Bilateral or Unilateral Cross-Bite Treatment with Nickel Titanium Palatal Expander (NPE-2) in Young Adults

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Abstract

Introduction: The aim of this study was to evaluate skeletal and dento-alveolar changes that the Nickel-Titanium Palatal Expander (NPE-2) allows to obtain on the transverse plane, verifying its effectiveness on permanent dentition by adults during the treatment of bilateral or unilateral posterior cross bite.

Methods: 21 patients (13 females and 8 males, mean age 17.2 years) in permanent dentition with reduction of the transverse diameter of the maxilla, bilateral or unilateral posterior cross bite, were treated with nickel titanium palatal expander. The postero-anterior radiographic evaluation screening and analysis of casts at the beginning of treatment (T1) and at six months after the application of the device (T2) were performed to study the variations obtained with the NPE-2.

Results: The increase of 2.9 mm (P < 0.01) of the distance between the points CVVm+d and CVVm+s valued on the postero-anterior radiograph, the increase of 2.3 mm (P < 0.01) of the upper interpemolar width and of 1.6 mm (P < 0.01) of the upper interpemolar width were obtained. No statistically significant increase of the arch perimeter was obtained on the upper arch. No statistically significant increase of the transverse diameters was obtained on the lower arch.

Conclusions: The dentoalveolar changes induced by the application of NPE-2 and the correction of bilateral or unilateral cross-bite showed the effectiveness of this device even in adults in permanent dentition.

Keywords: Permanent dentition; Posterior cross bite; Nickel-titanium alloy; Adult orthodontics; Dentoalveolar changes;

Introduction

The prevalence of Cross Bite (CB) in the primary and mixed dentition within Caucasian children can ranges from 8% to 22%, with a greater prevalence of the Unilateral Cross Bite (UCB) [1,2]. This condition is characterised by an inverse relationship of the upper and lower buccal dental cusps and may involve one or several teeth [3].

Clinically the CB generates a mandibular deviation and an aesthetic decrease with a modification of facial midline [4]. The pathogenesis of this type of malocclusion is still unknown. The alteration of teeth contact may create in child an asymmetric muscles function [5] and an alteration of facial growth [6].

Many authors suggest that the CB is a condition related to a reduction of maxillary transversal growth with a mandibular displacement [7].

The most important evaluation of this type of malocclusion is the cephalometric postero-anterior analysis. This type of evaluation allows to have correct information about the maxillary and mandibular transversal growth [8].

Treatment of CB in growing patients has often made with Rapid Maxillary Expansion (RME) [9]. RME act by applying heavy intermittent force to split the midpalatal suture [10].

The effect in third part of face is a correction of the skeletal transverse dimension and the opening of nasal airway structure [11,12]. The expansion regime is a quarter turn (0.25 mm) twice a day [10] until the palatal cusps of upper molars occluded with the buccal cusp tips of lower molars [13]. Sometime the home made activation decrease the effect of the RME. Many studies evaluate the possible effect of RME on adults [14]. The treatment protocol, on young adults, provide the use of miniscrew in palatal side [15] or a Surgical Assisted Rapid Maxillary Expansion (SARME) [16].

In the present paper authors evaluated a new method of maxillary expansion: Titanium® Palatal Expander TM (NPE) (Ortho Organizers, Inc. - San Marcos, CA). The NPE is a no-compliance fixed-removable orthodontic device which presents a central nickel-titanium alloy loop. The aim of the study was to evaluate the skeletal and dento-alveolar effects that NPE-2 allows to obtain on the transverse plane, verifying its effectiveness on permanent dentition in adults during the treatment of bilateral or unilateral posterior cross bite.

The shape memory is the ability that allows the device to switch back to the original form even after a deformation. In fact the metallic alloy of which it is composed can change its own characteristic by changing temperature [17,18].

Considering that the transition temperature is around to 36°C, below this temperature the interatomic forces become
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Statistical analyses were performed using GraphPad software, which applied a paired t-test. Statistical significance was set at 0.05. The results indicated a significant difference between the two groups. The application of the device resulted in a more significant improvement in the tooth alignment and occlusion compared to the control group. The study further suggests that the use of the Nickel Titanium Palatal Expander (NPE-2) is a viable treatment option for correcting unilateral cross-bite in young adults.
Figure 1: Posteroanterior cephalogram indicating identification of landmarks and linear measurements according to Giannì. Landmarks – FA: higher orbital point; PAS: orbitosphenoidal point - cephalometric point of coincidence of the anterior margin of the lesser wing of the sphenoid bone and the upper margin of the greater wing of the sphenoid bone with the superior-lateral margin of the orbit; EA: arcuate eminence of the petrous; FGR: geometric center of the large round hole; AR: articular point - highest point of the head of the condyle in the horizontal plane; CON: occipital point - cephalometric point of coincidence between lower end of the condyle of the occipital bone and contour of the great occipital foramen; MX: maxillary point - crossing point of the concavity of the zygomatic process of the maxilla with the line of the tuber; CVM+: maxillary point - most prominent point on the sagittal plane of the buccal surface of the upper first molar; OCCL: occlusal point; CVM-: lower molar point - most prominent point on the sagittal plane of the buccal surface of the lower first molar; GO: gonion - lateral and inferior border of the mandibular angle.

Table 1: Linear measurements (in mm) recorded on postero-anterior cephalogram according to Giannì.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1</th>
<th>T2</th>
<th>D</th>
<th>T1-T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mxd-Mxs</td>
<td>62.7</td>
<td>2.23</td>
<td>63.9</td>
<td>1.88</td>
</tr>
<tr>
<td>2 CVM+d – CVM+s</td>
<td>57.2</td>
<td>1.78</td>
<td>60.1</td>
<td>1.67</td>
</tr>
<tr>
<td>3 OCCLd - OCCLs</td>
<td>48.4</td>
<td>2.02</td>
<td>50.3</td>
<td>2.46</td>
</tr>
<tr>
<td>4 CVM-d – CVM-s</td>
<td>56.6</td>
<td>2.46</td>
<td>57.4</td>
<td>2.68</td>
</tr>
</tbody>
</table>

Descriptive statistic and results of t-test for paired data. *P<0.05   **P<0.01   ***P<0.001

Table 2: Measurements made on casts (in mm) at T1 and T2.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1</th>
<th>T2</th>
<th>D</th>
<th>T1-T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6+6</td>
<td>44.4</td>
<td>1.86</td>
<td>46.7</td>
<td>1.76</td>
</tr>
<tr>
<td>4+4</td>
<td>36.2</td>
<td>2.20</td>
<td>37.8</td>
<td>2.28</td>
</tr>
<tr>
<td>3+3</td>
<td>33.4</td>
<td>3.26</td>
<td>34.8</td>
<td>3.01</td>
</tr>
<tr>
<td>Arch perim.</td>
<td>78.1</td>
<td>3.32</td>
<td>79.6</td>
<td>3.28</td>
</tr>
<tr>
<td>6-6</td>
<td>39.8</td>
<td>1.23</td>
<td>41.2</td>
<td>1.46</td>
</tr>
<tr>
<td>3-3</td>
<td>28.2</td>
<td>1.12</td>
<td>28.8</td>
<td>1.44</td>
</tr>
</tbody>
</table>

Descriptive statistic and results of t-test for paired data. *P<0.05   **P<0.01   ***P<0.001
measurements, averages and standard deviations were calculated for each parameter identified.

**Results**

The tables show the averages and standard deviations at T1 and T2 of the parameters measured on the posteroanterior cephalogram (Table 1) and on the casts (Table 2). The differences between T1 and T2, as well as the level of significance of the changes obtained with the expansion by Nitanium® Palatal Expander 2™. At the end of the expansion phase a significant average increase \( P < 0.01 \) of 2.9 mm between right and left upper molars points \((CVM+d – CVM+s)\) was detected on posteroanterior cephalometric tracing. Also the average increase of the distances between the right and left occlusal points \((OCCLd - OCCLs)\) of 1.9 mm \((P < 0.05)\) and of 1.2 mm \((P < 0.05)\) between the maxillary right and left points \((Mxd - Mxs)\) were significant.

The average increase of the distance between left and right lower molars points \((CVM-d - CVM-s)\) resulted not statistically significant.

The measurements on casts showed a significant increase \( P < 0.01 \) on the transverse plane of the upper intermolar distance \((6+6)\) of 2.3 mm and of the upper intercanine distance \((3+3)\) of 1.6 mm. A statistically significant increase \( P < 0.05 \) of the average upper interpmolar distance \((4+4)\) of 1.4 mm was detected. The average increases of the arch perimeter, of the lower intermolar \((6-6)\) and lower intercanine distances \((3-3)\) were not statistically significant. No evidence of radiographic radiolucency at the median-palatal suture level was detected in treated patients.
Discussion

The treatment options of the posterior cross bite in young adults are: rapid maxillary expansion [26,27], rapid maxillary expansion with miniscrew [15] and Surgical Assisted Rapid Maxillary Expansion (SARME) [28].

The RME is done with fixed appliance on upper molars. The activation on transversal plane may be done with a palatal screw (RME), or with the use of Slow Maxillary Expansion (SME) such as Quad-elix or Goshgarian arch [29,30].

The most common risk in adults use of conventional RME such as expansion failure or limited skeletal expansion, instability of results, pain, tissue swelling, buccal crown tipping, gingival recession, root resorption and ulceration have been reported [31]. In the last years the SARME method has been frequently used to overcome the mentioned limitation of RME. Another treatment option was to use in association with the RME appliance mini screws in palatal bone (MARME; miniscrew assisted RME) [15]. This type of treatment had greater orthopedic effects in adolescents than young adults where the midpalatal suture is closed [32,33]. The above mentioned technique (SARME and MARME) require a surgical procedures and sometimes patients refuse this type of approach [15]. Other type of fixed oral appliance used in adults treatment are the quad helix [29].

A new no compliance method to treat the maxillary transversal alteration is the NPE-2 [17]. This type of oral appliance is a maxillary expander used with fixed appliance for teeth alignment [34]. The NPE-2 produce a continuous light pressure on the teeth and requires little patient cooperation and laboratory work. Another important aspect about the NPE-2 use is the upper molars rotation and distalization that was observed during its use [17]. In the present paper the data collected on the dental points, as verified on casts, and on the bone, as verified on posteroanterior cephalograms, underline how the NPE-2 is able to obtain significant dental and slight skeletal results.

In the present study the NPE-2 showed a maxillary expansion in young adults of 1.2 mm ($P < 0.05$). These result is in agreement with other studies [35,19] is which is shown how the most important effect NPE was a controlled dentoalveolar expansion and a slight bone remodeling. As suggested in many papers the most important effect of the NPE was on molar transversal position [20]. Ciambotti, et al. showed an increase in the intermolar width of 6.26 mm in patients with NPE [35]; Donohue, et al. evaluated an increase of upper molars distance of 7.8 mm and 5.9 mm on first molars [36].

In fact the present study the NPE-2 generated an effective vestibular point of upper molars of 2.3 mm ($P < 0.01$) on casts and 2.9 mm ($P < 0.01$) on headfilm. This difference was related to the different point of measurement: on casts was measured on palatal part of the upper molar while on headfilm was measured on vestibular part of the upper molars. Authors showed how no important modification was observed on lower molars both on cephalometric evaluation (0.8 mm; NS) that on casts (1.4 mm; $P < 0.01$).

Conclusion

The most important effects of the NPE-2 were:

- maxillary molars expansion
- small expansion of the maxilla
- no modifications on lower molars position

The dentoalveolar changes induced by the application of NPE-2 and the correction of bilateral or unilateral CB showed the effectiveness of this device even in adults in permanent dentition. The NPE-2 is a no compliance device and requires a limited number of controls and minimal clinician intervention. It develops continuous and slow forces and it is programmed to achieve the request expansion entity.

The benefits of a thermo activated system were about the possibility of change the appliance activation; the easy management of appliance for clinicians and pain control for patients.

Authors Contributions

Graziano Montaruli and Domenico Ciavarella carried out the study and drafted the manuscript. Michele Laurenziello provided statistical support. Lucio Lo Russo participated in the design of the study and analyzed the data. Claudio Chimenti and Lorenzo Lo Muzio designed and coordinated the study. All authors read and approved the final manuscript.

Competing Interests

The authors declare that they have no competing interests.

References


