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The Relationship Between Cervical Headgear Treatment And Maxillary Third Molar Space: A Retrospective Controlled Study

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ABSTRACT

Introduction: The effect of headgear on the space available for the eruption of upper third molars needed further investigation. Only a few studies looked at the after-treatment effect of headgear on that space, and none have evaluated the long-term effect after the average age of third molar eruption. Therefore, this retrospective study evaluated the short and long-term effects of cervical headgear on the space and eruption of the maxillary third molars and their long-term eruption status.

Materials and Methods: Records of Class II cases treated with cervical headgear were collected at the following time points: (T1) before treatment, (T2) after treatment, and (T3) taken at least 4 years after T2. An untreated control sample was collected from the Bolton-Brush study records. They were matched for age at each time point and malocclusion. Lateral cephalograms were used to measure the distance from the distal surface of the maxillary first molar (U6) to the pterygoid vertical plane (PTV). The third molar status at T3 was categorized into five groups: impacted, extracted, erupted, congenitally missing, and formation stage. Thirty-three cases were included in the cervical headgear group and 19 in the control group.

Results: The position of U6 changed significantly between the headgear and control group at T2 but was similar at T3. In the headgear group, the U6 was significantly distalized (3.3 ±2.9 mm) between T1 and T2 (P=0.006), however, there was a significant relapse of 5.9 (±4.6) mm between T2 and T3 (P<0.001). In the control group, the distance between U6 and PTV increased significantly from T1 to T2 (4.8 ±4.4mm) with minimal change from T2 to T3 (1.5 ±4.8mm). There was no significant relationship between headgear use and third molar status (p=0.108).

Conclusion: Headgear caused a temporary decrease in the U6-PTV distance that was recovered later. This decrease was not observed in the control group. Using cervical headgear to correct Class II malocclusion does not increase the risk of upper third molar impaction.

Keywords: Headgear, Class II malocclusion, maxillary third molars, U6-PTV, cephalometric radiograph

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INTRODUCTION

Third molars have the highest impaction rate.[1-3] Some etiologies of impaction are space deficiency, inadequate skeletal bone growth, unfavorable direction of eruption, root configuration, or the large mesiodistal width of the impacted tooth.[1, 4, 5] The available retromolar eruption space usually depends on the remaining space available after the eruption of all teeth. This retromolar space is affected by the growth potential, [6] amount of crowding, and mesial migration of the dentition. [5]

Various treatment modalities in orthodontics might have variable effects on the available space for the maxillary third molar eruption. [4] Premolar extraction, for example, might result in mesial migration of the 1st and 2nd molars, increasing the available space for the eruption of third molars and decreasing the likelihood of impaction or eruption in an unfavorable angulation.[7, 8] Moreover, premolar extraction was shown to increase the distance between the maxillary first molars (U6) and pterygoid vertical plane (PTV) by 3 mm and reduce the impaction rate of maxillary third molars.[7, 9]

With the theory of retromolar space in mind, orthodontic treatment options causing distalization or inhibition of the mesial migration of dentition, may negatively impact the space available for third molar eruption. [4, 10-12] Although several studies evaluated the efficiency of different orthodontic appliances used for distalization and their effect on the U6 to PTV distance, [12-14] only limited studies assessed the effect of headgear on that space.[15-17] Moreover, no study evaluated the long-term effect after the average age of third molar eruption. Therefore, this study aimed to examine the short and long-term effects of cervical headgear on the eruption space of the maxillary third molars and to examine the actual eruption status of maxillary third molars at the long-term follow-up. The results of this study are valuable for dentists of all specialties when referring patients for headgear treatment as they might be asked by the patients whether this kind of treatment will affect the eruption of 3rd molars later in life.

MATERIALS AND METHODS

Sample size calculation was performed using the G*Power 3 software. [18] A total sample of n=52 was adequate for a power of 80% with an α of 0.05 error probability and effect size f = 0.5 to test the difference between both groups.

This retrospective study included orthodontic patients who were treated using the cervical headgear to correct molar relationships. Their mean ages at T1 (within 6 months before treatment), T2 (on the day of appliance removal), and T3 (taken at least 4 years after T2) are reported in Table 1.

This study was conducted over a period of 9 months in Saudi Arabia and ethical approval was obtained from King Abdulaziz University Ethics Committee. The inclusion criteria included: 1) age at T1 between 8-14 years old, 2) at least half cusp Class II molars at T1, 3) patients treated only with a cervical headgear to distalize the maxillary first molars to achieve Class I molar relationships, 4) availability of good quality records with a minimum of 4 years after T2, 5) lateral cephalometric radiographs taken using the same machine, and 6) Class I molars at T2 and T3. The exclusion criteria included: 1) patients with systemic diseases, hormonal disturbances, or craniofacial anomalies, 2) patients with missing permanent teeth, and 3) cases where the eruption status of the right and left third molars were different, 4) Patients treated with any appliance (fixed or removable) other than cervical headgear.. A total of 46 cervical headgear cases were examined, 13 were excluded due to missing data, unclear lateral cephalometric radiograph, and missing permanent teeth.

To differentiate the changes induced by the cervical headgear treatment from those that occurred due to natural growth, an untreated control sample was selected from the Bolton-Brush study center (Cleveland, Ohio) available at: https://www.aaoflegacycollection.org/aaof_searchDemog.html using the following criteria: 1) Age at T1, T2, and T3 matched the headgear group, 2) availability of good quality lateral cephalometric radiographs, 3) at least half cusp Class II molars at T1, and 4) no history of orthodontic treatment. The untreated Class II control group included 19 subjects. Mean ages at T1, T2, and T3 and mean observation periods for the control group are given in Table 1.

Dental charts were examined for age, treatment start date, end date, and post-retention record date. Dolphin Imaging® software (version 11.95, Dolphin Imaging and Management Solution, Ca, USA) was used to trace the lateral cephalograms by two consultant orthodontists. The distance from the distal surface of the maxillary first molar to the pterygoid vertical plane (U6 to PTV) on lateral cephalometric radiographs was measured at the three time points (Figure 1). The pterygoid vertical plane (PTV) was constructed by drawing a vertical line passing through the distal aspect of the pterygomaxillary fissure crossing the Frankfort horizontal line at 90 degrees. The lateral cephalograms at (T3) were examined to identify the status of the maxillary third molar. The status of third molars was categorized as Erupted: if it was at the level of the occlusal plane; Extracted: if it was present at T2 but not present at T3; Impacted: if complete root formation was achieved while it was above the occlusal plane; Congenitally missing: if there were no signs of the tooth bud at T1, T2 and T3; and Formation stage: if there was incomplete root formation at the T3 record. All the selected cases had to have a similar third molar category on both the right and left sides.

Intra-examiner reliability/agreement testing was done using Cronbach's alpha test tracing 10 randomly selected pre-treatment radiographs twice, two weeks apart. Intra-examiner reliability scores were 0.975.

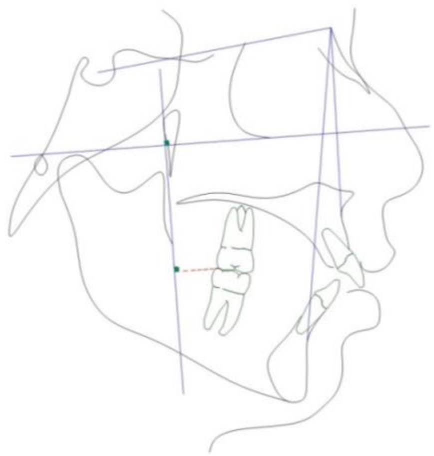

Figure 1: U6-PTV distance is shown in a red dotted line.

Statistical Analysis: Data were tabulated and the results of the Shapiro–Wilk test demonstrated that most of the variables were not normally distributed at T1, T2, and T3. Moreover, since the sample size between the headgear and control groups was not equal, non-parametric analyses were performed. The Kruskal-Wallis test was used to study the main effect and the Mann-Whitney-U tests for bivariate comparisons of the changes in treatment and observation values (T2–T1, T3–T2, and T3–T1). The contingency tables were performed to study the relationship between headgear use and third molar status. Bonferroni correction was used to prevent a Type-I error when running multiple comparisons; hence, the basic P level of significance was lowered to P < 0.017. Otherwise, the level of statistical significance was P < 0.05. The statistical analysis was performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Mac. Armonk, NY: IBM Corp).

RESULTS

Intra-examiner reliability testing was done using Cronbach's alpha test tracing 10 randomly selected pre-treatment radiographs twice, two weeks apart. Intra-examiner reliability scores were 0.994.

Table 1 shows the baseline bivariate comparisons between the headgear and control groups for age at the three-time points, observation periods, and at T1 for U6 to PTV. No significant statistical difference between the two groups was found, indicating the proximity of age of the two groups at three-time points and during the observation periods and the similarity of the U6-PTV distance at the start point.

Table 1. Bivariate comparisons between the headgear and control groups for age (years) at different time points, observation periods (years), and U6-PTV (mm) at baseline (data are presented as means ±SD).

Group	Age (years)			Observation period (years)			U6-PTV (mm)
	T1	T2	T3	T1-T2	T2-T3	T1-T3	T1
Headgear (n=33)	11.2 (±1.6)	14.3 (±1.9)	22.7 (±4.3)	3.1 (±1.0)	8.3 (±4.2)	11.5 (±4.1)	16.5 (±4.0)
Controls (n=19)	11.1 (±0.3)	14.1 (±0.3)	27.8 (±13.0)	3.1 (±0.3)	13.7 (±13.1)	16.7 (±13.1)	14.3 (±4.9)
Difference	0.1	0.2	2.2	0.0	5.4	5.2	2.2
P value*	0.863	0.738	0.060	0.619	0.436	0.562	0.060

* Based on the Mann-Whitney U test.

As shown in Table 2, the results of the Kruskal-Wallis test were significant in both groups for U6-PTV (P<0.001). The position of U6 changed significantly between the headgear and control group at T2 but was similar at T3. Table 3 shows comparisons of distalization of U6 in the headgear and control groups. Between T1 and T2, the U6 was significantly distalized in the headgear group (P=0.006), followed by a significant mesialization from T2 and T3 (P<0.001). While in the control group, the U6 and PTV mesialized significantly from T1 to T2 (P<0.001) with minimal change from T2 to T3 (P>0.05).

Table 2. Bivariate comparisons between the headgear and control groups for U6-PTV (mm) at different time points (data are presented as means ±SD).

Group	U6-PTV				Changes		
	T1	T2	T3	Kruskal-Wallis*	T1-T2	T2-T3	T1-T3
Headgear (n=33)	16.5 (±4.0)	13.3 (±4.3)	19.2 (±4.4)	<0.001	-3.3 (±2.9)	5.9 (±4.6)	2.7 (±4.3)
Controls (n=19)	14.3 (±4.9)	19.1 (±3.2)	20.6 (±6.4)	<0.001	4.8 (±4.4)	1.5 (±4.8)	6.3 (±6.8)
Difference	2.2	5.8	1.4		1.5	4.4	3.6
P value**	0.060	<0.001	0.177		<0.001	0.003	0.002

* Kruskal-Wallis test, ** Mann-Whitney U test

Table 3. Results of the *post-hoc* pairwise comparisons of distalization of U6 in the headgear and control groups (data are presented as means ±SD).

Group	Time	U6-PTV change (mm)	P value	Adjusted P value*
Headgear	T1-T2	-3.3 (±2.9)	0.006	0.017
	T2-T3	5.9 (±4.6)	<0.001	<0.001
	T1-T3	2.7 (±4.3)	0.025	0.075
Control	T1-T2	4.8 (±4.4)	<0.001	0.002
	T2-T3	1.5 (±4.8)	0.346	1.000
	T1-T3	6.3 (±6.8)	<0.001	<0.001

* P values have been adjusted by the Bonferroni correction for multiple tests.

When evaluating the third molar status at T3 in Table 4, contingency tables analyses showed there was no significant relationship between headgear treatment and third molar status (p=0.108). Furthermore, an attempt was made to combine impacted and extracted cases together since the reason for extraction is unknown to us. Thus, combining them would cover any possible chances that they were extracted because of impaction, still, there was no significant statistical relationship (P=0.298).

Chi-square test was done to analyze if there was a relationship between the third molar status and the distance of U6-PTV at T3. No statistically significant differences were found P<0.493 (results not tabulated).

Table 4. Relationship between headgear use and third molar status at T3 (data are presented as frequency and percentage).

3rd Molar Status	Headgear (n=33)	Control (n=18)	P Value*
Impacted	18 (54.5 %)	6 (33.3 %)	0.108
Extracted	5 (15.2 %)	7 (38.9 %)	
Erupted	5 (15.2 %)	5 (27.8 %)	
Congenitally missing	4 (12.1 %)	0 (0.0%)	
Formation	1 (3 %)	0 (0.0%)	
Impacted + Extracted	23(69%)	13(72.2%)	0.298

* Contingency tables.

DISCUSSION

This study aimed to examine the short and long-term effects of headgear treatment on space available for the eruption of maxillary third molars and the status of eruption of maxillary third molars at the post-retention follow-up. The U6 to PTV distance has been used to measure the available retromolar space in our study, as in previous studies. [7, 12, 16-17, 19]

Miclotte et al.[15] evaluated the immediate headgear effect on the eruption of maxillary third molars. They found that the U6 to PTV distance decreased after headgear treatment by around 1 mm compared to the control group. The control experienced an increase of 1.9 mm in this distance, while the headgear group experienced an increase of only 0.9 mm, and they did not evaluate the U6 to PTV distance at a follow-up time point. In addition, their control group consisted of Class II cases treated with non-extraction fixed appliance therapy, including functional appliances or Class II elastics.

In contrast, this current study evaluated the effect of headgear on U6-PTV distance before, immediately after, and an average of 8 years post treatment and compared it to untreated Class II controls. The findings of our study show that the available space for eruption of the maxillary third molars decreased because of cervical headgear treatment, but this decrease was temporary as it increased again after cessation of headgear treatment at the long-term follow-up time point. In the headgear group, it decreased on average by 3.3 mm and then increased by 5.9 mm at the third follow-up record, whereas in the control group, the distance increased by 4.8 mm and then increased again but only 1.5 mm at the third follow-up time point. The net increase for headgear and control groups was not significant. Thus, it appears that this distance follows the normal growth pattern, which is the apposition of bone at the tuberosity, [20] and even though headgear treatment has restrained this forward growth, the maxilla recovers after the stop of headgear use and starts gaining the horizontal bone length that was ceased at the time of headgear use. This is in parallel with the study by Ricketts, who found that the headgear-treated group showed distalization of 1.3 mm while the control group showed mesialization by 2 mm.[17] In addition, a similar pattern was seen in a study by Mitani and Brodie where they found that the controls showed a continuous increase of about 6 mm from the age of 8 to 16 years, whereas the headgear-treated sample showed stability in the U6 to PTV distance during headgear treatment, then it caught up with an increase in this distance at the follow-up record of about 2.7 mm. However, it is important to note that their sample was much younger than ours at the follow-up time point, so that might explain the difference in the amount of increase in T3-T2 between our results and theirs. [16]

Ganss et al [21] stated that 60 percent of the maxillary third molars in their sample had erupted when the U6-PTV was 25 mm and only 10 percent had erupted in a space less than 25 mm.[21] In addition, another study stated that the U6-PTV should be at a minimum of 18 mm for the maxillary third molars to erupt. This was not true for our study where only 20% of the erupted maxillary third molars had U6- PTV greater than 25mm, and 60% of maxillary 3rd molars had erupted in a space less than 25 mm. Furthermore, we found 1 case where the maxillary third molar had erupted in a space as small as 13 mm. In addition, we also observed third molars that had been impacted even when the space was 26 mm wide. Chi-square test did not show statistical significance between the U6-PTV distance and the eruption status of the third molars at T3. This is coincident with the study by Kim et al [7], which experienced similar results with third molars erupting in a space less than 13 mm and being impacted in a space as big as 24 mm. Furthermore, 70 percent of the maxillary third molars that erupted in their study had a space less of than 25 mm. This indicates that there are definitely variables other than the retromolar space that play a significant role in the eruption of maxillary third molars.

The average age of maxillary third molar eruption has been recorded to be between 18 to 24 years.[22] In our sample, the average age of both groups at T3 was 25.5 years. Most of the study sample was older than 17 years except for 2 in the headgear group; one was 16.7 years old, and the third molar was diagnosed as erupted, the second was 15.2 years old, and the third molar was in the formation stage.

Evaluating the third molar status from a panoramic radiograph would have been a better diagnostic tool, but multiple records were missing. We used visual evaluation on the cephalometric radiograph, which has its limitations due to the overlapping of the right and left sides.

There was no significant statistical difference between the headgear group and the control group in the maxillary third molar status at T3. Among the control group, almost 40% had impacted third molars, whereas only 15.2% of the headgear treated group were impacted. Moreover, 33.3% of the controls had third molars extracted, while about 55%% of the headgear treated group were extracted. Although this was not statistically significant, this difference in percentage could probably be attributed to the care those treated patients were receiving from their orthodontist. This close monitoring could have led to the referral for extractions when impactions were suspected. Unfortunately, we do not have the justification for extractions in the headgear and control groups; thus, an effort was made to normalize this problem by combining the impacted and extracted groups together. This resulted in the controls having 69% while the headgear-treated group had 72% of impacted plus extracted third molars. However, this was still not significant statistically.

CONCLUSIONS

Within the study's limitations, the following conclusions could be drawn:

1. Headgear treatment caused a transient decrease in the retromolar space that would recover later with normal growth.
2. Cervical headgear treatment did not increase the prevalence of maxillary third molar impaction.

SOURCE OF FUNDING

No funding was received for the study.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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