Expansion Changes By Removable Quad Helix Appliance On Constricted Maxilla In Growing Patients

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ABSTRACT

Objective: to evaluate expansion changes by removable Quad helix appliance on cephalometric measurements in growing patients. Materials and methods: The present prospective clinical study consisted of fourteen subjects (7 girls and 7 boys) with cross bite due to constricted maxillary arch. Cases were selected to be treated for 8 months. Results: A significant difference of cephalometric measurements for FMA, S-GO, ANS-Me, and all measurements for cast analysis and postero–anterior cephalometric measurements. Conclusion: Treatment of Growing patients with cross bite by quad helix appliance was effective due to expansion of maxilla and correcting cross bite malocclusion.

INTRODUCTION

Many patients have a noticeable cross bite of the buccal segments when their occlusion is in maximum intercuspation. (Binder, R.E., 2004)

Posterior crossbite is one of the most common malocclusions in the young patients. (Petrén, S., et al., 2013)

Posterior crossbite is defined as an abnormal buccolingual relation between opposing molars, premolars or both in centric occlusion. (Arvinth, R., et al., 2016)

The etiology of posterior crossbite can include any combination of dental, skeletal, and neuromuscular functional components, sucking habit obstruction of the upper airway, and certain swallowing patterns have been identified as etiologic factors of the posterior crossbite. (Toroglu, M.S., et al., 2002)

The early correction of posterior cross-bites requiring maxillary expansion has been advocated to redirect the developing teeth into more normal positions, eliminate untoward temporomandibular joint positions and mandibular closure patterns, and make beneficial dentoskeletal changes during growth periods involving a reduced treatment complexity and time. (Bell, A., 1982)

Various modes of posterior crossbite correction have been suggested, including rapid maxillary expansion, slow expansion with the quad-helix and removable expansion plates. (Petrén, S., L. Bondemark, 2008)

Three expansion treatment modalities are used today: rapid maxillary expansion (RME), slow maxillary expansion (SME) and surgically assisted maxillary expansion. Practitioners select treatment appliances based on their personal experiences and on the patient’s age and malocclusion. (Argawal, A., 2010)

Animal studies suggest that SME (slow maxillary expansion) maintains sutural integrity during expansion, producing a more stable result than RME (rapid maxillary expansion). (Wong, C.A., et al., 2011)

Orthodontic expansion can cause increases in archperimeter and the correction of dental crowding and constricted maxilla. (Germane, N., et al., 1991)

Slow expansion by The quad-helix produces forces between 180 and 667 g, depending on the material...
used, and the length and the size of the wire. (Corbridge, J.K., et al., 2011)

The main advantages offered by the quad-helix appliance are that child or parent compliance with the treatment is not strictly necessary, and that the patient enjoys greater comfort and better adaptation. (Vizzotto, M.B., et al., 2008)

Quad helix delivers a constant physiologic force until the required expansion is obtained. (Marzban, R., 1999)

MATERIAL AND METHODS

The sample of this study was consisted of fourteen patients, each enrolled patient had the procedures explained, their questions answered and a written consent was signed by the patients’ guardians. All patients were selected from the clinic of orthodontics department, faculty of dentistry, Mansoura University according to following criteria:

- Constricted maxillary arch.
- Age ranged from 6-12 years old.
- Fully erupted maxillary frist permanent molar.
- Free from any congenital anomalies or systemic disease that might have an influence on tooth movement.
- Good oral hygiene

The Quad Helix has 4 spiral helicoidal bends, two on the anterior zone, which must descend from the bridge to the palate, and the other two are located slightly behind the molar band, to allow rotation and molar expansion. The Qued helix appliance removable ready made 0.9 mm MIA (Mobile intra oral arch system) inserted in the palatal sheaths of the band molar (fig 1 a b).

The Qued helix appliance activation was activated with three prong plire outside of patient mouth. Verification of activation amount was by inserting one retention loop and observing the relationship of the other retention loop to its sheath, repeated on opposite side to confirm was be done.

- Activation the posterior helical loops were move the free wires buccally.
- Activation the anterior helical loops were move the molar bands buccally.

New activations was be posted on 40 – 40 day period; on majority of cases the activation were not exceed 1-2 mm in order to keep case under control. The arch arms contacts all posterior teeth, the contacts was close to but not touched the soft tissue at the cervical margin.

Patients were appointed every week for evaluation and instructed to clean the appliance after every meals daily by tooth brush and mouth wash and call us if any emergency was happened. When the palatal cusp tips of the maxillary first molars were in contact with the corresponding buccal cusps of the mandibular first molars, expansion was rendered complete and post expansion records were obtained.

The same appliance was left in place as a retainer for 3-4 months during leveling and alignment (Fig 2 and 3). Each patient had their panoramic, lateral and postero-anterior (PA) cephalometric x-rays before and just after the expansion. Hand wrist radiocentegraphy was taken only before treatment for growth and maturity indication (4).

Lateral and PA cephalometric radiographs were performed in a standardized fashion by the same technician. All cephalometric radiographs were hand traced by the same examiner.

Skeletal and dental changes of the Quad helix appliance were evaluated through radiography and study models. (Table 1, 2, 3)

Definite points on the dental casts obtained before and immediately after expansion were measured using a digital caliper.

Data analysis and statistics:

The distributions of quantitative variables Cephalometrics (lateral and postero-anterior) and dental cast data were tested for normality. Significance of the obtained results were judged at the 5% level. Paired t-test was used for normally quantitative variables, to compare between pre and post-expansion (T1 and T2) respectively.

Results:

All included cases successfully achieved the intended expansion in 3 to 4 months. All appliances were fitted in patient mouth and remained so after the post expansion records were taken and during the retention phase of 4 months. The values of the lateral cephalometric variables, before and immediately after expansion, (Table 1), showed no significant increase in the means of SNA (0.11), ANB (0.47); with no apparent alteration in the sagittal position of the mandibular base; SNB: (0.54). Wilcoxon ranks test was used to obtain Wits appraisal which recorded a significant increase (1.26).
The vertical behavior of the apical bases immediately after expansion showed an increase in the means of variables FMA (1.71), this change, however, were statistically significant p < 0.05.

An increase in the means of variables of facial height: ANS-Me (1.87 mm), S-Go (1.39 mm) was noted., this increase was statistically significant for ANS-Me and S-Go.

The measured dental cephalometric variables, U1-SN (0.54), L1-MP (0.44) and inter-incisal angle (0.48) increased insignificantly after expansion, p > 0.05.

PA cephalometric measurements revealed significant increases in the skeletal measurements (facial, nasal and maxillary) transverse dimensions and no significant increase in (mandible) transverse dimension.

Skeletal FTD (0.95), NTD (0.96), MXTD (1.43), were p value < 0.05 and MDTD (0.68) p value > 0.05 (Table 2)

### Table 1: Lateral Cephalometric findings before treatment (T1), after expansion (T2) and the mean difference of each variable before and after expansion (T2-T1).

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Pre-expansion (T1)</th>
<th>Post- expansion (T2)</th>
<th>mean</th>
<th>SD</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anteroposterior</strong></td>
<td></td>
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<tr>
<td>SNA</td>
<td>79.2100</td>
<td>3.23833</td>
<td>79.3289</td>
<td>3.48520</td>
<td>.11889</td>
</tr>
<tr>
<td>SNB</td>
<td>75.8122</td>
<td>3.43730</td>
<td>75.3411</td>
<td>3.41299</td>
<td>.47111</td>
</tr>
<tr>
<td>ANB</td>
<td>3.3969</td>
<td>2.42623</td>
<td>3.9389</td>
<td>2.85478</td>
<td>.54000</td>
</tr>
<tr>
<td><strong>Vertical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMA</td>
<td>25.6800</td>
<td>5.22067</td>
<td>27.3967</td>
<td>5.28567</td>
<td>1.71667</td>
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<tr>
<td>SN-OCC</td>
<td>22.1422</td>
<td>3.46172</td>
<td>20.9956</td>
<td>3.63535</td>
<td>1.14667</td>
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<td>SN-GOGN</td>
<td>37.0122</td>
<td>3.72261</td>
<td>37.2422</td>
<td>4.22120</td>
<td>.23000</td>
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<td><strong>Dental</strong></td>
<td></td>
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</tr>
<tr>
<td>U1-SN</td>
<td>104.6478</td>
<td>6.36843</td>
<td>105.1956</td>
<td>7.50904</td>
<td>.54778</td>
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<td>L1-MP</td>
<td>86.7667</td>
<td>4.05959</td>
<td>87.2122</td>
<td>4.24436</td>
<td>.44556</td>
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<tr>
<td>L1-L1</td>
<td>129.3411</td>
<td>7.49622</td>
<td>128.8600</td>
<td>8.25542</td>
<td>.48111</td>
</tr>
<tr>
<td>U1-NA</td>
<td>25.4944</td>
<td>5.19434</td>
<td>25.6044</td>
<td>5.19434</td>
<td>.000</td>
</tr>
<tr>
<td>L1-NB</td>
<td>20.7044</td>
<td>6.68186</td>
<td>21.8822</td>
<td>5.03534</td>
<td>1.17778</td>
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<td><strong>Facial height (mm)</strong></td>
<td></td>
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<tr>
<td>S-GO</td>
<td>64.6189</td>
<td>3.39372</td>
<td>66.0718</td>
<td>3.93378</td>
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<tr>
<td>ANS-ME</td>
<td>60.1489</td>
<td>5.54048</td>
<td>62.0189</td>
<td>3.86228</td>
<td>1.87000</td>
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</table>

* t: Paired t-test \*: Statistically significant at p ≤ 0.05

### Table 2: Posterior-Anterior Cephalometric findings before treatment (T1), after expansion (T2) and the mean difference of each variable before and after expansion (T2-T1).

<table>
<thead>
<tr>
<th>Measurements (mm)</th>
<th>Pre-expansion (T1)</th>
<th>Post- expansion (T2)</th>
<th>mean</th>
<th>SD</th>
<th>P values</th>
</tr>
</thead>
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<td><strong>SKELETAL</strong></td>
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<td>FTD1</td>
<td>113.8356</td>
<td>6.38455</td>
<td>114.7933</td>
<td>6.64616</td>
<td>.95778</td>
</tr>
<tr>
<td>NTD1</td>
<td>21.1111</td>
<td>1.47599</td>
<td>22.0800</td>
<td>1.60749</td>
<td>.96889</td>
</tr>
<tr>
<td>MXTD</td>
<td>60.0733</td>
<td>3.03129</td>
<td>61.5111</td>
<td>3.03146</td>
<td>1.43778</td>
</tr>
<tr>
<td>MDTD1</td>
<td>76.4989</td>
<td>3.49728</td>
<td>77.1576</td>
<td>3.38089</td>
<td>.68889</td>
</tr>
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</table>

### Table 3: Study Model analysis before treatment (T1), after expansion (T2) and the mean difference of each variable before and after expansion (T2-T1).

<table>
<thead>
<tr>
<th>Measurements (mm)</th>
<th>Pre-expansion (T1)</th>
<th>Post- expansion (T2)</th>
<th>mean</th>
<th>SD</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEAN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OB</td>
<td>1.944</td>
<td>2.1858</td>
<td>1.389</td>
<td>1.9167</td>
<td>5.556</td>
</tr>
<tr>
<td>MAP</td>
<td>75.2333</td>
<td>3.81994</td>
<td>82.1567</td>
<td>4.35834</td>
<td>6.92333</td>
</tr>
<tr>
<td>WPR</td>
<td>32.1356</td>
<td>3.57918</td>
<td>38.9100</td>
<td>4.70480</td>
<td>6.77444</td>
</tr>
<tr>
<td>WMR</td>
<td>40.9889</td>
<td>3.82617</td>
<td>51.0922</td>
<td>3.79779</td>
<td>10.10333</td>
</tr>
</tbody>
</table>

(a) lateral arms left and right sides

(b) Anterior bridge

(c) Posterior bridge

(d) Anterior helix

(e) Posterior helix
Fig. 1: The Quad Helix Expander

Fig. 2: Case presented before expansion.

Fig. 3(a): The Quad Helix inserted in palatal sheath and the arch arms contacts all posterior teeth.
The early correction of posterior cross-bites requiring maxillary expansion has been advocated to redirect the developing teeth into more normal positions, eliminate untoward temporomandibular joint positions and mandibular closure patterns, and make beneficial dento skeletal changes during growth periods involving a reduced treatment complexity and time. (Bell, A., 1982; Bell, R a., et al., 1981)

The Quad Helix is one of the most versatile appliances that can be used in the early mixed dentition, (Vergata, T., T. Vergata, 2001) and increases anterior mandibular closure because it is easy to use and well tolerated by patients. (Cozza, P., et al., 2000)

Angular measurements for the sagittal skeletal dimensions of the present work (Table 1) were not significant changes for the sample before and after treatment for SNA. No change significance in A point position was detected in current study. Those finding were in agreement with other different expansion studies. (Sandikçioğlu, M., S. Hazar, 1997; Ramoğlu, S.I., Z. Sari, 2009; Gabriel, O., P. Montes, 1995)

Present study agree with Piskai et al (2016) that FMA angle showed significant increase change (1.7°). This change could be indicating a tendency to ward vertical growth pattern, and the major contributors to the vertical increases were the FMA angle, ANS-Me. (Saadia, M., M.S.E. Torres, 2001) Where S-GO (1.4 ) and ANS-Me (1.8), SNA- ME, S- GO measurements showed significance increase, and this increased due to tipping of the first molars buccally and extrusion of palatal cusps, bite opening increased lower anterior facial height, increased in the skeletal vertical dimensions during expansion treatment period. These results consisted with that obtained by others. (Conroy-piskai, C., et al., 2016; Rossi, M De., et al., 2010; Vergata, T., T. Vergata, 2001).

A number of analysis of PA cephalographs emerged, depends on the linear measurements. (Huertas, D., et al., 2001) Regarding the transverse changes (Table 2)

MXTD the maxillary bases showed 1.44 mm increase in the width were statistically significant. This increase showed amount of skeletal expansion produced by the appliance in agreement with several previous researchers Brosh et al (Orthopedics, D., et al., 1998), Olmez (2007), Sari et al, Karman (2002), Cotton (1978), Chung and Font (2004), Machado et al (2006), Marzban and Nanda (1999), Asanza et al (1997)

FTD was significant increase due to maxillary expansion and postero anterior radiographs revealed an skeletal increase the lateral dimension in nasal cavity this increase was stable after expansion. These results was agreement with these authors. (Sari, Z., et al., Chung, C.H., et al., 2004; Garland, H., W. Warren, 1976).

In the present study, mouth breathing patients suffering from uni- or bilateral cross bite and the use of QH appliance promoting expansion the maxilla to correct posterior cross bite.
FTD was significant increase with 1 mm this denote the amount of skeletal expansion produced by the appliance. Disagree results were reported by Christopher et al (Cameron, C.G., et al., 2002), Letizia Perillo et al (2014).

Concerning the transverse expansion changes by study cast measurements (Table 3) the WPR width at pre molar region increased significantly after expansion averaged 6.8mm While the amount of molar width expansion WMR averaged 9.1 mm.

Inter premolar, inter molar changes in width display the total amount of alveolar and dental expansion produced by QH in consistent with Corbridge et al., (2011), Karman (2002), Marzeban and Nanda (1999), Raju et al., (2014).

The Maxillary arch perimeters MAP (Table 3) increased significantly after expansion with average 6.9 mm for 9.1 mm inter molar width in ratio 0.7 mm for every 1 mm of inter molar expansion; this result due to expansion was greater in the posterior than in the anterior region of the maxilla. (Ladner, P.T., Z.F. Muhl, 1995) Nearly similar results was found by Akkaya (1999) was 0.7: 1mm, Bell (1982), Wong et al., (2011) While Berlocher et al (1980) reported 1mm increase for every 1mm of inter molar expansion.

Over bite (Table 3) decreased significantly due to the opening of mandibular plane angle by QH maxillary Expansion procedure. That results was in agreement with Bell (1982), Karman (2002), Hass (1980), Lander et al (1995).

Conclusion:
1- The QH appliance was an effective fixed invisible non compliance expander appliance that expanded the maxillary arch in average period of 4-6 months.
2- The average rate of dental maxillary expansion at first molar by QH expander appliance was 2.5 mm / month.
3- The maxillary bases MXTD from posteroanterior cephalograph was increased 1.44 in width, nasal aperture 0.98 mm.
4- The QH appliances produced 0.7 mm increase in arch perimeter for every increase of 1mm in the inter molar distance . 0.9 mm in perimeter for every increase of 1mm in the inter premolar distance.

Contribution Of Knowledge:
The quad-helix appliance developed with a vision to generate low force magnitudes. The inclusion of four helical loops in the design led to increased appliance size and improved the system’s flexibility. the patient enjoys greater comfort and better adaptation.

REFERENCES


