were treated without extractions and with molar distalization using cervical headgear and fixed appliances. A cervical headgear with bands on maxillary first permanent molars was used, with the outer bow tilted upward at 15° . A force of 350 g was used for the first two weeks, after which it was increased to 400 g. This force

was checked at each visit (every four weeks) at the clinic, and reactivation was conducted when necessary. All of the patients were instructed to use the appliance at least 14 h/d. At each visit to the clinic, the patients submitted a form in which they recorded how many hours per day they used the appliance.

Patients used cervical headgear until Class I molar relationship was achieved. Immediately afterwards, fixed orthodontic treatment (Roth OmniArch brackets, GAC International Inc., USA) was started. The amount of first molar distalization was calculated through the superimposition of the initial and final cephalometric radiographs of these patients. The mean amount of distalization was 3.18 ± 1.03 mm.

At the end of the fixed orthodontic treatment, the braces were removed and Hawley retainers were used in the maxillary and mandibular arches. The average orthodontic treatment period was about 35.5 ± 0.7 months.

All pretreatment radiographs were taken within one month before the start of the orthodontic treatment. All post treatment radiographs were taken on the day or within one week of debonding. All radiographs were taken on the same panoramic unit (Planmeca-Proline 2002 CC, Helsinki, Finland).

Panoramic radiographs were evaluated using a standardized technique of tracing the images of the molar teeth on acetate paper. The occlusal plane was constructed using the cusp tips of the maxillary first molar and first premolar; the orbital plane was constructed using the lowest points of the orbital cavity. All second premolars were fully erupted at the beginning of the treatment.

The anterior angles formed by the long axis of the third molar and the occlusal plane, the angle between the long axes of the second and the third molars, the anterior angles formed by the long axis of the third molar and the orbital plane, and the anterior angles formed by the long axis of the second molar and the orbital plane were measured for the right and left sides separately (Figure 1).

Statistical analysis

Statistical analysis was performed with SPSS 11.5 software. Kolmogorov-Smirnov test was used to test the normality of distribution for the variables and the data were distributed normally. The pretreatment values were compared with the post treatment values using a paired samples t-test. The statistical significance was established at $p < 0.05$.

Sample size

A sample size of 40 was required to detect a difference of -5.4 ± 1.2 between before and after treatments for RU3-

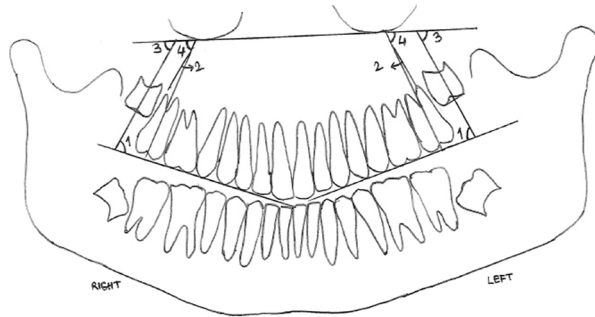


Figure 1. (1) The anterior angle between the long axis of the maxillary third molar and the occlusal plane (RU3-OccP, LU3-OccP); (2) the angle between the long axes of the maxillary second and third molar (RU2-RU3, LU2-LU3); (3) the anterior angle between the long axis of the maxillary third molar and the orbital plane (RU3-OrbP, LU3-OrbP) (4) the anterior angle between the long axis of the maxillary second molar and the orbital plane (RU2-OrbP, LU2-OrbP)

OccP, with a power of 81% at the 5% significance level using a two-sided, one-sample t-test.¹⁵

Measurement Error

The measurement error was assessed by replication of the measurements on 15 panoramic radiographs at 4-week intervals by the same examiner (B.A-G.). Random error was measured using Dahlberg's formula ($SE = \sqrt{\Sigma d^2 / 2n}$), where n = number of patients undergoing repeated measurements and d = the difference in measurements. The measurement error of the parameters was found between 0.204 and 0.474 degrees.

RESULTS

Table 1 presents the descriptive statistics of the changes in the maxillary third molar angulations. Comparing the changes in maxillary third molar angulations resulting from maxillary molar distalization showed no significant difference between pretreatment and post treatment using the dependent T-test ($p > 0.05$). The groups were similar in the second and third maxillary molar angulations before and after the orthodontic treatment, although a slightly distal angulation was observed in all calculation in all planes.

DISCUSSION

The maxillary third molar is the most frequently impacted tooth after the mandibular third molar.^{17,18} The average age for eruption is considered 20 years, although this time shows variations among populations ranging from 14 to 24 years. Generally, the last eruption in both maxillary and mandibular arches, the insufficient jaw size, the mesiodistal width of the

third molar, and the angulation that makes eruption impossible are some of the reasons to explain third molar impaction. The best way to evaluate the eruption of third molars is the direct clinical evaluation of each patient. Nevertheless, this type of evaluation is almost impossible to perform because of the retrospective design of the study. Angulation in tooth germ increases the possibility of inclination and eruption. In our study, because all of the patients were less than 17 years old at the end of the treatment period, we could not determine the final clinical eruption or impaction of the third molars. We only determined the angulation of the maxillary third molars. Thus, this study was conducted to determine how maxillary molar distalization affects the eruption pattern of maxillary wisdom teeth.

Despite the possibility and limitation of magnification and distortion, the evaluation of molar angulation on the panoramic radiographs becomes a reliable analysis method if the same device, settings, and accurate head position are used in all X-ray exposures.^{16,19} Earlier studies showed that this method is reliable for both vertical and angular measurements from the rotational panoramic radiographs of the region of the second and third molars.²⁰ Previous studies used occlusal plane, vertical axis of the second molar, and reference planes in the maxillofacial area.^{15,21-25} If the occlusal plane and/or vertical axis of the second molar are chosen as reference lines only, the angulation of the third molar may be miscalculated because of the ongoing maxillofacial growth and orthodontic treatment. In this study, we preferred to use the long axis of the second molar, occlusal plane, and orbital plane (lower contour of the orbits)¹⁵ as the reference lines to determine the position of the maxillary third molars to prevent an inaccurate evaluation.

In this retrospective study, efficiency of the maxillary molar distalization with cervical headgear and fixed orthodontic appliances in the third molar angulation was investigated. The result shows that, despite the slight distalization observed in third molar angulation, the differences are not statistically significant ($p > 0.05$, Table 1). The question of how maxillary molar distalization affects third molar angulation has not been particularly focused in any study in the literature. It seems reasonable that orthodontic treatment leading to distal movement of maxillary first molars would provide the space needed for the eruption of the third molars. The scientific literature on the upper third molar angulation after molar distalization published in databases (PubMed) has limited information

Table 1. Comparison of pretreatment and post treatment measurements (statistical analysis paired-samples t-test)

	Pretreatment	Post treatment	Difference	
Variables	X±SD	X±SD	X±SD	P value
RU3-OccP (°)	68.9±16.5	67.8±15.8	-1.2±13.4	.591
LU3-OccP (°)	68±13.1	66±13.8	-2.1±14.3	.366
RU2-RU3 (°)	14±14.5	13.1±9.8	-0.9±13.8	.698
LU2-LU3 (°)	11.1±9.4	14.8±11.3	3.7±13.3	.091
RU3-OrbP (°)	52.2±17.4	51.1±15.7	-1.1±15.1	.647
LU3-OrbP (°)	50.2±12.2	47.6±14.6	-2.7±17.4	.342
RU2-OrbP (°)	57.8±10.4	58.6±7.3	0.8±9.5	.585
LU2-OrbP (°)	57.2±7.6	57.9±10.1	0.8±11.8	.680

Values are presented as mean ± standard deviation (X±SD)

on studies conducted on the success of different types oral appliances¹¹, effects of tooth extraction¹⁵, or second and third molar eruption stages.^{26,27} Ghosh and Nanda¹⁴ observed in a study on the evaluation of maxillary molar distalization with different intraoral appliances that the effect of distalization on the maxillary third molars is extremely variable. Moreover, only the crowns of the third molar teeth are visible in most radiographs showing distal tipping in an insignificant amount of horizontal change in position. Ghosh and Nanda¹⁴ stated the importance of patients' longitudinal follow-ups to determine whether maxillary first molar distalization has any effect on either the timing, path of eruption, or imminent impaction of maxillary third molars. The results of our study are similar to those of Ghosh and Nanda's study.¹⁴ However, the mean distalization amounts of the maxillary third molars according to different planes are variable, ranging from 0.85° to 3.65°, and the differences are not statistically significant. In our opinion, the patients' early age, undeveloped third molar roots, and bodily movement of the second molars are the possible reasons for the ineffectiveness of molar distalization in the third molar angulations.

Kinzing et al.¹¹ introduced "fulcrum theory," which states that the wisdom tooth causes molar tipping during molar distalization, and they recommended the extraction of the third molar bud before molar distalization. In our study, the third molars clearly slightly tipped to the distal side. Our results were in contrast to those of Kinzing's study. The scarcity of research addressing maxillary third molar angulation change through distal tipping after maxillary

molar distalization may potentially lead orthodontists and dental surgeons to give indication for impacted third molar extraction to eliminate anterior crowding and facilitate molar distalization. Therefore, they may expose patients to unnecessary wisdom teeth extraction operation.

The findings of the present study may introduce prospective studies about the effects of maxillary molar distalization on impacted third molar angulation in the future. This study addresses the efficiency of distalization forces in the angulation of maxillary third and second molars in panoramic radiographs. In the subsequent stages of research about this subject, future investigations should be conducted to evaluate the occurrence and types of tipping or angulations, and establish correlations with pretreatment factors.

Our study has some limitations. All the subjects in our study group received orthodontic treatment. The results of the subjects who did not receive orthodontic treatment would be valuable for comparison them with those of the study group. Future studies, ideally prospective ones with larger sample sizes, should add further insight into the discussion. The critical timing of distalization may have less to do with gaining more horizontal and less angular distalization and more to do with minimizing the deleterious side effects (e.g., excessive molar tipping and increased treatment duration) in selective cases.

CONCLUSION

The effect of maxillary first molar distalization on the second and third molar angulation seems to be minimal before the eruption of the maxillary second molar. The large

variability in the outcome should be considered clinically. This conclusion is only based on a small sample of evidence from clinical trial.

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