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# Compare molar's alveolar bone width and angulation changes between cleft lip and palate and non-cleft patients following transverse correction of maxillary hypoplasia (CBCT based study)

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***Abstract*---**Purpose: This study aimed to compare maxillary alveolar bone width in 1st molar region and molar angulation between growing individuals with Cleft Lip and Palate (CLP) and Non-Cleft Class III instances that received Rapid Maxillary Expansion (RME) as a treatment of maxillary hypoplasia. Subjects and Methods: This retrospective study included two groups, Cleft Group; 8 CLP patients and Non-Cleft Group; 12 Non-Cleft cases with maxillary hypoplasia. The children's ages spanned from 8 to 12 years old. The two groups received treatment consisting of maxillary expansion utilizing with RME protocol followed by 6 months of consolidation. Cone Beam Computed Tomography (CBCT) was taken prior therapy (T1) and following six months of expansion (T2). Results: In Cleft and Non-Cleft groups, the buccal alveolar bone width displayed statistically significant decline, however the palatal alveolar bone width displayed statistically significant increase. The molar angulation was increased significantly in the two groups. There were statistically non-significant variations in alveolar bone width and 1st molar angulation changes among Cleft and Non-Cleft groups. Conclusion: Patients with CLP have the same maxillary first molar angulation changes as well buccal and palatal alveolar bone width at molar area as non-cleft patients those have Class III malocclusion.

***Keywords*---**Cleft palate, Maxillary Hypoplasia, maxillary expansion, molar angulation.

## Introduction

Maxillary hypoplasia is a prevalent condition and commonly associated with Class III deformity. Different etiological factors could lead to maxillary transvers hypoplasia including: mouth breathing, parafunctional habits, hypodontia, and cleft palate. Maxillary expansion treatment, among the most often used therapy procedures for enlarging a transversally narrow maxilla, is required to improve this developmental defect.

Cleft lip and palate condition are a common deformity that causes a significant psychological strain on both parents and kids. When a parent learns that their kid has a cleft malformation, they experience emotional setback, uncertainty, guilt, worry, anxiety, and melancholy [1]. Because risk factors resulting from genetics and environment contribute to non-syndromic orofacial clefts and interact with one another, their etiology is complicated. Children with CLP typically experience skeletal class III malocclusion, maxillary hypoplasia, and collapsed maxillary arches as an outcome of restricted maxillary development. A minimum of a single dental issue affects CLP patients: aberration involving the amount, dimensions, and form of teeth, hypodontia being the most common usually in the upper jaw. Velopharyngeal dysfunction is the most prevalent anatomical abnormality affecting speech in CLP patients. When speaking, there is a continuous air leak through the nasal cavity and nasal resonance whenever the soft palate doesn't flex against the posterior pharyngeal wall [2-5].

After Angell invented the Rapid Maxillary Expansion (RME) approach, Haas, along with others, continued to work on it. The theory behind the method is that the maxillary sections can be mechanically separated by the orthopedic force applied by fixed appliances with a jackscrew [6]. The combined use facemask and RME methods are frequently used as a therapeutic alternative for developing individuals having constricted maxillary arch specially in Class III malocclusion during mixed or early permanent dentition to correct a posterior crossbite and to disarticulate of the circum-maxillary sutures [7]. During RME many orthopedic, dentoalveolar and dental changes always concurrent with it. Those changes including nasal cavity, zygomatic bones, maxillary bones, dental arch perimeter and dental relations. Among those changes alveolar bone inclination and thickness in molar region and molar angulation have been reported in few literatures that they are affected with presence of palatal cleft and palatal scaring. Following RME, fixed device treatment can lead to alterations in the alveolar bone via buccal tipping, rotation, and translation of teeth [8]. In cleft patients, RME was performed on average between the ages of 9 and 10 years old. Considering both the intended secondary alveolar bone graft and the extent of expansion [9].

Since both cleft and non-cleft cases may result in a rise in vertical dimensions, root resorption, and diminished periodontal attachment involving fenestration or dehiscence of the buccal cortical bone, the dental consequences are usually unfavorable [10–14].

CBCT is the most accurate and sensitive imaging examination, which was frequently used within the dento-maxillofacial area for the last 20 years. In comparison to panoramic radiography, it has several benefits over traditional (CT), such as being less expensive, using less radiation, and being easier to accommodate in dental clinics. It has additionally been demonstrated that it effectively lowers the likelihood of inter-operative mistakes [15,16].

Therefore, this retrospective study was purposed to compare alveolar bone width at molar region and molar angulation changes between Cleft and Non-Cleft Patients Following transverse correction of maxillary hypoplasia with rapid maxillary expansion. CBCT had been used to evaluate the treatment outcome by comparing the pre and post expansion data.

**Subjects and Methods**

The current research was retrospective, according to the sample size calculations with a power of 80% and alpha=0.05, a total sample of 8 complete CLP (2 unilateral and 6 bilateral) and 12 skeletal Class III patients with constricted maxillary arch (Non-Cleft group). Patients aged from (8 to 12 years old). Cleft patients' records were allocated from patients archive of Al-Azhar Cleft Lip and Palate Treatment Center, Cairo, Egypt, and non-cleft patients from archive of the private practice.

Inclusion criteria were including; (1) Complete cleft lip and palate non-syndromic patients, (2) Class III patients with transverse maxillary hypoplasia, (3) No preference for sex, (4) Fully erupted permanent maxillary first molars (5) Rabid maxillary expansion using bonded expander with posterior bite plane was the device of choice for selected patients. (Fig 1) However, excluding criteria included (1) Previous fixed orthodontics, (2) Previous maxillary protraction, or surgically assisted RME. The retrieved records included a whole skull Cone Beam Computed Tomography (CBCT) were taken before (T1) and at least six months after expansion (T2).

Figure 1: Bonded Hyrax appliance, A: Cleft Case, B: Non-Cleft Case

The expanders were activated by two quarter-turns twice daily as RME activation protocol. After the consolidation time, post-treatment documentation and a full-skull CBCT (T2) were acquired. Utilizing version 4.10.2 of the 3D Slicer program (www.slicer.org), 3D superimposition registered at anterior cranial base was done and CBCT analysis was performed to assess dentoalveolar and molar changes following expansion treatment. Three perpendicular reference planes were used during superimposition, Axial palatal plane, Vomer coronal plane and Mid-sagittal plane. The CBCT landmarks and measurements were located in order to evaluate expansion outcomes. Table (1). The CBCT measurements were done by 2 investigators and the average readings for both were recorded to allow inter-examiner validation.

Table 1: CBCT measurements landmarks definitions

| | Measurement | Definitions |
|---|---|---|
| 1 | Molar Buccal Alveolar Bone Width: | The horizontal distance from the external border of the buccal cortical plate to the center of buccal aspect of mesio-buccal and disto-buccal roots of each maxillary first molar. (in axial view).(Fig2 a) |
| 2 | Molar Palatal Alveolar Bone width: | The horizontal distance from the external border of the palatal cortical plate to center of palatal root of each maxillary first molar (in axial view). (Fig 2 a) |
| 3 | Molar Angulation: | Angle between long axis of each maxillary first molar palatal root and axial palatal plane passing through tip of palatal cusp (in coronal view). (Fig 2 b) |

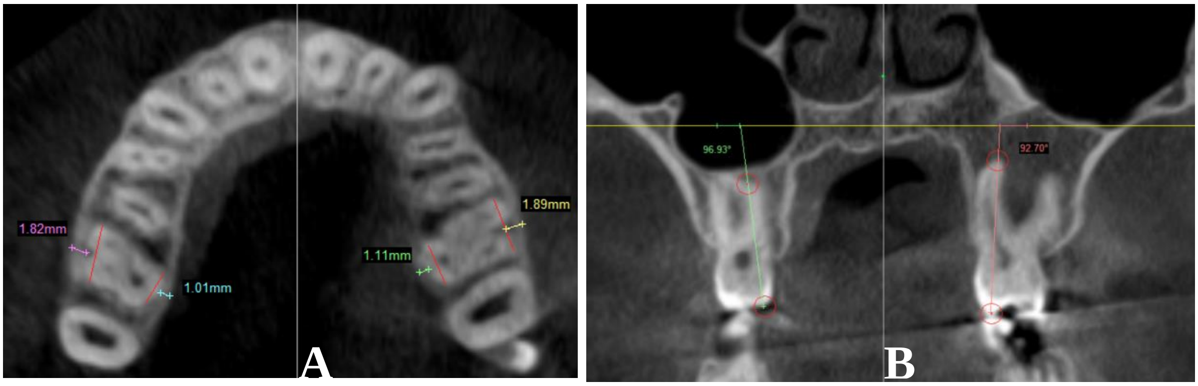


Figure 2: CBCT measurements. A; Buccal and palatal alveolar bone width measurements on axial view. B; Molar angulation measurements on coronal view.

**Statistical analysis**

The gathered information was analyzed for normality and described as a mean and standard deviation. The changes in maxillary molar alveolar bone width and molar angulation in the two groups were compared.

**Results**

For this retrospective study, two groups were allocated. Cleft Group; 8 Complete cleft lip and palate and Non-Cleft Group; 12 skeletal Class III individuals with constricted maxillary arch. The results of this study were presented as descriptive statistics and comparison of CBCT measurements before expansion (T1) and (T2) following six months of maxillary expansion.

The Descriptive and comparative statistics of CBCT Maxillary first molar buccal and palatal alveolar bone width measurements at (T1) and (T2) using paired T-test to Cleft group were described in table (2). The results indicated that the palatal alveolar bone width of the maxillary 1st molar increased and the buccal alveolar bone width of the right and left maxillary 1st molar decreased significant statistically (P≥0.05). The same results had been recorded in Non-Cleft Group regarding alveolar bone width and illustrated in table (3).

Table (2): Descriptive and comparative statistics of CBCT molar alveolar bone width measurements for Cleft Group prior (T1) and following (T2) expansion using paired t-test

| Variables | Descriptive statistics | | | | Paired Differences (T2-T1) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | Mean (Mm) | S.D. | 95% Confidence Interval of the Difference | | T-value | Sig. (2-tailed) |
| | Mean (Mm) | S.D. | Mean (Mm) | S.D. | | | Lower | Upper | | |
| **Molar buccal alveolar bone width (16)** | 1.6616 | .70173 | 1.3393 | .62946 | -.3223 | .23992 | -.52296 | -.12179 | -3.800 | .007* |
| **Molar buccal alveolar bone width(26)** | 1.6170 | .50433 | 1.2294 | .46910 | -.3876 | .24647 | -.59368 | -.18157 | -4.448 | .003* |
| **Molar palatal alveolar bone width(16)** | 1.3413 | .45515 | 2.0511 | .84555 | .70985 | .75906 | .07526 | 1.34444 | 2.645 | .033* |
| **Molar palatal alveolar bone width (26)** | 1.5162 | .60590 | 2.1579 | .63343 | .64168 | .44360 | .27082 | 1.01253 | 4.091 | .005* |

SD= Standard deviation, P-value= Probability value, sig*. = Significance, NS = Nonsignificant (P≥0.05), T1= before expansion, T2=after expansion

Table (3): Descriptive and comparative statistics of CBCT molar alveolar bone width measurements for Non-Cleft Group prior (T1) and following (T2) expansion using paired t-test

| Variables | Descriptive statistics | | | | Paired Differences (T2-T1) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | Mean (Mm) | S.D. | 95% Confidence Interval of the Difference | | T-value | Sig. (2-tailed) |
| | Mean (Mm) | S.D. | Mean (Mm) | S.D. | | | Lower | Upper | | |
| **Molar buccal alveolar bone width (16)** | 1.5950 | .06722 | 1.2850 | .07914 | -.31000 | .12136 | -.38711 | -.23289 | -8.849 | 0.002* |
| **Molar buccal alveolar bone width(26)** | 1.6183 | .12691 | 1.3829 | .15947 | -.23542 | .14696 | -.32879 | -.14204 | -5.549 | 0.041* |
| **Molar palatal alveolar bone width(16)** | 1.3283 | .06322 | 2.3983 | .15608 | 1.07000 | .14863 | .97556 | 1.16444 | 24.938 | .000* |
| **Molar palatal alveolar bone width (26)** | 1.3358 | .04122 | 2.0417 | .12119 | .70583 | .10282 | .64050 | .77116 | 23.780 | .000* |

SD= Standard deviation, P-value= Probability value, sig*. = Significance, NS = Nonsignificant (P≥0.05), T1= before expansion, T2=after expansion

The Descriptive and comparative statistics of CBCT Maxillary first molar alveolar bone width measurements at (T1) and (T2) using independent T-test to compare between Cleft and Non-Cleft groups were described in table (4). It displayed that there was nonsignificant difference (P≥0.05) within the alveolar bone width at 1st molar between Cleft and non-Cleft patients after rapid maxillary expansion.

Table (4): Descriptive and comparative statistics of CBCT maxillary first molar buccal and palatal alveolar bone width measurements of Cleft and Non-Cleft groups at (T1) and (T2) using independent T-test

| Variables | Descriptive statistics | | | | Paired Differences (T2-T1) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-Cleft | | Cleft | | | | 95% Confidence Interval of the Difference | | T-value | Sig. (2-tailed) |
| | Mean (Mm) | S.D. | Mean (Mm) | S.D. | Mean (Mm) | S.E. | Lower | Upper | | |
| **Molar buccal alveolar bone width (16)** | -.310 | .121 | -.322 | .240 | .012 | .078 | -.164 | .140 | -.158 | .876 |
| **Molar buccal alveolar bone width(26)** | -.235 | .147 | -.388 | .246 | .152 | .083 | -.010 | .315 | 1.837 | .080 |
| **Molar palatal alveolar bone width(16)** | 1.070 | .149 | .710 | .759 | .360 | .223 | -.077 | .798 | 1.613 | .121 |
| **Molar palatal alveolar bone width (26)** | .706 | .103 | .642 | .444 | .064 | .131 | -0.193 | 0.322 | 0.488 | 0.630 |

SD= Standard deviation, P-value= Probability value, sig*. = Significance, NS = Nonsignificant (P≥0.05), T1= before expansion, T2=after expansion

The right and left 1st molar angulation showed a statistically significant increase (P≥0.05) after RME in both Cleft and Non-Cleft Groups. Table (5) and Table (6)

Table (5): Descriptive and comparative statistics of CBCT molar angulation in Cleft Group before (T1) and after (T2) expansion and protraction using paired t-test

| Variables | Descriptive statistics | | | | Paired Differences (T2-T1) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | | | 95% Confidence Interval of the Difference | | T-value | Sig. (2-tailed) |
| | Mean (Mm) | S.D. | Mean (Mm) | S.D. | Mean (Mm) | S.D. | Lower | Upper | | |
| **Molar angulation(16) (°)** | 105.662 | 9.98484 | 110.512 | 12.1154 | 4.8500 | 4.7422 | .88541 | 8.81459 | 2.893 | .023* |
| **Molar angulation (26) (°)** | 96.9938 | 11.47489 | 101.862 | 11.1477 | 4.8687 | 2.4057 | 2.85746 | 6.88004 | 5.724 | .001* |

SD= Standard deviation, P-value= Probability value, sig.* = Significance, NS = Nonsignificant (P≥0.05), T1= before expansion, T2=after expansion

Table (6): Descriptive and comparative statistics of CBCT molar angulation in Non-Cleft Group before (T1) and after (T2) expansion and protraction using paired t-test

| Variables | Descriptive statistics | | | | Paired Differences (T2-T1) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | Mean (Mm) | S.D. | 95% Confidence Interval of the Difference | | T-value | Sig. (2-tailed) |
| | Mean (Mm) | S.D. | Mean (Mm) | S.D. | | | Lower | Upper | | |
| **Molar angulation(16) (°)** | 99.8333 | 2.91807 | 107.2500 | 2.17945 | 7.41667 | 3.55370 | 5.15875 | 9.67458 | 7.230 | 0.003* |
| **Molar angulation (26) (°)** | 98.5833 | 4.87029 | 104.1667 | 3.09936 | 5.58333 | 2.53909 | 3.97007 | 7.19659 | 7.617 | 0.004* |

SD= Standard deviation, P-value= Probability value, sig*. = Significance, NS = Nonsignificant (P≥0.05), T1= before expansion, T2=after expansion

Moreover, The Descriptive and comparative statistics of CBCT Maxillary first molar angulation at (T1) and (T2) using independent T-test to compare between Cleft and Non-Cleft groups were described in table (7). The molar angulation was measured for both right and left maxillary 1st molar. It displayed that there was nonsignificant variation (P≥0.05) within 1st molar angulation amongst Cleft and non-Cleft patients after rapid maxillary expansion.

Table (7): Descriptive and comparative statistics of CBCT molar angulation at (T1) and (T2) for Cleft and Non-Cleft groups using independent t-test

| Variables | Descriptive statistics | | | | Paired Differences (T2-T1) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-Cleft | | Cleft | | Mean (Mm) | S.E. | 95% Confidence Interval of the Difference | | T-value | Sig. (2-tailed) |
| | Mean (Mm) | S.D. | Mean (Mm) | S.D. | | | Lower | Upper | | |
| **Molar angulation(16) (°)** | 7.417 | 3.554 | 4.850 | 4.742 | 2.567 | 1.711 | -.786 | 5.920 | 1.500 | .148 |
| **Molar angulation (26) (°)** | 5.583 | 2.539 | 4.869 | 2.406 | .715 | 1.010 | -1.264 | 2.694 | .708 | .487 |

SE= Standard deviation, P-value= Probability value, sig. *= Significance, NS = Nonsignificant (P≥0.05), T1= before expansion, T2=after expansion

## Discussion

Individuals with complete cleft lip and palate (CLP) require multidisciplinary care during their intricate rehabilitation. Therapy usually starts with lip and palate reconstruction in early childhood. Such surgical techniques restore function and appearance but permanently inhibit the development of the anteroposterior and transverse maxillary region [17]. It was claimed that maxillary hypoplasia in CLP patients is caused by the long-term impact of fissures changes [14]. Very few studies have identified the maxillary expansion's impact on the angulation of the

1st molar and its supporting buccal and palatal alveolar bone and is there correlation for being cleft or non-cleft palate.

Therefore, this retrospective research's goal was to contrast the dentoalveolar alterations in maxillary first molar region and how are those alterations affected by being cleft or non-cleft concurrent with rapid maxillary expansion in growing patients.

Due to the fact that the pressures were delivered occlusal from the central point of resistance of the supportive teeth, some buccal dental tilting was inevitable for all expanders (18). The external cortex can be stimulated by buccal dental motions to promote bone deposition, but the process of deposition cannot keep up with resorption, leading to a permanent bone defect (19).

In the current study, in cleft group, there was significant decreased within buccal alveolar bone width and increased within palatal alveolar bone width at 1 molar region after RME. This result is in agree with previous studies (19) which showed decrease of buccal alveolar bone width and increase palatal alveolar bone width after RME in bilateral cleft lip and palate. Moreover, other study (20) used fan expander with Alt- RAMEC procedure with unilateral cleft lip and palate had showed the same results. A previous study (19) compared hyrax, fan, inverted mini-hyrax expanders found reduction in buccal alveolar bone width with less adverse effects with fan type expander over the other tools. Due to its posterior area hinge, which serves as a fulcrum for the expansion action and severely limits posterior expansion, this reality may be described bio-mechanically.

Regarding non-cleft patient, significant reductions in the width of the buccal alveolar bone and a rise in anatomic abnormalities next to the expander anchor teeth have been linked to RME treatment. Anatomical abnormalities of the buccal bone that arise after treatment are less common in anchor teeth whose original buccal bone thickness was larger (21). However, a previous study (22) displayed that after RME, the thickness of the buccal bone did not alter as the changes were not significant at (P >.05). However, in the present trial the buccal bone width showed significant decrease and significant rise in the palatal bone breadth.

The comparison between the Cleft and Non-Cleft groups, in the current study there was no significant variation between both groups in the buccal and palatal alveolar bone width alterations at molar region prior and following 6 months of RME. In literature there aren't many investigations that compared how alveolar bone thickness alterations after RME between unilateral and bilateral cleft lip and palate cases. Other research (19) displayed that there was no discernible change in the posterior buccal bone volume between the cleft and noncleft sides in the premolar region of children with cleft lip and palate as a result of the orthopedic stresses of rapid maxillary expansion. Nonetheless, there is no study comparing it in cleft and non-cleft cases to figure out if there an effect of the palatal scare on alveolar bone thickness especial in molar region.

In the current study molar angulation increased statistically significant after expansion with RME protocol in both groups. Such result is consistent with the investigation's outcomes (23) when used two types of expanders with RME in individuals having bilateral cleft lip and palate and research [20] when used fan expander with Alt-RAMEC procedure in unilateral cleft lip and palate patients. Moreover, previous study [17] was compared buccal inclination in slow (Quad-helix) and rapid (Hyrax) maxillary expansion in bilateral cleft lip and palate concluded increase in buccal inclination with less increase with slow maxillary expansion than RME.

Moreover, a previous study [24] compared the buccal segment inclination changes in CLP and Class III non cleft patients, and it concluded that there was a notable variation in the upper premolar inclination, which was primarily negative in CLP individuals. They attributed that to scarring following surgery. Following cleft palate operation, the deficient bone suture is covered by scar tissue, and strong collagen fibers join with periodontal ligament fibers via the palate, dragging the teeth to tilt to the lingual side. This causes a negative angle to be measured [19, 25].

In noncleft patients, previous study [26] has been shown increase buccal inclination of maxillary first molar after using Hass type expander with RME. Moreover, a study [27] found increase of buccal inclination of anchorage teeth when used expander with differential opening and Hyrax expanders with less increase of inclination with differential appliance. According to Figueiredo et al. [18], symmetric expansion was accomplished, albeit more successfully in the molar region, and buccal tiling was comparable on the cleft and non-cleft sides.

**Conclusions**

After rapid maxillary expansion, individuals with CLP have the same first molar angulation as well buccal and palatal alveolar bone width changes at molar area as Non-Cleft patients those have maxillary hypoplasia and Class III malocclusion.

**Limitations**

The sample availability that matches the inclusion criteria was limited. Additional prospective investigations are required to evaluate the stability throughout the longtime of cases treated by RME with and without CLP. Moreover, consider sorting the sample into three groups unilateral CLP and bilateral CLP and Class III.

**Conflict of Interest**

The authors affirm that they possess no conflicts of interest.

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