Original Article

Mandibular Cervical Headgear vs Rapid Maxillary Expander and Facemask for Orthopedic Treatment of Class III Malocclusion

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ABSTRACT

Objective: To compare the effectiveness of the rapid maxillary expander and facemask (RME/FM) and mandibular cervical headgear (MCH) protocols when followed by fixed appliances and evaluated at a postpubertal observation in patients with dentoskeletal Class III malocclusion.

Materials and Methods: The sample treated with the RME/FM followed by fixed appliances included 32 patients (12 boys and 20 girls). The sample treated with the MCH followed by fixed appliances included 26 patients (eight boys and 18 girls). Cephalometric analysis was performed at T_1 (before treatment) and T_2 (after the first phase of orthopedic therapy and the second phase of fixed appliances). T_1-T_2 changes were evaluated by means of *t*-tests.

Results: Midfacial length, mandibular length, and the sagittal position of the chin all showed significantly smaller increases in the MCH group than in the RME/FM group. The amount of increase in the overjet was also significantly smaller in the MCH group, whereas the amount of molar correction was greater. The upper incisors were significantly less proclined and the lower incisors were significantly less retroclined in the MCH group when compared with the RME/FM group.

Conclusions: RME/FM therapy appears to be indicated in Class III patients with a component of maxillary retrusion, whereas MCH therapy is preferable in patients with mandibular prognathism.

KEY WORDS: Facemask; Mandibular headgear; Class III malocclusion

INTRODUCTION

Early treatment of a Class III dentoskeletal disharmony through growth modification can be accomplished by means of several therapeutic strategies aimed both to restrict mandibular growth and to enhance maxillary growth along with dentoalveolar modifications. Among these treatment options, two orthopedic approaches have demonstrated effectiveness in the treatment of growing Class III patients: the combination of the rapid maxillary expander with the orthopedic facemask (RME/FM) and the mandibular cervical headgear (MCH). Whereas the former appliance has been investigated extensively, the outcome of the latter treatment approach has been studied more sporadically.

During the past 10 years, a number of studies[1–12] have described the treatment effects of RME/FM during a single phase of treatment, with a combination of skeletal and dentoalveolar modifications in both the maxilla and mandible noted. Several studies[1,2,7–12] have evaluated also the craniofacial modifications that occur in the period after the orthopedic correction. They have indicated that in the years after active treatment the pattern of Class III disharmony is reestablished. A recent investigation[12] of the postpubertal outcome of RME/FM therapy with the use of untreated Class III controls showed that the favorable skeletal change observed over the long-term was attributed al-

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most entirely to the amount of orthopedic correction achieved during the first intervention with the RME/FM protocol. Aggressive ''overcorrection'' of the Class III skeletal malocclusion, even toward a Class II occlusal relationship, appears to be advisable, with the establishment of positive overbite and overjet relationships essential to the long-term stability of the treatment outcome.

On the other hand, the outcomes of MCH therapy for Class III malocclusion have been investigated less often. After classical studies on experimental animals,[13,14] the clinical use of the MCH in human patients[15–18] has shown that treatment of Class III patients with MCH for a period of 1 year produced a significant inhibition of mandibular growth, an increase of lower face height, and distalization of the lower molars. Recently, MCH therapy followed by fixed appliances proved to be an effective treatment for the correction of skeletal Class III malocclusion at postpubertal observation.[18] The favorable skeletal effects consisted mainly of smaller increases in mandibular length and advancement with respect to controls, with the final outcome a significant improvement in the sagittal skeletal and dental parameters. The MCH treatment protocol also induced a significant downward rotation of the mandible.

The purpose of the present cephalometric study was to compare the effectiveness of the RME/FM and MCH protocols when followed by fixed appliances and evaluated at a postpubertal observation in patients with dentoskeletal Class III malocclusion.

MATERIALS AND METHODS

The sample treated with the RME/FM followed by fixed appliances included 32 patients (12 boys and 20 girls). The sample treated with the MCH followed by fixed appliances included 26 patients (eight boys and 18 girls). The two treatment groups were composed of consecutive patients who satisfied the following inclusion criteria:

Caucasian ancestry;

Class III malocclusion at the time of the first observation (T_1) characterized by an anterior cross-bite or edge-to-edge incisal relationship and a Wits appraisal of −1.5 mm or less;

No permanent teeth congenitally missing or extracted before or during treatment;

Cephalograms of adequate quality available before the start of therapy (T_1) and at the time of long-term observation after the two-phase treatment (T_2);

Patients had to present with prepubertal skeletal maturation (stage 1, 2, or 3 in cervical vertebral maturation [CVM]) at the beginning of the first phase of treatment (T_1) and postpubertal skeletal maturation at the final observation (T_2) based on the CVM method of developmental staging (stage 4, 5, or 6 in CVM).[19]

Table 1. Demographics of the Study Groups[a]

	Mandibular Cervical Headgear Class III Group (n = 26; eight boys, 18 girls)		Rapid Maxillary Expander and Facemask Class III Group (n = 32, 12 boys, 20 girls)	
	Mean	SD	Mean	SD
Age				
T_1	10 y 3 mo	1 y 5 mo	9 y 7 mo	1 y 9 mo
T_2	15 y 4 mo	1 y 9 mo	15 y 2 mo	1 y 10 mo
Observation interval				
T_2-T_1	5 y 4 mo	1 y 7 mo	5 y 7 mo	1 y 11 mo

[a] SD indicates standard deviation; T_1, before treatment; and T_2, after the first phase of orthopedic therapy and the second phase of fixed appliances.

Lateral cephalograms for each patient were analyzed at the two observation periods. All linear measurements were standardized at an 8% enlargement factor. The mean ages of the treated group at T_1 and T_2 along with mean duration of observation interval are reported in Table 1.

Treatment Protocols

Rapid maxillary expander and facemask. The three components of the orthopedic FM therapy used in this study were a maxillary expansion appliance, an FM, and heavy elastics. Treatment was initiated with the placement of a bonded or banded maxillary expander with attached vestibular hooks extending in a superior and anterior direction. Patients were instructed to activate the expander one to two times per day until the desired transverse width was achieved.

Patients were given FMs with pads fitted to the chin and forehead for support either during or immediately after expansion. Elastics were attached from the soldered hooks on the expander to the support bar of the FM in a downward and forward vector, producing orthopedic force levels up to 300–500 g per side. Patients were instructed to wear the FM for a minimum of 14 hours per day. All patients were treated to a positive dental overjet before discontinuing treatment, and most patients were overcorrected toward a Class II occlusal relationship. As occurs in studies involving any removable device, compliance with the instructions of the orthodontist and staff varied among patients but was generally good. The duration of RME/FM treatment was about 1 year.

Mandibular cervical headgear. At the initial phase of the treatment protocol with the MCH, bands with soldered double buccal tubes were adapted on the lower first permanent molars. The inner arch of the headgear

Table 2. Statistical Comparison on Cephalometric Measures Between the Two Treated Class III Samples at the Time of First Observation (T_1)[a]

Cephalometric Measures	Mandibular Cervical Headgear Group at T_2 n = 26		Rapid Maxillary Expander and Facemask Group at T_1 n = 32		*t*-Test Significance
	Mean	SD	Mean	SD	
Cranial base					
Cranial flexure (°)	127.2	4.4	127.4	4.7	NS
Maxillary skeletal					
Co-PtA (mm)	81.0	4.9	82.6	4.2	NS
SNA (°)	80.5	3.8	80.4	3.8	NS
PtA to nasion perpendicular (mm)	−1.7	2.9	−1.2	2.7	NS
Mandibular skeletal					
Co-Gn (mm)	110.6	6.1	109.0	6.6	NS
SNB (°)	79.9	3.3	80.5	3.5	NS
Pg to nasion perpendicular (mm)	−2.8	4.2	−2.0	4.8	NS
Gonial angle (°)	133.4	4.5	130.4	5.4	*
Maxillary/mandibular					
Wits (mm)	−5.1	2.4	−5.2	1.9	NS
Maxillary/mandibular difference (mm)	26.9	2.2	26.4	4.1	NS
ANB (°)	0.5	2.5	0.2	1.8	NS
Vertical skeletal					
FH to palatal plane (°)	−0.8	2.5	0.7	3.5	NS
MPA (°)	27.7	4.4	26.4	4.2	NS
Nasion to ANS (mm)	48.6	3.6	47.8	3.9	NS
ANS to Me (mm)	62.8	4.1	60.8	4.7	NS
Interdental					
Overbite (mm)	0.5	1.6	0.5	1.6	NS
Overjet (mm)	−0.2	1.4	−1.3	2.0	NS
Interincisal angle (°)	131.0	9.8	132.4	10.2	NS
Molar relationship (mm)	3.6	1.1	4.0	1.9	NS
Maxillary dentoalveolar					
U1 to Frankfort (°)	115.0	6.2	112.5	6.6	NS
Mandibular dentoalveolar					
L1 to PtA Pg (mm)	2.9	2.3	3.1	1.8	NS
L1 to MPA (°)	86.8	6.8	89.8	7.8	NS
Soft tissue					
Nasolabial angle (°)	102.3	8.8	104.1	11.2	NS

[a] SD indicates standard deviation; NS, not significant; *$P < .05$.

was adapted with a bayonet stop, leaving the anterior part of the arch in front of the lips without interfering with lip seal. The external arch was adapted to the contour of the face of each patient for comfort, and the length of the bow was determined for each patient such that the line of action of the force passed through the center of resistance of the lower first permanent molar. At the first appointment the force delivered was 300 g per side, and it was checked at monthly appointments. All patients received instructions to use the appliance for 14 hours per day. The degree of collaboration was generally good for all patients. The duration of MCH therapy was approximately 2½ years.

Phase with fixed appliances. All patients in both treatment groups underwent a second phase of preadjusted edgewise therapy. The fixed appliance therapy lasted a mean of about 2 years. Patients who had worn the FM usually experienced an interim period between the end of the orthopedic treatment and the start of the fixed appliance therapy. During this period they wore retention plates. The MCH patients usually went into fixed appliance treatment right at the completion of the orthopedic phase. Class III elastics (and, in a few instances, Class II elastics) were used when appropriate to eliminate minor occlusal discrepancies. No extractions were made either before or during the appliance fixed phase.

Cephalometric analysis and method error. A customized digitization regimen and analysis was utilized for all the cephalograms that were examined in this study. The regimen contained measurements from the analyses of Jacobson,[20] and McNamara.[21]

Before carrying out the cephalometric analysis, the intraobserver variation was evaluated. Seven lateral cephalograms were selected from different patients included in the study and were traced and measured at two different times within a period of 1 week. In both instances the measurements obtained for each patient were analyzed through the intraclass coefficient correlation (ICC). The ICC oscillated between 0.966 for the SNB angle and 0.995 for the inclination of the upper incisor to the FH line. These values indicated a high level of intraobserver concordance.

As for the digitization and measurement error, the accuracy of linear measurements ranged from 0.1 mm to 0.3 mm with a standard deviation of approximately 0.8 mm. Angular measurements varied 0.1° with a standard deviation ranging from 0.4° to 0.6°.

Statistical Analysis

Descriptive statistics were calculated for all cephalometric measures at T_1 and T_2 for both treated groups. The data were analyzed with the Social Science Statistical Package Software (version 12.0, SPSS Inc, Chicago, Il). Statistical significance was tested at $P < .05$ and $P < .01$ levels.

An exploratory Shapiro Wilks test[22] was performed on all variables to test normality of the sample. The test was not significant, which indicated normality of distribution for the examined parameters and allowed for parametric statistics. Therefore, Student's *t*-tests were used for unpaired comparisons. The craniofacial starting forms at T_1 were compared in the two groups. The T_2-T_1 changes in the cephalometric variables between the two treatment groups were tested for significance as well. The homogeneity between the two

Table 3. Statistical Comparison of the T_2-T_1 Changes in the Cephalometric Measures Between the Two Treated Class III Samples[a]

	Mandibular Cervical Headgear Group T_2-T_1 Changes n = 26		Rapid Maxillary Expander and Facemask Group T_2-T_1 Changes n = 32		*t*-Test	
Cephalometric Measures	Mean	SD	Mean	SD	Difference	Significance
Cranial base						
Cranial flexure (°)	1.4	2.4	0.8	2.2	+0.6	NS
Maxillary skeletal						
Co-PtA (mm)	4.6	4.5	6.9	3.2	−2.3	*
SNA (°)	0.8	2.9	1.7	2.1	−0.8	NS
PtA to nasion perpendicular (mm)	0.6	2.4	1.6	1.7	+0.3	NS
Mandibular skeletal						
Co-Gn (mm)	8.7	4.9	11.6	5.4	−2.9	*
SNB (°)	−0.1	2.1	0.7	2.0	−0.8	NS
Pg to nasion perpendicular (mm)	0.6	3.7	2.9	4.0	−2.3	*
Gonial angle (°)	−0.5	2.2	−2.0	3.7	+1.5	NS
Maxillary/mandibular						
Wits (mm)	2.8	2.0	3.2	2.3	−0.4	NS
Maxillary/mandibular difference (mm)	3.8	3.2	5.6	4.5	−1.8	NS
ANB (°)	1.1	2.0	1.0	1.6	+0.1	NS
Vertical skeletal						
FH to palatal plane (°)	−0.2	2.1	−0.9	2.3	+0.7	NS
MPA (°)	0.2	2.8	−1.0	2.9	+1.2	NS
Nasion to ANS (mm)	3.8	3.3	4.7	3.6	−0.9	NS
ANS to Me (mm)	6.1	2.9	6.4	3.8	−0.3	NS
Interdental						
Overbite (mm)	1.0	1.5	0.7	1.4	+0.3	NS
Overjet (mm)	1.6	1.3	3.0	2.1	−1.4	*
Interincisal angle (°)	−4.4	7.2	−4.8	10.9	+0.4	NS
Molar relationship (mm)	−1.3	0.8	−0.5	0.9	−0.8	*
Maxillary dentoalveolar						
U1 to Frankfort (°)	2.4	4.4	6.8	6.4	−4.4	*
Mandibular dentoalveolar						
L1 to PtA Pg (mm)	0.1	1.8	−2.1	2.1	+2.2	**
L1 to MPA (°)	1.4	4.8	−1.8	6.4	+3.2	*
Soft tissue						
Nasolabial angle (°)	−0.4	7.2	−2.4	8.2	+2.0	NS

[a] SD indicates standard deviation; NS, not significant; *$P < .05$; **$P < .01$.

treated groups (as to type of malocclusion, skeletal maturation at both time points, mean ages at each observation time, gender distribution, and mean duration of observation intervals) allowed for comparison of the groups without annualizing the data.

RESULTS

No significant differences were found between the RME/FM group and the MCH group at the time of the first observation (T_1) with the exception of the gonial angle, which was significantly larger in the MCH group (Table 2).

The statistical analysis of the T_2-T_1 changes in the two treatment groups revealed several significant differences (Table 3). Midfacial length (Co-PtA), mandibular length (Co-Gn), and the sagittal position of the chin (Pg to nasion perpendicular) all showed significantly smaller increases in the MCH group than in the RME/FM group. The amount of increase in overjet was also significantly smaller in the MCH group, whereas the amount of molar correction was greater. The upper incisors were significantly less proclined and the lower incisors were significantly less retroclined in the MCH group when compared with the RME/FM group.

DISCUSSION

The present study was aimed at comparing two orthopedic treatment approaches to Class III malocclusion in the growing patient that have been demonstrated effective in previous research in the literature: the RME/FM protocol and the MCH protocol. Features of the current investigation were the inclusion of a second phase of treatment with fixed appliances in the observation period for both treatment protocols and the appraisal of skeletal maturation at the beginning of

therapy and at the long-term observation (postpubertal for all patients in both groups).

The results of the present study showed that the RME/FM protocol was able to induce a more effective enhancement of maxillary growth. A significant 2.3-mm difference in the change in midfacial length was found between the two treatment groups. This favorable outcome in the RME/FM patients, however, was not associated with a significant improvement of the sagittal position of the maxilla when measured by the SNA or PtA to nasion perpendicular.

On the other hand, the MCH protocol appeared to be significantly more effective in controlling the amount of mandibular growth. A significant net difference of almost 3 mm was assessed between the two treatment approaches in favor of the MCH protocol. These findings are in agreement with previous data[1,2,7–10,15–18] and they directly reflect the mode of action of the two different orthopedic appliances. The RME/FM exerted primarily posteroanterior forces on the maxilla, and the MCH delivered anteroposterior forces to the mandibular region through the mandibular dentition. Some definite indications for treatment of Class III malocclusion can be derived from these two different outcomes. The use of the RME/FM has to be preferred in patients with a Class III malocclusion associated with maxillary retrusion, whereas the MCH is a viable treatment option in patients with Class III malocclusion attributed to mandibular prognathism.

The evaluation of maxillary and mandibular measures revealed the lack of a substantial difference between the two treatment approaches regarding the effectiveness on the overall sagittal skeletal relationships of treated patients at a postpubertal observation. The two treatment protocols were also similar as to the response of the craniofacial structures in the vertical dimension. A slight increase in the mandibular plane angle was assessed in the MCH group with respect to the RME/FM group (1.2°). This difference, however, was not statistically significant. When compared with untreated Class III samples in previous studies,[10,18] a significant opening of the mandibular plane angle was apparent after MCH therapy, whereas the RME/FM did not modify the vertical skeletal relationships significantly.

At the dentoalveolar level, the changes in both the overjet and the molar relation showed statistically significant differences between the two treatment groups, though the absolute value of these differences was limited (1.4 mm for the overjet, 0.8 mm for the molar relation). The improvement in the overjet was greater in the RME/FM sample, whereas the improvement in the molar relation was greater in the MCH sample. This latter difference can be explained by the fact that bands on the lower molars constitute the attachment of the MCH to the dentition. Therefore, a direct effect of distal movement of the lower molars during the MCH therapy was expected.

As for the changes in the overjet, the different modifications produced by the two treatment protocols in the inclination of the incisors need to be taken into consideration. RME/FM treatment followed by fixed appliances induced significantly greater amounts of both proclination of the upper incisors and retroclination of the lower incisors when compared with the MCH protocol. The MCH followed by fixed appliances left the upper and lower incisor positions relatively unchanged from T_1 to T_2, thus achieving the final clinical improvement of the malocclusion without the need for significant dentoalveolar compensation in the anterior portion of the occlusion.

A previous investigation by Battagel and Orton[16] compared a group of Class III patients treated with a MCH and a group of Class III patients treated with a customized FM (without the use of RME). The authors did not include a phase II treatment in their investigation, and their final observation was at a mean age of 14.5 years for the MCH group and 12.9 years for the FM group. No postpubertal observation was included in the study. In their short-term study, Battagel and Orton[16] reported results similar to the findings of the current investigation, with a forward development of the maxilla and labial movement of the upper incisors seen only in the FM group. Increases in mandibular length (measured as Ar-Pg) were smaller in the MCH group, though not at a significant level. The counterclockwise rotation of the mandible that the authors described in both treatment groups was found only in the RME/FM group of the present investigation.

From a clinical point of view it should be noted that the duration of wear is different for the two appliances examined here. Whereas the RME/FM appliances are worn for approximately 1 year, the MCH requires at least 2 years to produce the orthopedic correction of the disharmony. However, this difference in efficiency of the appliances is compensated by the fact that the RME/FM therapy usually has to be followed by an interim period with removable plates as retention appliances before fixed appliances, whereas patients treated with the MCH are able to start fixed appliance therapy during the use of the MCH.[23]

CONCLUSIONS

- The RME/FM protocol produces a greater enhancement of maxillary growth, whereas increases in mandibular length are smaller in patients treated with the MCH protocol.
- The RME/FM protocol leads to a greater improvement in the overjet. However, this is achieved by

means of a greater degree of proclination of the upper incisors and retroclination of the lower incisors.

REFERENCES

1. Ngan P, Hagg U, Yiu C, Wei H. Treatment response and long-term dentofacial adaptations to maxillary expansion and protraction. *Semin Orthod.* 1997;3:255–264.
2. Williams MD, Sarver DM, Sadowsky PL, Bradley E. Combined rapid maxillary expansion and protraction facemask in the treatment of Class III malocclusion in growing children: a prospective study. *Semin Orthod.* 1997;3:265–274.
3. Nartallo-Turley PE, Turley PK. Cephalometric effects of combined palatal expansion and facemask therapy on Class III malocclusion. *Angle Orthod.* 1998;68:217–224.
4. Macdonald KE, Kapust AJ, Turley PK. Cephalometric changes after correction of Class III malocclusion with maxillary expansion/facemask therapy. *Am J Orthod Dentofacial Orthop.* 1999;116:13–24.
5. Saadia M, Torres E. Sagittal changes after maxillary protraction with expansion in Class III patients in the primary, mixed, and late mixed dentitions: a longitudinal retrospective study. *Am J Orthod Dentofacial Orthop.* 2000;117:669–680.
6. Yuksel S, Ucem TT, Keykubat A. Early and late facemask therapy. *Eur J Orthod.* 2001;23:559–568.
7. Baccetti T, McGill JS, Franchi L, McNamara JA Jr, Tollaro I. Skeletal effects of early treatment of Class III malocclusion with maxillary expansion and face-mask therapy. *Am J Orthod Dentofacial Orthop.* 1998;113:333–343.
8. Kapust AJ, Sinclair PM, Turley PK. Cephalometric effects of face mask/expansion therapy in Class III children: a comparison of three age groups. *Am J Orthod Dentofacial Orthop.* 1998;113:204–212.
9. Baccetti T, Franchi L, McNamara JA Jr. Treatment and posttreatment craniofacial changes after rapid maxillary expansion and facemask therapy. *Am J Orthod Dentofacial Orthop.* 2000;118:404–413.
10. Shanker S, Ngan P, Wade D, et al. Cephalometric A point changes during and after maxillary protraction and expansion. *Am J Orthod Dentofacial Orthop.* 1996;110:423–430.
11. Gallagher RW, Miranda F, Buschang PH. Maxillary protraction: treatment and posttreatment effects. *Am J Orthod Dentofacial Orthop.* 1998;113:612–619.
12. Westwood PV, McNamara JA Jr, Baccetti T, Franchi L, Sarver DM. Long-term effects of Class III treatment with RME and facemask therapy followed by fixed appliances. *Am J Orthod Dentofacial Orthop.* 2003;123:306–320.
13. Janzen EK, Bluher JA. The cephalometric, anatomic and histological changes in *Macaca mulatta* after application of a continuous-acting retraction force on the mandible. *Am J Orthod.* 1965;51:823–855.
14. Joho JP. The effects of extraoral low-pull traction to the mandibular dentition of *Macaca mulatta*. *Am J Orthod.* 1973; 64:555–577.
15. Orton HS, Sullivan PG, Battagel JM. The management of Class III and Class III tendency occlusions using headgear to the mandibular dentition. *Br J Orthod.* 1983;10:2–12.
16. Battagel JM, Orton HS. Class III malocclusion: the post-retention findings following a non-extraction treatment. *Eur J Orthod.* 1993;15:45–55.
17. Battagel JM, Orton HS. A comparative study of the effects of customized facemask therapy or headgear to the lower arch on the developing Class III face. *Eur J Orthod.* 1995; 17:467–482.
18. Rey D, Oberti G, Angel D, Baccetti T. Treatment and post-treatment effects of mandibular cervical headgear followed by fixed appliances in Class III malocclusion. *Am J Orthod Dentofacial Orthop.* In press.
19. Baccetti T, Franchi L, McNamara JA Jr. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod.* 2005;11:119–129.
20. Jacobson A. Application of the ''Wits'' appraisal. *Am J Orthod.* 1976;70:179–189.
21. McNamara JA Jr. A method of cephalometric evaluation. *Am J Orthod.* 1984;86:449–469.
22. Sheats RD, Shane Pankratz V. Understanding distributions and data types. *Semin Orthod.* 2002;8:62–66.
23. Rey D, Aristizabal JF, Oberti G, Angel D. Mandibular cervical headgear in orthopedic and orthodontic treatment of Class III cases. *World J Orthod.* 2006;7:165–176.