A prospective study of the treatment effects of a removable appliance with palatal crib combined with high-pull chincup therapy in anterior open-bite patients

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Introduction: The aim of this prospective clinical study was to cephalometrically investigate the dentoalveolar and skeletal changes produced by a removable appliance with palatal crib associated with high-pull chincup therapy in children with Angle Class I anterior open-bite malocclusions. Methods: Thirty children with initial mean age of 8.61 years and mean anterior open bite of 4.01 mm were treated with removable appliances with palatal crib associated with chincup therapy for 12 months. A control group of 30 subjects with initial mean age of 8.33 years and mean anterior open bite of 3.95 mm with the same malocclusion was followed for 12 months for comparison. Results: The removable appliance with palatal crib combined with vertical chincup did not yield significant changes in maxillary and mandibular skeletal components, maxillomandibular relationship, or vertical facial pattern. Overall, effects in the treated group were exclusively dentoalveolar. Open bite in the treatment group showed a mean closure of 5.01 mm (SD ± 1.73). Conclusions: The association of high-pull chincup therapy with a removable appliance and palatal crib provided no positive skeletal influence on the vertical facial pattern of patients treated for open bite in the mixed dentition. (Am J Orthod Dentofacial Orthop 2006;129:418-23)

Anterior open bite is defined as a negative overbite between the incisal edges of the maxillary and mandibular teeth with the posterior teeth in occlusion.1,2,3 This malocclusion affects nearly 16% of North American blacks and 4% of whites.4 Some authors state that the percentages of this type of malocclusion tend to increase during adolescence.1,4,6 Many authors emphasize that a skeletal open bite should be treated early in the mixed dentition.5,7,8 Chincup therapy is indicated by some authors for vertical control of the anterior open bite.9,10,14 No study associating the chincup with a removable palatal crib was found. To our knowledge, only 1 study compared 2 homogeneous groups with anterior open bite treated early with removable functional appliances.15 The purpose of this prospective clinical study was to cephalometrically analyze the dentoalveolar and skeletal changes of a removable appliance with palatal crib associated with high-pull chincup therapy in children with anterior open bites treated for 12 months.

MATERIAL AND METHODS
The control group comprised 30 untreated Class I children with an initial mean anterior open bite of 3.95 mm. The treated sample comprised 30 Class I children with an initial mean anterior open bite of 4.01 mm. They were treated with removable appliances with palatal crib associated with high-pull chincup therapy Table I. The initial mean cephalometric characteristics of both groups are shown in Table II. The subjects were consecutively selected according to the following criteria: children aged 7 to 10 years with Angle Class I anterior open bite malocclusions (>1.00 mm), and no tooth agenesis, lost permanent teeth, crowding, maxillary constriction, or posterior crossbites. Oral habits
were not studied. The mean cervical vertebrae matura-
tion stage for all groups at T1 was stage 1. The
removable appliance used has been described previ-
ously by Almeida et al. A high-pull chincup delivering 450-550 g of force per side was used. The patients
were instructed to wear the appliances 14 to 16 hours a
day for a 12 months.

The reference points and measurements are shown
in Figures 1 and 2. To evaluate the data distribution, the
data were analyzed with the Kolmogorov-Smirnov test.
In considering a normal distribution of the data, a
paired $t$ test was used to examine sexual dimorphism
and between-group differences of pretreatment mor-
phology. The results show no evidence of intragroup
sexual dimorphism between the boys and the girls in
the groups. Furthermore, no statistically significant
differences between the initial values of both groups
were detected. Comparison of pretreatment and post-
treatment changes over time between the groups was
accomplished with a paired $t$ test and the Mann-Whitney
U test. Twenty cephalograms of the 2 groups were
randomly selected and remeasured by the same inves-
tigator (F.P.) 1 month later. Random error was calcu-
lated with Dahlberg’s formula. The systematic error
was detected by comparison of measurements by the
paired $t$ test. The systematic error was significant for
only 2 measurements: Ar.GoMe and L6-GoMe. Random
measurement error did not exceed 1.47° and 1.02 mm for
angular and linear measurements, respectively.

RESULTS

Figure 3 shows the mean cephalometric tracings of
the 2 groups at pretreatment and posttreatment, respec-
tively. Table III shows the differences between initial
and final mean cephalometric changes of the groups.
There were no significant differences in the sagittal and
vertical skeletal changes between the groups. The mean
overbite was improved from $-4.01$ to $1.02$ mm with a
mean increase of $5.01$ mm in the treated group, but
overbite remained negative with a mean increase of
$1.38$ mm in the control group. The inclination of the
maxillary incisors remained almost constant during the
study period, increasing an average of only $0.08°$ and
$0.70$ mm in the control group. However, in the treated
group, retrusion of the maxillary incisors was $6.77°$ and
$0.63$ mm. The improvement in axial inclination of the
maxillary incisors was found to be statistically signifi-
cant in the treated group. Interestingly, the control
group had nearly $0.80$ mm of extrusion or vertical
development of the maxillary incisors compared with
almost $2.98$ mm in the treated group. The maxillary first
molars in both groups maintained their positions rela-
tive to the palatal planes. However, the mean incremen-
tal increase of maxillary posterior dentoalveolar height
in the treated group (0.78 mm) was much more pro-
nounced than in the control group (0.14 mm). Also, the
maxillary molars moved mesially a similar amount in
both groups. The inclination of the mandibular incisors
remained essentially unchanged during the study pe-
riod, increasing an average of only $0.08°$ and
$0.70$ mm in the control group. However, in the treated
group, retrusion of the mandibular incisors was $3.17°$ and
$0.33$ mm. This lingual axial inclination of the mandib-
ular incisors was found to be statistically significant in
the treated group. The extrusion of the mandibular
incisors was only $1.14$ mm in the control group,
compared with 2.22 mm in the treated group. The maxillary and mandibular molars, in both vertical and sagittal directions, had similar changes in the 2 groups.

DISCUSSION

In this prospective clinical study, we found no statistically significant differences between the 2 groups in maxillary and mandibular skeletal components, maxillomandibular relationships, and the ratio of upper to lower anterior facial height. The protocol of treatment with a removable plate with palatal crib combined with high-pull chincup therapy did not yield favorable skeletal control of the vertical facial height. Similar results were achieved by Sankey et al,6 who investigated whether the high-pull chincup with a bonded palatal expander can yield favorable skeletal effects. Surprisingly, patients who were treated with the chincup did not differ from those who were not. Contrasting with our investigation, Erbay et al15 found that the spontaneous downward and backward growth direction of the mandible was changed to an upward and forward direction by therapy with the Fränkel function regulator. İscan et al14 found that the vertical chincap is effective in treating skeletal open bite and decreasing the gonial angle.

There was a significant change in the treated group’s overbite with a mean increase of 5.01 mm. Open bite was corrected in 24 of the 30 treated subjects. Proba-
bly, the failure of overbite correction in the 6 subjects was attributable to their higher values (from $-4.60$ to $-7.60$ mm), yet the remaining overbite ranged from $-0.40$ to $-1.20$ mm. Similarly, in the results of Erbay et al,15 the treated group had a mean overbite of $-3.95$ mm, which increased to 1.1 mm, whereas the mean overbite closure in the control group was approximately 1.4 mm. The maxillary and mandibular incisors in the treated group were retruded and extruded, as in other studies.6,7,13,17,18 This fact played a major role in correcting the open bite patients in our study and is also associated with the effectiveness of the removable plate with palatal crib, by elimination of the tongue contact, clinical improvement in lip posture, and active action of the labial archwire on the maxillary incisors.18

In our study, of the 30 subjects in the control group, 4 had spontaneous correction of the anterior open bite. The mean overbite increase in the control group was 1.38 mm. This finding might be because of the smaller overbite of these patients at pretreatment (from $-1.00$ to $-1.90$ mm) and a more favorable facial growth pattern (MPA of 27.2° to 37.8°).

Interestingly, in the treated group, the maxillary molars showed slightly greater extrusion (0.78 mm) compared with the controls (0.14 mm). Different results have been shown in previous studies.6,13 For example, Sankey et al6 found 1.00 mm of maxillary molar intrusion in their treated sample. Ritucci and Nanda,13 evaluating the changes with the chin cup, observed that the maxillary and mandibular molars moved mesially, yet without extrusion. Our treated sample showed only 0.80 mm of mandibular molar eruption; this was not significantly different from the control group (0.68 mm) and compares well with previous descriptions of Sankey et al.6 Conversely, Pearson12 found an absolute intrusion of the mandibular molars with the vertical-pull chin cup.

The early treatment protocol under study provided no orthopedic effect on skeletal components. However, there were wide ranges of open bites and MPA angle values in both groups; these could have biased the results. Further studies should be conducted to analyze whether the use of this treatment protocol for a longer time would have a significant skeletal effect in patients with anterior open bite. Other studies should also evaluate long-term stability and the influence of oral habits and patient compliance with this approach.

CONCLUSIONS

Based on the results of this study, the palatal crib associated with the vertical chin cup did not produce significant changes on the skeletal maxillary and mandibular components. The effects of this therapy were primarily dentoalveolar. The mean spontaneous closure of anterior open bite in the control group was
1.38 mm, which was enough for overbite reduction in only 4 (13%) of the 30 subjects. On the other hand, the protocol used for the treated group showed closure of the anterior open bite of 5.01 mm, which allowed overbite correction in 24 (80%) of the 30 subjects.16

**REFERENCES**


Table III. Differences between control and treated groups

<table>
<thead>
<tr>
<th>Cephalometric measurements</th>
<th>Control group</th>
<th>Treated group</th>
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X, Mean change; NS, not significant.

*P < .01.

See Fig 2 for definitions.