Three Dimensional Assessment of soft tissue and Airway changes after Rapid Maxillary Expansion in Cleft Palate Patients using Cone Beam CT

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Abstract: Objective: Measuring air way and soft tissue changes in cleft palate patients after rapid maxillary arch expansion by bonded hyrax appliance using cone-beam computed tomography. Material and methods: RME for 10 cleft patients ranged from 8-12 years old then pre and post expansion CBCT image was taken to them and analyzed by on demand 3D app software (Cybermed, South Korea) was utilized for linear and angular measurement. Results: Significant increase in nasal width, air way width, no change in air way depth and enhance soft tissue measurement. Conclusion: Enhanced air way and soft tissue measurements after RME on cleft patients. [Ahmed M. Elbahar, Wael M. Refai, Mohamed E. Ibrahim, Mohamed G. Elshal. Three Dimensional Assessment of soft tissue and Airway changes after Rapid Maxillary Expansion in Cleft Palate Patients using Cone Beam CT. Life Sci J 2019;16(11):79-87]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 8, doi:10.7537/marslsj161119.08.

Key Words: RME, Cleft patients and Air way.

1. Introduction:

Cleft lip and palate (CLP) is the most common human congenital malformation affecting the facial region. Cleft lip and palate occurs at the time of early embryogenesis from a failure in fusion of medial nasal and maxillary processes that result in orofacialclefting involving the upper lip, alveolus and/or primary palate. The most widely adopted management strategy includes the surgical reconnection of the cleft anatomical structures followed by their development to gain proper appearance, occlusion, and speech. Maxillary growth in operated CLP patients is often decreased in the 3 dimensions. The maxillary growth deficiency affects the dental arches relationship on the vertical, sagittal, and transverse planes, frequently resulting in anterior and/or posterior crossbite occurring in the early dentition. (3)

Early correction of posterior crossbite is considered necessary for children with cleft palate to relocate the permanent tooth follicles in a more favorable position, and improve the potential for normal development of occlusion. (44)

Rapid maxillary expansion (RME) is an orthodontic procedure that aims to correct the maxillary arch constriction by transversal separation of maxillary halves. The aim of maxillary expansion is not only to treat the posterior crossbite, but also to align the maxillary segment. This procedure increases the alveolar cleft width and creates room for bone graft placement. CBCT images are valuable for determining the volume of the alveolar defect. From all previously mentioned, the skeletal and dental changes that occur due to RME in cleft patients proved to be a point of worthy investigation. Accordingly this study will be conducted to highlight this aim. (27)

Materials and Methods:

This study performed on 10 unilateral cleft lip and palate patients (UCLP) in the mixed dentition with cleft lip and palate surgical repair performed at early childhood with constricted maxillary arch. The patients’ age’s ranged from 8-12 years old. They were collected from the clinic of the department of orthodontics faculty of dentistry Minia University. Patients were treated by RME as a part of their comprehensive treatment using the bonded hyrax appliance. Patient Age from 8-12 years. Patient in mixed dentition with constricted maxillary arch. Patient performed lip and palatal repair in early childhood. Posterior cross bite is present. Free from any systemic diseases. No previous orthodontic or orthopedic treatment.

For each patient these records were obtained. Standardized extraoral and intraoral photographs. Standardized dental casts. Panorama and lateral cephalometric radiographs. CBCT before and after expansion (after 6 months of treatment). Palatal arch was constructed to the patients for retention. Each patient was treated by RME utilizing bonded hyrax appliance. Activation of appliance One quarter turns twice per day for each patient. The expansion continue until over correction was obtained to the extent that palatal cusps of the maxillary first molar touches the buccal cusps of the opposing teeth then the appliance...
was left in situ as a retainer for six months and then the appliance was removed.

All patients under this study were submitted for CBCT scanning for angular and linear evaluation. After acquisition, data were exported and transferred in DICOM format and downloaded via a Compact Disk (CD) to a personal computer for analysis, where, Ondemand 3D App software (Cybermed, South Korea) was utilized for linear and aList of Landmarks.

![Fig 1 extra oral photographs before expansion](image1)

- Frontal view
- Lateral view

![Upper occlusal view](image2)

![Lower occlusal view](image3)

- Frontal view
- Right side view
Fig 2. Pre-expansion intra-oral photographs

Left side view

Fig 3. Frontal view with hyrax

Fig 4. Extra-oral photographs after expansion

Lateral view

Frontal view

Upper occlusal view

Lower occlusal view
Nasion
Sella Turcica
The most superior point of the anterior wall if sella turcica at the junction with tuberculum sellae
Right Porion
Left Porion
Right Orbitale
Left Orbitale
Basion
Anterior Nasal Spine
Posterior Nasal Spine
Pognion
Gnathion
Menton
Right Gonion
Left Gonion
Mesial cusp tip of upper right first molar
Mesial root tip of upper right first molar
Mesial cusp tip of upper left first molar
Mesial root tip of upper left first molar
Incisal edge of upper right central incisor
Root tip of upper right central incisor
Incisal edge of lower right central incisor
Root tip of lower right central incisor
Incisal tip of upper right canine
Root tip of upper right canine
Incisal tip of upper left canine
Root tip of upper left canine
Glabella
Soft tissue Nasion

Fig5. Post-expansion intra-oral view
| PN     | Pronasale          |
| Sn     | Subnasale         |
| Col    | Columella         |
| A’     | Soft tissue A Point |
| Ls     | LabraleSuperius  |
| Li     | LabraleInferius   |
| B’     | Soft Tissue B point |
| Pog’   | Soft tissue Pogonion |
| Gn’    | Soft tissue Gnathion |
| Me’    | Soft tissue Menton |
| R Co   | Right Condylon   |
| L Co   | Left Condylon    |
| JR     | Deepest point of right zygomatic process of maxilla |
| JL     | Deepest point of left zygomatic process of maxilla |
| MRPP   | Right Maxillary posterior point |
| ELSA   | Computer modified medial point between right and left foramen spinosum |
| Right Nasal Point | Most lateral point at the middle of right inferior nasal concha |
| Left Nasal Point  | Most lateral point at the middle of right inferior nasal concha |
| Right Airway Point | Most lateral point at the right pharyngeal wall at the level of hard palate |
| Left Airway Point  | Most lateral point at the left pharyngeal wall at the level |
| Anterior Airway Point | Most anterior point at the pharyngeal wall at the level of tip of the soft palate |
| Posterior Airway Point | Most posterior point at the pharyngeal wall at the level of tip of the soft palate |

**Measurements:**

1. **Linear soft tissue measurement**

   - **Upper Lip/ E line**
     - Linear horizontal distance between Ls and E line
   - **Lower Lip/ E line**
     - Linear horizontal distance between Li and E line
   - **Nasal Width**
     - Linear horizontal distance between R and L nasal points

2. **Angular soft tissue measurement**

   - **Angle of facial convexity**
     - Angle between G-Sn-Pog
   - **H angle**
     - N’-Pog/ H line

3. **Airway measurements**

   - **Airway Width**
     - Linear distance between Right and Left Airway points
   - **Airway Depth**
     - Linear distance between Anterior and Posterior Airway pointed

**Fig. 6 Measurements automatically generated by software**
Statistical method:
The collected data were coded, tabulated, and statistically analyzed using SPSS program and graphical presentation was done using Microsoft excel version 2016.

Descriptive statistics were done for parametric quantitative data by mean ± standard deviation and for non-parametric quantitative data by median and interquartile range (IQR), while they were done for categorical data by number and percentage.

Determination of the normality of data was done by Shapiro-Wilk test.

Analyses were done for parametric quantitative data using Paired Samples T test between pre and post treatment.

Analyses were done for non-parametric quantitative data using Wilcoxon Signed rank test between pre and post treatment.

The level of significance was taken at (P value < 0.05)

Results:
Data from this study were gathered, tabulated and then statistically analyzed.

Results are presented under the following heading:

1. Soft tissue measurement analysis:
   a. Soft tissue angular measures:
      i. H-angle
      ii. G-Sn-Pog
   b. Soft tissue linear measures:
      i. Upper lip/E line
      ii. Lower lip/E line.

2. Nasal measurement analysis:
3. Air way measurements

Soft tissue measures
Soft tissue angular measures:

As regarding soft tissue angular measures there was significant decrease in G-Sn-Pog angles after treatment; while H angle showed in significant change.

Soft tissue linear measures:
As regarding soft tissue linear measures: upper lip/E line showed significant decrease after treatment. While lower lip/E line showed insignificant change after treatment.

Nasal measures:
As regarding nasal width there was significant increase after treatment.

Airway measures
As regarding airway measures: airway width showed significant increase after treatment. While airway depth showed insignificant change after treatment.

4. Discussion:
The craniofacial morphology of children with unilateral cleft lip and palate (UCLP) differs from that
of children without clefts. Maxillary arch constriction is frequently observed in operated patients with UCLP. Therefore, rapid maxillary expansion (RME) is often required in children with UCLP.

Early treatment of crossbite by RME prevents skeletal asymmetry and muscle functional disturbances in cleft patients. Eliminating crossbites improve masticatory functions, speech, permanent teeth eruption and alignment, nasal breathing and providing more space to the tongue that lead to decrease sleep apnea later on in cleft patients.

We chose rapid expansion not slow one according to Garib et al (37) and Vasant et al (28) who concluded that minimal buccal tipping of molars occur with rapid expansion and more buccal tipping is seen with slow expansion. Gregorio L et al (29) said that slow palatal expansion take greater expansion time that is minimized by using rapid expansion with nearly same results. This study revealed statistically significant increase in the nasal width after treatment that measured from linear horizontal distance between R and L nasal points with a Mean ± SD from (23.3±3 to 25.9±4.3) these findings are in agreement with Garib D et al (47), Figueirado DS et al, (10), Trindade et al (24) and Iwasaki T et al (38).

As regarding to soft tissue linear measurement upper lip / E line show significant decrease after treatment with a Mean ± SD from (6.4±5.1 to 5.3±4.7) while lower lip / E line show in significant change after treatment which confirm that mandibular length doesn’t changed after treatment while slight increase in the maxillary antero-posterior measures.

As regarding to soft tissue angular measurements there was a significant decrease in the G- Sn – Pog angle after treatment while H angle show in significant change due to slight maxillary advancement.

Improvement of soft tissue profile is of obvious psychological importance to cleft patients as reported by Casai D et al (6) and Tindlund RS et al (35).

As regarding airway measurements. airway width measured from right airway point (most lateral point at the right pharyngeal wall at the level of hard palate) to left airway point (most lateral point at the left pharyngeal wall at the level of hard palate) there was a significant increase after treatment.

Airway depth that measured from anterior airway point (most anterior point at the pharyngeal wall at the level of tip of soft palate) to the posterior airway point (most posterior point at the pharyngeal wall at the level of tip of the soft palate) showed insignificant change after treatment that means that only airway width increase after expansion in cleft patients.

Conclusion:

1. Nasal width was increased after expansion.
2. No significant change in H angle after expansion.
3. There was significant decrease of angle of facial convexity.
5. Airway depth showed no change after treatment.

References:

2. Al-gunaïd T, Ashiihito T, Ph D, Yamaki M, Ph D, Hanada K. Relapse Tendency in Maxillary Arch Width in Unilateral Cleft Lip and Palate Patients With Different Maxillary Arch Forms. The cranio facial journal 2003. doi:10.1597/07-053.1
4. Carolina Baratieri, a Matheus Alves, Jr, a Margareth Maria Gomes de Souza, b Monica Tirre de Souza Ara. and Lucianne Cople Maia. Does rapid maxillary expansion have long-term effects on airway dimensions and breathing. 2010:146-156. doi:10.1016/j.ajodo.2011.02.019
6. Cassi D, Alberto Â, Blasio D. Dentoalveolar Effects of Early Orthodontic Treatment in Patients With Cleft Lip and Palate. jraniofacsurg 2017;00(00):1-6. doi:10.1097/SCS


29. Lagravère MO, Major PW. Proposed reference point for 3-dimensional cephalometric analysis


33. Rolf Tindlund, per Rygh. Different Effects On Facial Morphology In Unilateral And Bilateral Cleft Lip And Palate Patients. the cleft palate-cranio facial journal 1993 30 (2)- 208-221.


