Effects of maxillary protraction with or without expansion on the sagittal pharyngeal dimensions in Class III subjects

Manuela Mucedero, Tiziano Baccetti, Lorenzo Franchi, and Paola Cozza
Rome and Florence, Italy

Introduction: The aim of this cephalometric study was to analyze the effects of rapid maxillary expansion (RME) and facemask (FM), or FM combined with bite block (BB), on the sagittal pharyngeal dimensions in subjects with Class III malocclusion when compared with an untreated Class III control group. Methods: Thirty-nine subjects (22 girls, 17 boys) were divided into 2 groups: the FM/BB group (22 subjects; mean ages, 8.9 years ± 1.5 before treatment and 10.5 years ± 1.3 after treatment) and the RME/FM group (17 subjects; mean ages, 7.1 years ± 1.8 before treatment and 9.2 years ± 1.8 after treatment). The treated groups were compared with an untreated Class III control group of 20 subjects (mean ages, 8.1 years ± 1.2 at the first observation and 10 years ± 1.7 at the second observation). All subjects were at prepubertal stage of skeletal maturity at both times. Comparisons of these changes between the 3 groups were analyzed with the Kruskal-Wallis 1-way analysis of variance (ANOVA) on ranks with post-hoc tests. Results: The favorable skeletal maxillary and mandibular changes produced by maxillary protraction with or without RME were not associated with significant changes in the sagittal oropharyngeal and nasopharyngeal airway dimensions. Conclusions: Orthopedic treatment of Class III malocclusion does not produce a significant increase in airway dimensions in the short term. (Am J Orthod Dentofacial Orthop 2009;135:777-81)

A abundant literature shows that maxillary protraction appliances (facemask [FM]) with or without rapid maxillary expansion (RME) produce favorable changes in Class III malocclusions by anterior displacement of the maxilla and downward or backward redirection of mandibular growth.1 A skeletal change that can occur from orthopedic treatment of Class III malocclusion is the alteration of the size of airway.2-5 Significant changes of both oral and nasopharyngeal dimensions have been reported after FM therapy,4,5 although Hiyama et al2 did not assess significant changes in the airway dimensions, and Sayinsu et al3 found significant changes only for nasopharyngeal size. Hiyama et al2 and Oktay and Ulukaya3 treated Class III patients with maxillary protraction only, whereas the others3,4 used FM combined with RME. Only 1 short-term study included a control group of untreated Class III subjects.4

The aim of this investigation was to analyze the effects of RME and FM, or FM combined with bite block (BB), on the nasopharyngeal and oropharyngeal sagittal airway dimensions in subjects with dentoalveolar Class III malocclusions compared with an untreated Class III control group.

MATERIAL AND METHODS

The treated group comprised 39 subjects (22 girls, 17 boys) with Class III malocclusion divided into 2 groups according to the following treatment protocols.

1. The FM/BB group consisted of 22 subjects (12 girls, 10 boys) who were treated consecutively with FM combined with a mandibular removable BB appliance at the Department of Orthodontics of the University of Rome Tor Vergata, Italy.

2. The RME/FM group included 17 subjects (10 girls, 7 boys) who were treated consecutively with a bonded acrylic splint RME followed by FM therapy at the Department of Orthodontics of the University of Florence, Italy.

Lateral cephalograms were taken before treatment (T1) and at the end of active treatment (T2). The average ages were 8.9 years ± 1.5 years at T1 and 10.5 years ± 1.7 years at T2.

References


The mean ages were 7.1 years ± 1.8 years at T1 and 9.2 years ± 1.8 years at T2 in the RME/FM group. At T1, all patients had Class III malocclusion in the mixed dentition characterized by a Wits appraisal of /C0 – 2 mm or less, anterior crossbite, or incisor end-to-end relationship, and Class III molar relationship.

In the FM/BB group, the patients were instructed to wear the FM at least 14 hours per day. The FM was attached to a double-arch structure cemented to the maxillary first molars. During FM treatment in the FM/BB group, a removable BB appliance was used full time to counteract any tendency toward clockwise mandibular rotation.

In the RME/FM group, a bonded acrylic splint RME was activated until overcorrection of the transverse relationships before maxillary protraction therapy. This group did not wear a mandibular BB appliance.

All patients in both groups were treated at least to a positive dental overjet before discontinuing treatment; most patients were overcorrected toward a Class II occlusal relationship. Forces of 600 g for each side were used during protraction therapy. Cooperation was good for all patients. The T1 to T2 interval comprised active therapy followed by 6 to 9 months of post-treatment with a Hawley retainer at the maxillary arch.

The treated groups were compared with an untreated group of 20 subjects (8 girls, 12 boys) with Class III malocclusion selected from the Department of Orthodontics of the University of Florence. The average ages were 8.1 years ± 1.2 years at T1 and 10 years ± 1.7 years at T2.

All treated and control subjects were at a prepubertal stage of skeletal maturity (CS 1 or CS 2) at both T1 and at T2.

Lateral cephalograms for each subject in all groups at T1 and T2 were taken by using a standardized protocol, with an 8% magnification factor. All cephalograms were hand traced by 1 investigator (M.M.), and the landmarks were verified by a second (P.C.). Four sagittal measures (Co-A, A to nasion perpendicular, Co-Gn, and Pg to nasion perpendicular) and 1 vertical measurement (palatal plane to mandibular plane angle) were used to assess the maxillary and mandibular skeletal changes. Specific variables to evaluate the sagittal nasopharyngeal and oropharyngeal airway dimensions were chosen according to the definitions of McNamara and Martin et al (Fig and Table I).

The method error for all cephalometric variables was assessed on 20 sets of repeated measurements.

---

**Table I. Definitions for the cephalometric measurements of the airways**

<table>
<thead>
<tr>
<th>Cephalometric measurement</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PNS-AD1</td>
<td>Lower airway thickness; distance between PNS and the nearest adenoid tissue measured through the PNS-Ba line (AD1)</td>
</tr>
<tr>
<td>2. AD1-Ba</td>
<td>Lower adenoid thickness; defined as the soft-tissue thickness at the posterior nasopharynx wall through the PNS-Ba line</td>
</tr>
<tr>
<td>3. PNS-AD2</td>
<td>Upper airway thickness; distance between PNS and the nearest adenoid tissue measured through a perpendicular line to S-Ba from PNS (AD2)</td>
</tr>
<tr>
<td>4. AD2-H</td>
<td>Upper adenoid thickness; defined as the soft-tissue thickness at the posterior nasopharynx wall through the PNS-H line (H, hormion, point located at the intersection between the perpendicular line to S-Ba from PNS and the cranial base)</td>
</tr>
<tr>
<td>5. PNS-Ba</td>
<td>Total lower sagittal depth of the bony nasopharynx</td>
</tr>
<tr>
<td>6. Ptm-Ba</td>
<td>Posterior sagittal depth of the bony nasopharynx</td>
</tr>
<tr>
<td>7. PNS-H</td>
<td>Total upper airway thickness</td>
</tr>
<tr>
<td>8. McNamara’s upper pharynx dimension</td>
<td>Minimum distance between the upper soft palate and the nearest point on the posterior pharynx wall</td>
</tr>
<tr>
<td>9. McNamara’s lower pharynx dimension</td>
<td>Minimum distance between the point where the posterior tongue contour crosses the mandible and the nearest point on the posterior pharynx wall</td>
</tr>
</tbody>
</table>
The errors were 0.1 to 0.3 mm for linear measurements and 0.2° to 0.4° for angular measurements.

**Statistical analysis**

Descriptive statistics were calculated for all cephalometric measures in the 3 groups at T1 and for the T1 to T2 changes. The craniofacial starting forms at T1 between the 2 treated groups and the control group were compared. The T1 to T2 changes in the FM/BB treatment group were compared with those in the RME/FM treatment group and in the Class III control group. All statistical comparisons were carried out with Kruskal-Wallis 1-way ANOVA on ranks with the
RESULTS

No significant differences between the 2 treated groups and the control group at T1 for the airway measurements and for any craniofacial variable were found (Table II). The FM/BB and RME/BB groups both showed statistically significant advancements of the maxilla when compared with the untreated controls (Point A to nasion perpendicular, +2.0 and +1.7 mm, respectively) (Table III). Treatment also induced favorable (but not statistically significant) mandibular skeletal changes: the FM/BB and RME/BB groups both had decreases in mandibular protrusion (Pg to nasion perpendicular, −2.3 mm) associated with a smaller amount of mandibular growth (Co-Gn, −1.2 and −1.9 mm, respectively) compared with the untreated controls. The FM/BB group showed a statistically significant increase in the inclination of the palatal plane to the mandibular plane with respect to the controls. No statistically significant changes were found for any variables describing the sagittal nasopharyngeal and oropharyngeal airway dimensions.

DISCUSSION

We analyzed the changes in the sagittal oropharyngeal and nasopharyngeal airway dimensions after orthopedic therapy of Class III malocclusion with FM with or without RME. A group of 20 children with untreated Class III malocclusions was used as a longitudinal control sample.

These results showed that the favorable skeletal maxillary and mandibular changes after orthopedic treatment were not associated with significant changes in the sagittal oropharyngeal and nasopharyngeal airway dimensions when comparing either the FM/BB or the RME/FM group with the untreated control group. No significant differences in the sagittal airway dimensions were found between the 2 treated groups either. These findings differ from those of Sayinsu et al,3 who found significant changes in the nasopharyngeal airway dimensions, and from those of Kilinci et al4 and Oktay and Ulukaya,5 who reported significant effects on the oropharyngeal and nasopharyngeal airway dimensions of FM therapy with or without RME. Our results agree with those of Hiyama et al2 (FM only) and Sayinsu et al3 (RME and FM), who found no statistically significant increments in the oropharyngeal airway dimensions. The study with untreated controls of Kilinci et al4 was short term (observation interval, 9 months), whereas we had a longer observation period (including a 6-9 month posttreatment period) in our investigation.

When analyzing the effects of orthopedic therapy on airway modifications, one should consider the physiological changes in the lymphoid tissue on the posterior pharyngeal wall. Handelman and Osborne10 reported that, during the preschool years, the adenoid area increases more than the bony nasopharyngeal area, resulting in restriction of the air space. Linder-Aronson and Leighton11 analyzed the development of the posterior nasopharyngeal wall between 3 and 16 years of age and found that the size of the soft tissues was greater at age 5 years; thereafter, a decrease occurred from 6 to 10 years. In agreement with this physiological growth pattern of the oronasal lymphoid tissue, our results showed a decrease of the lymphoid tissue on the posterior pharyngeal wall (AD1-Ba) in all 3 groups of Class III subjects. Even when considering this decrease of pharyngeal lymphoid tissue between 7 and 10 years (an age interval similar to that investigated here), therapeutic intervention with either protocol could not produce a significant increase in the airway dimensions.

The modifications in the sagittal airway dimensions induced by therapy or physiological growth showed great interindividual variability in subjects with Class III malocclusion, as indicated by the relatively high standard deviations of the cephalometric findings. In terms of changes in the dimension of the upper pharynx, for example, approximately one third of the subjects in all 3 groups had a net increase greater than 3 mm (up to 11 mm), one third had an increase between 0 and 3 mm, and one third had a decrease (between −0.2 and −6.5 mm).

CONCLUSIONS

Our findings demonstrated that no significant changes for the oropharyngeal and nasopharyngeal sagittal airway dimensions were induced by maxillary protraction with or without RME when compared with subjects with untreated Class III malocclusions.

REFERENCES