Early Treatment of Skeletal Open Bite with Spring-loaded Bite Blocks and Vertical Pull Chin Cup (Soft tissue analysis)

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INTRODUCTION

Improvement of imbalanced facial soft tissue that accompanies open bite malocclusions of skeletal pattern is psychologically important for growing children to promote their self-confidence. Patient's parents think that teeth are imperative for the total facial esthetics (Trulsson, et al., 2002) and society's acceptance (Klages, et al., 2004).

Face disharmony in the vertical dimension, including skeletal openbite, is challenging to orthodontists (Janson, et al., 2003) because it requires successful treatment mechanics to ensure long-term stability after treatment. (Nemeth RB and Isaacsan RJ. 1974 and (Nielsen H, 1991). The difficulty of such malocclusion is attributed to its etiology which is clearly unknown but it's argued that the causative factors are genetic and environmental frequently present (Torres, et al. 2006), (Huang, et al. 1990) and (Insolf, et al., 1996).

Facial soft tissue in patients with skeletal openbite are distinguished by a group of morphologic characteristics including long inferior face height, incompetent lips with decrease in their lengths and decrease in thickness of upper lip, large interlabial gap and decrease in both nasolabial and mentolabial angles.

ABSTRACT

Background: The skeletal open bite malocclusion affects the facial esthetics of individuals because its disturbances in the skeletal and dentoalveolar structures will be always reflected on the soft tissue of the face including facial height, lips, chin position and relation of the nose to the lips. Therefore, this type of malocclusion is favorable to be treated as early as possible to enhance the facial soft tissue of the children and improve their self-esteem. Objective: the purpose of the present study was to evaluate the soft tissue improvement associated with the early treatment of skeletal openbite with spring-loaded bite blocks and vertical pull chin cup. Methods: The sample comprised of fifteen female patients aged 8-12 years with skeletal open bite were selected to be treated with spring-loaded bite blocks and vertical pull chin cup for 12 months. The patients wore the same appliances for additional 3 months as a retention. Lateral cephalometric radiographs were taken pre and post treatment to evaluate the soft tissue changes after open bite correction. Results: The results showed a significant change in the facial profile of the patients which accompanied the underlying dentooskeletal changes that were achieved due to closure of the bite. The primary changes were related to the lips where significant decreases in the Interlabial gap and upper lip-E line as well as significant increases in the lower lip length and nasolabial angle were obtained. Conclusion: The Spring loaded bite blocks combined with the vertical pull chin cup could effectively improve the facial soft tissue harmony through closing the bite of children in the mixed dentition period with less chair time and simple treatment mechanics.
The early open bite treatment in the mixed dentition period is favorable as it allows redirecting the growth of craniofacial structures and reduces the likelihood of more aggressive approach in the future and accordingly Orthodontists have used several treatment alternatives to correct anterior open bite and improve facial esthetics of growing children such as high-pull head gear, functional appliances, bite blocks, vertical pull chin cup or any combination of these. (Sankey et al., 2000).

Posterior bite blocks have been effectively used to resume facial harmony in patients with skeletal open bite (Altuna, G. and D. G. Woodside, 1985), (Darendeliler, M. A. et al, 1995) and (Dellinger, E. L. 1986), (Iscan et al., 1992).

Although aesthetics plays an important role in modern society and people have come to understand the contribution of well aligned teeth to beauty of face, the overall effect of skeletal open bite treatment on soft tissue improvement is still controversial according to the few reports in the literature. Taking this into consideration, the purpose of this work was to document the soft tissue changes that associated early treatment of skeletal open bite with spring-loaded bite block and vertical pull chin cup.

MATERIALS AND METHODS

Sample:
The study sample consisted of fifteen female patients in the mixed dentition period. They were selected from the patients presented to the clinic of Orthodontics Department, Faculty of dentistry, Mansoura University, Egypt according to the following criteria:
- Ages ranging from 8-12 years
- Skeletal open bite class I with SNGoGn angle > 35°.
- Presence of all permanent incisors.
- Patients with or without oral habits.
- No previous or concurrent orthodontic treatment.
- No history of systemic diseases or craniofacial anomalies.

The patients' parents were informed in detail about the aim of this study and that their children would be treated for 12 months. The investigator also let them know their right to refuse or stop participation at any time and accordingly the parents signed an arabic consent form to participate in this work.

Records:
For all patients the following records were taken before and after 12 months of treatment:
1. Case history and clinical examination.
2. Hand wrist radiograph (before treatment) for patients above 10 years to ensure that they didn't pass the pubertal growth spurt.
3. Upper and lower study models.
4. Photographs: a set of extraoral photographs were taken including frontal at rest, frontal at smiling and profile and another set of intraoral radiograph were taken including frontal .right and left in centric occlusion.
5. Lateral cephalometric radiographs to obtain points, lines and planes to calculate both soft tissue linear and angular measurements for the proper diagnosis and evaluation of soft tissue changes. These radiographs were hand traced by the same investigator before and after treatment on 8 x 10 translucent tracing paper over an illuminated view box using 0.5mm lead pencil.

Soft tissue points, linear and angular measurements that were used in this study are shown in Fig. (1) and table (1).

Patient preparation:
Patients were treated with spring-loaded bite blocks combined to vertical pull chin cup .This treatment was carried out by one examiner R. A. Upper and lower impressions were taken for every patient using orthodontic trays and silicon impression material, then the impressions were then poured with orthodontic stone type III to obtain the upper and lower casts which were formed and trimmed according to orthodontic standards. Next patient bite was registered in such a way that the mandible was hinged 2mm beyond the rest position in a centric relation using a red wax wafer which was used later to orient the upper and lower working casts on a simple hinge articulator for fabrication of spring loaded bite blocks appliance.

Design of Spring-Loaded Bite Blocks (SLBB):
The appliance has two acrylic portions: a mandibular lingual plate with occlusal coverage and maxillary bite-block overlies the mandibular plate.
The acrylic plate is extended incisally to the cingulae of the incisors to prevent their supraeruption.
The maxillary bite-block is extended from lower first premolar and first primary molar area to the upper last erupted molar.

These two acrylic portion are connected together by 2 helical springs (buccal and lingual) made from 0.9-mm stainless steel wire.

The spring is located with the helices facing the first premolar or Primary 1st molar.

The inferior end of the buccal spring is soldered to the Adams clasp (0.8-mm stainless steel), and the superior end is embedded in the maxillary bite block.

The lingual spring has its inferior end embedded in the mandibular plate and the superior end embedded in the maxillary bite-block.

Both buccal and lingual springs are parallel to each other. A hook made from 0.9-mm stainless steel wire is embedded in the occlusal bite-block in the molar region on the buccal side to measure the amount of delivered force which should be within 300g Fig. (2).

**Insertion of SLBB appliance:**

The appliance was inserted in the patient mouth in the deactivated state Fig(3)to allow the patient to adapt to it for 2 weeks. During the insertion, the appliance was checked for retention and stability and the patient was informed to return after two weeks to activate the appliance and remove any sharp or bulky areas which may interfere with speech or function.

**Vertical pull chin cup:**

Vertical pull chin cup was used as a supplemental device and it was adjusted to deliver 300gm of force after adjustment Fig.(4). The device was delivered to patient at the same day of insertion of SLBB.

**Instructions to the patients following delivery of appliances:**

All the patients were instructed to:

1. Wear the spring-loaded bite blocks full time except during meals while vertical pull chin cup for 16 hours/day.
2. Remove spring-loaded bite blocks and clean it with warm water and soap every day to avoid foul odor.
3. Recall every 3 weeks to activate the Spring-loaded bite block at every appointment.
4. Present to the clinic immediately in case of fracture of any part of the spring-loaded bite blocks to repair it as fast as possible.

**Retention:**

After the closure of skeletal open bite, patients were advised to wear the same appliances for additional 3 months with recall every month to avoid relapse which was not observed in any of them during retention period.

**Statistical Analysis:**

All quantitative data were tabulated and analyzed using IBM SPSS software package version 21.0. and were described using mean, standard deviation pre and post treatment. Significance of the obtained results was calculated at $P \leq 0.05$.

**Method Error:**

All Cephalograms were traced and analyzed by the same investigator and were repeated by a second investigator to confirm anatomical landmark placement, and tracing superimpositions.

**Results:**

All the open bites of the patients participating in this study were closed in varying time during the treatment period and this was accompanied with improvement in facial soft tissue as shown in Table 1 and Fig.

(5). The significance of the attained results at ($P < 0.05$) was observed in the lower anterior face height and total face height whereas the upper face height showed insignificant increase. A significant improvement in the interlabial gap was observed. A significant increase in lower lip length and decrease in upper lip-E line was found. However, no significant differences were found in upper lip length, upper lip thickness, lower lip thickness and lower lip-E line. The nasolabial angle was significantly increased.
Table 1: Comparison between pre and posttreatment soft tissue measurements

<table>
<thead>
<tr>
<th>parameters</th>
<th>Pre-treatment</th>
<th>Posttreatment</th>
<th>Changes</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>UAFH</td>
<td>47.11</td>
<td>3.36</td>
<td>49.28</td>
<td>3.63</td>
<td>2.17 ± 3.88</td>
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<td>LAFH</td>
<td>62.02</td>
<td>6.82</td>
<td>64.65</td>
<td>6.49</td>
<td>2.63 ± 2.36</td>
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<tr>
<td>TAFH</td>
<td>109.12</td>
<td>8.39</td>
<td>113.93</td>
<td>6.51</td>
<td>4.81 ± 5.29</td>
</tr>
<tr>
<td>ILG</td>
<td>-3.75</td>
<td>1.02</td>
<td>1.45</td>
<td>0.35</td>
<td>-2.34 ± 0.82</td>
</tr>
<tr>
<td>ULL</td>
<td>20.08</td>
<td>3.27</td>
<td>20.43</td>
<td>2.10</td>
<td>0.35 ± 1.73</td>
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<tr>
<td>LLL</td>
<td>35.97</td>
<td>4.98</td>
<td>39.17</td>
<td>4.34</td>
<td>3.20 ± 5.13</td>
</tr>
<tr>
<td>ULT</td>
<td>9.08</td>
<td>1.86</td>
<td>9.17</td>
<td>1.71</td>
<td>0.02 ± 1.62</td>
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<td>LLT</td>
<td>12.35</td>
<td>1.46</td>
<td>11.93</td>
<td>1.14</td>
<td>-0.43 ± 1.0</td>
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<tr>
<td>UL-E line</td>
<td>2.04</td>
<td>3.04</td>
<td>0.49</td>
<td>0.49</td>
<td>-1.55 ± 1.29</td>
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<tr>
<td>LL-E line</td>
<td>3.74</td>
<td>2.93</td>
<td>2.79</td>
<td>3.16</td>
<td>-0.95 ± 1.25</td>
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<tr>
<td>NLA (°)</td>
<td>113.7</td>
<td>11.8</td>
<td>119.12</td>
<td>12.25</td>
<td>5.42 ± 14.26</td>
</tr>
</tbody>
</table>

t: paired t-test. P: P values for paired t-test for comparison between pre and posttreatment parameters. *: significant at $P \leq 0.05$. **: Significant at $P \leq 0.001$.

Fig. 1: Soft tissue profile measurements: 1, Upper Facial Height (UAFH); 2, Lower Facial Height (LAFH); 3, Interlabial Gap (ILG); 4, Upper Lip Length (ULL); 5, Lower Lip Length (LLL); 6, Upper Lip Thickness (ULT); 7, Lower Lip Thickness (LLT); 8, E-Line 9, Nasolabial Angle (NLA)

Fig. 2: Spring-loaded bite blocks

Fig. 3: Insertion of spring-loaded bite blocks
Discussion:
Evaluation of the soft tissue changes that associate the treatment of skeletal open bite is important because parents presenting to treat their children hyperdivergent skeletal pattern, complain their unaccepted facial configuration. This study evaluated the cephalometric soft tissue alterations secondary to treatment of skeletal open bite in a group of growing female patients with age ranging from 8-12 years. Because of the complicated nature, clearly unknown etiology, and dentofacial form of open bite malocclusion, treatment approaches varies from habits control to orthodontic and orthopedic treatment. The initial cephalometric radiographs revealed a negative overbite of 3mm or more. The suggested treatment strategy aimed to close the skeletal open bite and improve facial profile esthetics using spring-loaded bite blocks combined with vertical pull chin cup. These treatment goals were achieved by growth modification which could inhibit the posterior teeth overeruption.
Eleven soft tissue variables were evaluated as shown in (Table I). The results achieved demonstrated increase in the lower anterior face height and total face height by 2.63mm and 4.81mm, respectively whereas the upper anterior face height showed insignificant increase, this was not in agreement with (Taher S, 2003).

The interlabial gap showed a significant decrease (-2.3mm) which came in accordance with (Gehring et al. 1998). However, (Torres, et al., 2006), did not find any change in the interlabial gap after open bite treatment.

Other important variables related to lips were evaluated, the lip length and thickness. A significant increase of lower lip length (3.2 mm) while insignificant increase in the upper lip length (0.35 mm) were observed . Such increase was reported by (Nanda et al., 1990) to be 1.1mm and 1.5mm in upper and lower lips respectively, for females with ages between 7-18 years. It was also supported by (El-Sayed and El-bokle, 2000) who found a significant increase in the upper lip length which may be attributed to the palatal inclination of the upper incisors and with( Taher S, 2003) who observed significant increase in the lower lip length after skeletal open bite correction. However, these findings came not in accordance with (Torres et al., 2006) and (Abdel Kader HM, 1983), who noticed insignificant increase in the lip height although overjet and overbite exhibited significant decreases after the treatment. As for the lip thickness, the upper and lower lips showed insignificant changes, this result was in conflict with prior studies, (Ricketts RM, 1960) and (Erdinc, et al., 2007) who observed an increase in the upper lip thickness after open bite treatment but this may be due to the age of the patients included in this study when compared to those studies.

Concerning the relation of the upper and lower lips to the esthetic line, decreases were noticed in the upper lip-E line and the lower lip-E line by -1.55 mm and -0.95mm, respectively. However, this line was significant for the upper lip but insignificant for the lower lip. These results came not in agreement with (Taher S, 2003) and (Torres et al, 2006) who claimed that insignificant changes in relation of the upper and lower lips to the E-line were achieved.

The last variable is the nasolabial angle, this angle has been described in the literature as a key factor in improvement of the facial profile, significantly exhibited an increase of 5.42° after treatment. This result was in agreement with (Nanda et al.,1990) who stated that uprighting of the upper and lower incisors enlarge the naso- and mentolabial angles.

**Conclusion:**

From the findings that was achieved in this study, we can conclude that; Spring loaded bite blocks combined with vertical pull chin cup could effectively improve both Soft tissue and dentoskeletal structures in all the participating patients, where greater reduction in the interlabial gap and upper lip-E line were observed in patients treated with this approach. However, changes produced by other researches regarding these parameters seem to be controversial even though those researches were with sounder methodological quality did not report significant changes. As well as, the spring loaded therapy combined with vertical chin cup could result in greater increase of lower lip length and nasolabial angle. The soft tissue changes reflect the treatment effects on hard tissues.

**REFERENCES**


