Original Article

Effects of Cervical Headgear on Overbite against the Background of Existing Growth Patterns

A Retrospective Analysis of Study Casts

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ABSTRACT

Objective: To test the questions ''Does cervical headgear treatment necessarily lead to a reduction of overbite?'' and ''Are there differences in treatment results due to different growth patterns or the initial overbite?''

Materials and Methods: Initial and intermediary casts of 247 patients who had been treated exclusively with headgear were analyzed for changes in the occlusal relationship of the first molars and overbite. Orthodontic treatment consisted of the application of cervical headgear with non-angulated external arms applied at a force of 3.5–4.0 N. Only patients showing dental changes of occlusal relationship ≥4 mm during at least a 6-month treatment duration were selected. Growth patterns were identified by the y-axis values measured on lateral cephalograms obtained at study entry. Six groups were formed on the basis of these growth patterns.

Results: Headgear treatment induced bite deepening in patients with vertical growth patterns and bite opening in patients with horizontal growth patterns. Further subdivision based on initial overbite revealed bite deepening in patients with small initial overbite and bite opening in patients with large initial overbite. These differences were statistically significant ($P < .05$). Only minor changes were observed in patients with an initial overbite of 3–4 mm.

Conclusions: Overbite reductions were not dependent on the growth pattern. Orthodontists should expect bite opening in deep-bite situations and bite deepening in open-bite situations. However, initial overbite situations of 3–4 mm should not be expected to change in a significant way.

KEY WORDS: Headgear; Growth; Overbite

INTRODUCTION

Despite the growing availability of orthodontic appliances whose effects are largely independent of patient compliance, cervical headgear are still an important option within the orthodontic treatment spectrum. After Kloehn[1] introduced them to clinical practice in 1953, their effects on vertical relations and growth patterns soon became a subject of discussion. Bite opening (ie, caused by extrusion and distal tilting of the maxillary first molars) is one phenomenon related to cervical headgear that has been described and explained in theoretical terms.[2,3] Most current studies continue to discourage the use of cervical headgear in the presence of open-bite situations or vertical growth patterns.[4–7]

Numerous authors, however, have not detailed the growth patterns or overbite situations of their patients at the beginning of treatment. In many cases, this information has been confined to mean values obtained for an entire patient series.[8–17] A number of studies have dealt with the effect of cervical headgear in deep-bite patients or patients with horizontal growth patterns.[18–25] The effects of headgear have frequently been discussed in combination with fixed appliances.[26–33] Some authors failed to observe any significant bite opening induced by skeletal or dental changes and therefore do not believe that cervical headgear are

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Accepted: January 2006. Submitted: December 2005.

 DOI: 10.2319/121305-436

Table 1. Classification by y-Axis at Baseline (± SD)

Group	Classification y-Axis [°]	n	Boys/Girls	Age, y	Headgear Treatment Time, mo	Molar Distal Occlusion, mm
H2	<61.5	10	6/4	11.1 ± 1.76	17.9 ± 9.72	5.8 ± 2.14
H1	61.5–64.4	30	14/16	10.9 ± 1.11	20.2 ± 10.37	7.0 ± 1.98
N	64.5–67.4	64	27/37	11.1 ± 1.40	18.5 ± 8.87	6.6 ± 2.26
V1	67.5–70.4	74	34/40	11.2 ± 1.79	16.1 ± 7.76	7.2 ± 2.78
V2	70.5–73.4	55	24/31	11.4 ± 1.20	15.8 ± 9.05	6.7 ± 2.42
V3	>73.4	14	8/6	11.0 ± 1.92	17.4 ± 8.39	7.2 ± 3.55
Total		247	113/134	11.2 ± 1.50	17.3 ± 8.84	6.8 ± 2.52

contraindicated in the presence of vertical growth patterns or open-bite situations.[34,35]

Similarly, our own group did not observe negative effects on overbite according to a limited patient sample with vertical growth patterns.[36] Instead, we found that headgear treatment induced bite opening in deep-bite situations and bite deepening in open-bite situations. We therefore took interest in verifying these results according to a larger patient sample, taking into consideration different growth patterns.

MATERIALS AND METHODS

The records of 247 patients (113 boys and 134 girls) in an orthodontic office who had been treated with cervical headgear were retrospectively analyzed. In all cases, an orthodontic force of 3.5–4.0 N was applied through headgear with nonangulated external arms. Treatment was continued for at least 6 months in the late phase of the mixed dentition. Patients were included only if their occlusal relationships at the upper first molars were changed by ≥4 mm.

The treatment plan included a first phase of isolated headgear treatment followed by a diagnostic phase and a second treatment phase in which a multiband appliance was used. In the intermediary diagnostic phase, study casts were fabricated and subsequently analyzed for molar occlusal relationships and overbite. The results were compared with the baseline values collected from the initial casts. The details of this approach have been described in a previous communication.[35] Growth patterns were determined based on the lateral cephalograms obtained at study entry.

The study groups summarized in Table 1 were defined in accordance with Rakosi[37] in that the y-axis values remain more or less stable during growth. Values of 64.5°–67.4°[36] were considered to reflect a neutral growth pattern (group N), values of <64.5° were considered to reflect a horizontal growth pattern (groups H1 and H2), and values of ≥67.5° were considered to reflect a vertical growth pattern (groups V1–V3). The age differences among the various groups were not significant (range 10.9–11.4 years). The mean duration of headgear treatment was 20.2 months in group H1, 17.9 months in group H2, 18.5 months in group N, 16.1 months in group V1, 15.8 months in group V2, and 17.4 months in group V3. The mean reduction in molar distal occlusion achieved in that treatment phase ranged from 5.8 mm (group H2) to 7.2 mm (groups V1 and V3). Other details are summarized in Table 1.

Table 2. Classification by Overbite at Baseline (± SD)

Group	AM OB	n	Headgear Treatment Time, mo	Molar Distal Occlusion, mm
OB1	<0.1	6	11.2 ± 4.35	7.0 ± 2.00
OB2	0.1–1.0	5	12.4 ± 5.62	7.2 ± 3.42
OB3	1.1–2.0	25	15.2 ± 7.32	7.0 ± 2.28
OB4	2.1–3.0	31	16.5 ± 7.49	6.2 ± 2.04
OB5	3.1–4.0	76	19.2 ± 9.94	7.0 ± 2.74
OB6	4.1–5.0	65	17.1 ± 0.35	7.0 ± 2.78
OB7	>5.0	39	17.6 ± 7.74	6.8 ± 2.12

Data were separately analyzed after subcategorizing the patients into seven groups according to initial overbite (Table 2). The mean duration of headgear treatment was 11.2 and 12.4 months in groups OB1 and OB2 and ranged from 15.2 months (group OB3) to 19.2 months (group OB5) in the remaining groups. The mean improvements achieved for distal occlusion ranged from 6.2 mm to 7.2 mm.

An error assessment (second measurement performed after >14 days) showed that the accuracy of measurements was <1 mm for molar relations and <0.5 mm for overbite. Student's *t*-test for independent samples was performed with JMP statistics software (SAS Institute Inc, JMP IN Version 5.1. Cary, NC). The significance levels for statistical analysis were .05, .01, and .001.

RESULTS

Figure 1 illustrates the overbite changes induced by headgear treatment depending on initial y-axis values. Positive values indicate increases in overbite, thus reflecting bite deepening. Results of this type were obtained with predominantly vertical growth patterns. Overbite increased by 0.1 mm in group N, 0 mm in group V1, 0.2 mm in group V2, and 0.4 mm in group

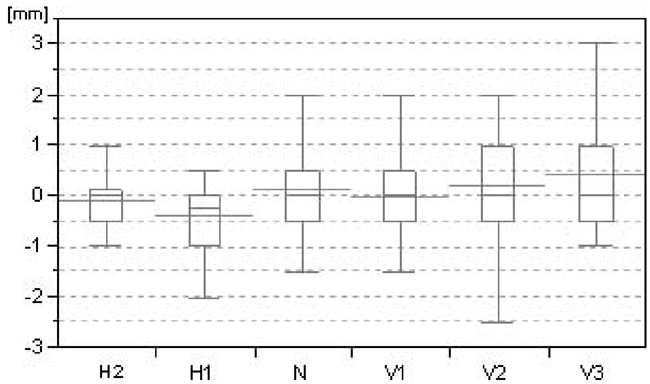

Figure 1. Development of overbite on headgear monotherapy as a function of growth patterns.

Table 3. Statistical Significance of the Differences in Changes in Overbite Among the Groups as per the Classification in Figure 1[a]

	Group					
Group	H2	H1	N	V1	V2	V3
H2		NS	NS	NS	NS	NS
H1	NS		**	NS	**	**
N	NS	**		NS	NS	NS
V1	NS	NS	NS		NS	NS
V2	NS	**	NS	NS		NS
V3	NS	**	NS	NS	NS	

[a] NS indicates not significant; * Significant at the .05 level; ** Significant at the .01 level.

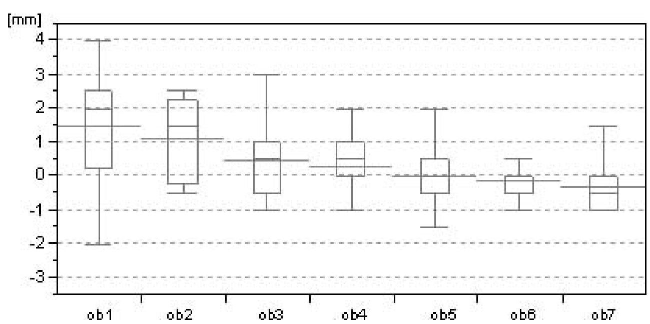

Figure 2. Development of overbite on headgear monotherapy as a function of overbite at baseline.

V3. Horizontal growth patterns, by contrast, were associated with bite opening. Overbite was reduced by 0.4 mm in group H1 and 0.1 mm in group H2. Statistically significant differences ($\alpha = .05$) were obtained for group H1 vs group N, group H1 vs group V2, and group H1 vs group V3 (Table 3).

Figure 2 illustrates the results grouped by initial overbite. Headgear treatment induced no overbite changes in group OB5 (initial overbite of 3.1–4.0 mm). Smaller degrees of initial overbite were generally associated with more pronounced bite deepening. Overbite increased by 0.3 mm in group OB4, 0.5 mm in group OB3, 1.1 mm in group OB2, and 1.5 mm in group OB1. Larger degrees of initial overbite, by contrast, were generally associated with bite opening. Overbite was reduced by 0.1 mm in group OB6 and 0.3 mm in group OB7. These differences between any two adjacent groups were not significant; there were significant differences between several of the other group pairings (Table 4).

Table 4. Statistical Significance of the Differences in Changes in Overbite Among the Groups as per the Classification in Figure 2[a]

	Group						
Group	OB1	OB2	OB3	OB4	OB5	OB6	OB7
OB1		NS	**	**	***	***	***
OB2	NS		NS	*	**	**	***
OB3	**	NS		NS	**	**	***
OB4	**	*	NS		NS	*	**
OB5	***	**	**	NS		NS	NS
OB6	***	**	**	*	NS		NS
OB7	***	***	***	**	NS	NS	

[a] NS indicates not significant; * Significant at the .05 level; ** Significant at the .01 level; *** Significant at the .001 level.

DISCUSSION

The objective of this study was to verify observations we have made previously in a smaller patient sample[36] by analyzing a larger number of patients and taking into consideration existing growth patterns.

The available literature on cervical headgear does not contain adequate information on their effect on overbite. Kim and Muhl[30] demonstrated overbite changes in connection with multiband appliances. Osvaldik-Trapl and Droschl[38] reported overbite reductions by 1 mm but did not specify the initial situation. Both groups used lateral cephalograms to determine the degree of overbite. They did not use study casts, as we have in the present study. Because additional studies containing details about overbite are not available, changes in the angles used to define growth have been discussed in connection with cervical headgear, even though establishing a relationship between angles indicating growth patterns and overbite may be problematic.[39]

Our study confirms the finding reported in numerous communications that headgear treatment will reduce overbite in the presence of horizontal growth patterns and deep-bite situations.[4–6,9,10,14,16,17,19–25,40,41] This phenomenon has also been explained in theoretical terms.[2,3]

Overbite changes were negligible in patients who revealed a neutral growth pattern or a moderate overbite of 3–4 mm. They were also negligible according to the mean value obtained for the entire study population. Klein[34] and Ringenberg and Butts,[35] though not being specific about the growth patterns and initial overbite situations in their respective patient samples, did not observe a clear-cut increase in vertical angles during headgear treatment.

Baumrind et al[42] described an average increase in SN-MeGo angles from 33.1° to 33.3° during treatment with cervical headgear. They reported, however, that ''high-angle'' cases do not generally differ from normal cases during headgear treatment and that the subsequent direction of growth cannot be deduced from the SN-MeGo or MPA values measured at the beginning of treatment.[43] They confirmed this hypothesis by asking five experienced specialists to predict how growth patterns would have evolved in selected patients according to available orthodontic baseline documentation and compared the results with the actual growth patterns on record.[44] The predictions barely exceeded the random-expectancy level. The lesson to be drawn from this—that growth patterns are basically unpredictable—is inconsistent with any treatment recommendations that are formulated on the basis of specific growth patterns.

The differences concerning the changes of the overbite among the subgroups turned out to be minimal. The maximum difference among the subgroups representing the growth patterns was $<$1 mm (Figure 1); however, the changes among subgroups in overbite was $<$2 mm (Figure 2), and some statistical significances were found using different levels of significance (Tables 3 and 4). Still, no direct clinical relevance can be derived from these statistical differences.

Most importantly, however, is that contrary to a widespread opinion[2–7] there was no bite opening in patients with a vertical growth pattern after treatment with cervical pull headgear. We therefore now treat patients with horizontal, neutral, and vertical growth patterns with cervical pull headgear when appropriate.

Without analyzing lateral cephalograms, one can only speculate about the reasons for bite deepening in patients with vertical growth patterns or small vertical overbite. One explanation might be that angles indicating vertical growth as measured on lateral cephalograms cannot be readily compared with overbite as measured on study casts.[39] The prolonged duration of treatment (17 months on average) could be another explanation, for the patients would wear their headgear overnight only after the treatment objective had been achieved, which may have caused a relapse of bite deepening. Further studies are needed to analyze these cause-effect relationships in greater detail. Cephalometric data might be helpful.

CONCLUSIONS

- Overbite reductions are not induced in all patients.
- Overbite reductions were not found to be dependent on the growth pattern. Therefore, a vertical growth pattern does not stand for a contraindication concerning the use of cervical pull headgear.
- Orthodontists should expect bite opening in deepbite situations and bite deepening in open-bite situations. However, initial overbite situations of 3–4 mm should not be expected to change in a significant way.

ACKNOWLEDGMENT

We wish to thank the staff at the Berger/Hense orthodontic office in VS-Schwenningen, Germany, for their kind support in collecting the data for this study.

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