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Cephalometric changes after headgear anchored to the deciduous second molars in the early mixed dentition

ABSTRACT

Aim *The present study aimed to evaluate the cephalometric effects of a headgear anchored to the deciduous second molars in the early mixed dentition.*
Materials and Methods *Study design: The study followed a retrospective longitudinal design and enrolled 31 consecutive patients (17 females and 14 males) treated with high pull (HP) headgear anchored to the deciduous second molars, average age 8y 5m ± 5m at pre-treatment time (T0) and 9y 8m ± 6m at post-treatment time (T1). All the patients wore the headgear for approximately 8-10 hours at night, with a force of 250 g per side. The active phase of treatment ended once patients obtained a distal step on permanent molars of at least 2 mm. Lateral cephalograms at T0 and T1 were taken; 10 angular measurements were chosen as variables of the study. The paired sample t-test was employed to assess the significance of the differences of each variable between T0 and T1.*
Results and Conclusion *In this group of Class II patients, HP headgear anchored to the deciduous second molars in the early mixed dentition produced: significant reduction of SNA angle, significant increase of SN/NL angle with no significant change in SN/ML angle, significant labial flaring of upper incisors. As clinically evaluated, the correction of the Class II occlusal relationship and the anterior crowding of maxillary arch were also accomplished.*

Keywords *headgear, deciduous teeth, Class II, early treatment, mixed dentition*

Introduction

Headgear is a simple and widely used orthodontic device to correct Class II malocclusion and maxillary arch crowding [Kirjavainen et al., 1997; Kirjavainen et al., 2000; Mäntysaari et al., 2004]. It is reported that cervical headgear, used alone or combined with additional orthodontic appliances, inhibits maxillary forward movement, producing a posteroinferior redirection of its growth [Melsen, 1978] and induces a downward tipping of the palatal plane [Kirjavainen et al., 2000; Lima Filho et al., 2003a]. The clockwise rotation of the mandible could also occur [Creekmore, 1967; Odom, 1983]. However some studies showed the relative constancy of the mandibular plane angle [Cook et al., 1994; Lima Filho et al., 2003b; Pirttiniemi et al., 2005] and no significant changes in the vertical facial growth [Mäntysaari et al., 2004]. In order to control the potential undesired vertical changes of cervical headgear, high pull (HP) and 'combi' headgear have been used by orthodontists [Baumrind et al., 1978].

No conclusive agreement has been achieved in literature about the most suitable treatment timing of Class II malocclusion. Scientific evidence indicates that the clinical signs of Class II are established in the deciduous dentition and persist into the mixed dentition [Baccetti et al., 1997; Antonini et al., 2005]. Besides, it is demonstrated that Class II molar relationship never corrects by itself from the deciduous to the permanent dentition [Bishara et al., 1998], if compared to other malocclusions [Rosa et al., 2012]. In this view, the correction of Class II problems should start early. Class II therapy in the mixed dentition seems to successfully correct the malocclusion and reduce the need and/or the invasiveness of the orthodontic treatment in the permanent dentition [Dugoni, 1998]. Several potential benefits of Class II early treatment are described in literature: a lower risk of traumatic injuries [Nguyen et al., 1999; Artun et al., 2005] and apical root resorption [Brin et al., 2003] of prominent incisors, as well as the reduction of negative social experiences

Pre-treatment inclusion criteria		
1.	early mixed dentition	
2.	Class II molar relationship	
3.	ANB > 0°	
	Initial sample	37
Primary exclusion criteria		
1.	Poor film quality	2
2.	Incomplete records	2
Secondary exclusion criteria		
1.	T0 to T1 > 18 months	1
2.	NL/ML > 30°	1
	Final sample	31

TABLE 1 Inclusion and exclusion criteria. Pre-treatment inclusion criteria were applied; the initial sample (n = 37) was selected. Primary and secondary exclusion criteria were applied to the initial sample; the final sample was selected (n = 31).

[Johnston, 2002]. A better alignment of the permanent incisors, an increased transversal upper arch dimension [Rosa, 2003; Rosa, 2006] and a major compliance from young patients than adolescent ones [Dugoni, 1998] are other reported advantages. However, different opinions are expressed by other authors, who demonstrated that early treatment tends to prolong treatment time, with no increase of the effectiveness of the overall treatment and no significant capability to affect facial growth better than one-phase treatment [Tulloch et al., 2004; Proffit, 2006; Thiruvenkatachari et al., 2013].

Very few data are available in literature on the effects of early headgear treatment when started in the deciduous [West, 1957] and early mixed dentition, even less when the headgear is used on the deciduous teeth [Rosa, 2003], if compared to other treatment protocols where the evidence on the application of deciduous teeth has dramatically increased [Cozzani et al., 2012; Fastuca et al., 2015a, 2015b]. The aim of the present study was then to evaluate the cephalometric effects of HP headgear anchored to the deciduous second molars in the early mixed dentition.

Materials and methods

Population and study design

This study followed a retrospective longitudinal design and enrolled subjects treated with HP headgear anchored to bands cemented on the upper deciduous second molars. The patients were selected from the available records [Caprioglio et al., 2009] according to pretreatment inclusion criteria (Table 1). Lateral cephalograms at pre-treatment time (T0) and post-treatment time (T1) were collected. During records collection, primary and secondary exclusion criteria were applied to the initial sample (Table 1). The final sample of the study consisted of 31 consecutively treated patients (17 females and 14 males), mean age 8y 5m ± 5m at T0 and 9y 8m ± 6m at T1. The employed appliance included a long-armed headgear, made of an inner bow soldered to an outer bow with diameters measuring 0.045 and 0.071 inches , high straps and upper bands with 0.045" welded tubes. The inner bow was adapted in order to be passively inserted into the tubes, minimizing the risk of bands failure. The outer bow was leveled to the intraoral area between the deciduous upper second molar and the permanent upper first molar. The force applied was approximately 250 g per side, measured by a calibrated dynamometer (501-0842, Forestadent, Pforzheim, Germany). Patients were instructed to wear the headgear at night, for approximately 8-10 hours. They were checked monthly and appliances were adjusted as needed. The active phase of treatment ended once patients obtained a distal step on permanent first molars of at least 2 mm as well as a Class I deciduous canine relationship. The average duration of the active treatment was 1y 3m ± 3m. After which, a period of retention was recommended to the patients. During this period, that lasted six months, patients were instructed to wear the headgear for a gradually decreased number of nights.

Cephalometric measurements

All the lateral head radiographs were performed at the same Radiographic Centre using the same X-ray machine (Sirona XG3D, Sirona Dental System, Verona, Italy) at T0 and T1. No additional radiographic exams were performed after the retention period. Cephalometric tracings were made with a 0.5 mm lead pencil on transparent acetate sheets on a laminator. Cephalograms were traced in random order by one investigator with verification of anatomic outlines and landmark position by a second investigator; in case of disagreement, the structures in question were retraced to the mutual satisfaction of both [Tettamanti et al., 2012]. In instances of bilateral structures the average of the two sides was considered, as suggested by literature [Lima Filho et al., 2003b]. Finally, 10 angular measurements were chosen as variables of the study (Fig. 1).

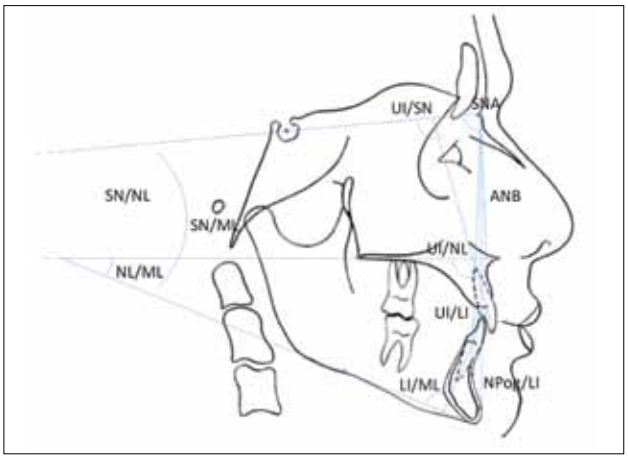


FIG. 1 Cephalometric measurements. 10 angular measurements (SNA, ANB, SN/NL, SN/ML, NL/ML, UI/SN, UI/NL, LI/ML, NPog/LI, UI/LI) were chosen as variables of the study.

Sample size calculation and method error analysis

A sample size of at least 16 subjects was necessary to detect an effect size (ES) coefficient of 1.0 for each recorded variable between the time points, with an alpha set at 0.05 and a power of 0.8. In order to minimise the method error, 15 randomly selected cephalograms were retraced by the same investigator after a period of 2 months and no significant mean differences between the two series of records were found by using paired t-tests. A range from 0.60° to 0.90° for the angular measurements was found.

Data analysis

The SPSS software, version 22.0 (SPSS® Inc., Chicago, Illinois, U.S.A.) was used to perform the statistical analyses. Parametrical methods were used after having tested the existence of the assumptions through the Shapiro-Wilk test and Levene test for the normality of the distributions and equality of the variances between the time points, respectively. The paired sample t-test was employed to assess the significance of the differences of each variable between the time points. A p value less than 0.05 was used in the rejection of the null hypothesis.

Results

Mean and standard deviation (SD) were calculated for all the tested variables and the correspondent results of the paired t-test are shown in Table 2.

A statistically significant reduction of SNA angle between T0 and T1 was observed. ANB angle was found decreased in T1 compared to T0 and this difference was not statistically significant.

As regards vertical changes, SN/NL angle was found significantly increased between T0 and T1, no significant changes were reported in SN/ML angle. NL/ML angle was found significantly decreased between T0 and T1. A significant increase of UI/SN and UI/NL angle occurred and no significant differences were found in NPog/LI and LI/ML angle. UI/LI angle was significantly decreased between T0 and T1.

The correction of the Class II occlusal relationship was accomplished; the maxillary anterior crowding, clinically diagnosed as space deficiency for the lateral incisors, was also improved allowing a correct eruption of these teeth (Fig. 2A, 2B).

Discussion

The present investigation aimed to evaluate cephalometric effects of HP headgear anchored to the deciduous second molars in the early mixed dentition. Little evidence is comparable to the present study regarding the use of headgear on the deciduous teeth in the early mixed dentition. Rosa [2003] showed the effects

Variable (n=31)	T0 mean±SD	T1 mean±SD	T1-T0 mean±SD	p
SNA	79,67±3,28	78,38±3,20	-1,29±0,37	0.005*
ANB	4,63±1,55	3,26±2,05	-1,37±0,98	0.109
SN/NL	7,87±2,73	9,31±2,23	1,44±0,53	0.043*
NL/ML	24,96±3,4	23,46±2,56	-1,50±0,76	0.020*
SN/ML	32,83±3,33	32,77±2,91	-0,06±0,24	0.110
UI/SN	97,45±8,34	98,12±8,35	0,67±3,46	0.002*
UI/NL	104,33±8,54	111,28±8,61	6,95±3,66	0.021*
NPog/LI	24,11±4,56	24,44±5,01	0,33±4,35	0.140
LI/ML	94,13±6,67	95,48±6,55	0,35±5,90	0.550
UI/LI	136,86±10,46	132,48±10,29	-4,38±10,16	0.010*

TABLE 2 Paired sample t-test results. Comparison between the time points T0 and T1 showing cephalometric effects after headgear therapy, using paired sample t-test at significance level *p<0.05. Data are shown as mean±SD.



FIG. 2 Intraoral photographs at pre-treatment and post-treatment time. A Intraoral photograph (right side) of an enrolled patient before the headgear therapy. Note the Class II occlusal relationship and the anterior crowding of the maxillary arch with lack of space for the eruption of the lateral incisor, which showed an ectopic eruption before treatment. B Intraoral photograph (right side) of the same patient after the headgear therapy. After 12 months of therapy the correction of Class II relationship was accomplished and the maxillary anterior crowding was corrected with increased available space for lateral incisors.

produced by using headgear anchored to the deciduous second molars in a small group of consecutive Class II patients in the early mixed dentition; the reported results are consistent with those of the present study.

The findings of this investigation showed that the headgear anchored to the deciduous second molars in the early mixed dentition (i.e. with erupted permanent first molars) produced a slight, but statistically significant, reduction of SNA angle, similarly to what is reported by literature when the headgear is anchored to the permanent first molars [Cangialosi et al., 1988; Lima Filho et al., 2003a]. It is controversial whether the changes in SNA angle might be more related to the orthopaedic effects of the headgear, producing a maxillary restraint and/or retraction [Melsen 1978], or might rely on dento-alveolar changes [Caldwell et al., 1984].

During the active treatment ANB angle decreased by -1,37° ± 0,98°, which is not a statistically significant value. In view of the relatively short treatment time (1y 3m ± 3m) and considering that, at the beginning of the headgear therapy, the selected patients were assessed to be at 1 Cervical Vertebral Maturation (CVM) stage [Litsas and Ari-Demirkaya, 2010; Perinetti et al., 2014], still far from the growth spurt, it is reasonable to think that the reduction of ANB angle derives much more from the effects of the headgear on the maxilla rather than being the result of the mandibular growth. However the lack of SNB angle measurements could represent a limit of this investigation since SNB angle might be a significant variable in evaluating craniofacial growth and morphology [Portelli et al., 2009; Perillo et al., 2013; Caprioglio et al., 2011].

A relevant result of this study concerns the increase of the SN/NL angle, which could indicate an inhibition of the vertical growth in the posterior part of the palate. It could be explained by the use of HP headgear, being the application point of the force distal to the maxillary center of resistance. Another possible hypothesis that could account for the orthopaedic effect of the headgear on the palatal plane is the behaviour of the deciduous second molars used as anchor-teeth, which appeared in some cases partially submerged and maybe ankylosed during treatment. However literature [Cangialosi et al., 1988; Lima Filho et al., 2003a] reported a similar trend of the palatal plane also using the cervical headgear on the permanent first molars. Mäntysaari studied the effects of the early Class II malocclusion treatment with the cervical headgear on the permanent first molars and reported no significant tipping of this plane [Mäntysaari et al., 2004].

The influence of the headgear on mandibular rotation was widely investigated and discordant data emerge from literature analysis [Caprioglio et al., 2014]. Traditionally cervical headgear was used in cases of skeletal maxillary protrusion with reduced vertical dimension, producing an increased vertical dimension because of molar extrusion [Creekmore, 1967]. Some authors reported the opening of the bite as an initial reversible effect of the headgear; in the long-term follow-up the mandibular plane angle decreased due to the anterior rotation of the mandible during growth [Melsen, 1978]. Other investigators showed that the mandibular plane remained unchanged as a result of the condylar growth, which would compensate the extrusion in the molar region [Baumrind et al., 1983; Lima Filho et al., 2003b]. No change in the mandibular angle was found in this study. It is plausible to suppose that the overall facial height was maintained by the erupted and occluding permanent first molars. A further hypothesis to consider is the early use of the headgear that could account for the lack of significant effects on the vertical facial growth [Mäntysaari et al., 2004]. Indeed the vertical growth pattern and characteristics might be considered [Biondi et al., 2016].

In the present study NL/ML angle decreased between T0 and T1 as a consequence of the previously mentioned change in SN/NL angle: the palatal plane tipped downward, whereas the overall vertical divergence and the facial height remained almost constant.

A significant increase of UI/SN and UI/NL angle was observed. The labial tipping of the upper incisors was found also by other authors [Mäntysaari et al., 2004; Pirttiniemi et al., 2005] that underlined the role of this dental change in increasing the arch length and improving crowding. The distal displacement of upper incisors apex could have also affected the previous mentioned posterior displacement of the A point, assuming the existence of a relationship between the roots of the upper incisors and A point [Mitchell and Kinder, 1973]. The progressive adjustment of the headgear arch at least 2 mm far from the upper incisors could be the reason for the reported flaring of these teeth, preventing the pressure exerted from lips on them [Mäntysaari et al., 2004]. However this finding is not consistent with other investigations in which a lingual tipping of maxillary incisors occurred; it is probably related to the use of additional orthodontic appliances, such as Class II elastics [Cangialosi et al., 1988], or to different methods in headgear management.

Considering the inclination of the upper central incisors at T0 in the enrolled patients (UI/SN and UI/NL angle within or below the normal range of values), the reported correction of the maxillary anterior crowding related to the flaring of these teeth after headgear, allows to speculate that HP headgear early treatment could be recommended in Class II malocclusions which show, in the early mixed dentition, crowded upper incisors [Portelli et al., 2012] and deep bite tendency. Furthermore, according to this clinical observation, starting treatment before the eruption of the permanent lateral incisors might be the most appropriate treatment timing.

Additional considerations about the clinical findings of this study are relevant to explain the rational of the use of the headgear on the deciduous second molars. The correction of the Class II permanent molars and Class II deciduous canine relationship was accomplished. No posterior cross-bite on permanent first molars, despite the palatal displacement of the deciduous second molars

during the active treatment, was reported; the potential adverse effects related to the use of orthodontic bands, such as the periodontal damages, were avoided on the permanent first molars.

The present study has some limitations: first of all the lack of a control group and a long-term investigation of the results; secondly, no cast analysis was performed to confirm the reported clinical occlusal data.

Conclusion

Treatment of Class II malocclusion in the early mixed dentition using HP headgear anchored to the deciduous second molars produced:

- significant reduction of SNA angle;
- significant increase of SN/NL angle with no significant change in SN/ML angle;
- significant labial flaring of upper incisors;
- relevant clinical changes, such as Class II occlusal correction and increased space in the maxillary arch for lateral incisors eruption.

Further studies would be required to test the effectiveness and the cost-benefit ratio of this early headgear therapy.

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