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Original Research Paper

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# ASSESSMENT OF TONGUE POSITION, HYOID BONE POSITION, AIRWAY SPACES AND SKELETAL CHANGES IN ORTHODONTIC PATIENTS TO EVALUATE MOUTH BREATHING HABIT: A CEPHALOMETRIC STUDY

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**ABSTRACT** **Background-**Human beings are considered to be nose breathers but various reasons can force them to adapt by breathing through their mouth instead of nose, and this can have extensive consequences. Breathing through both nose and mouth provide lungs with oxygen but with extremely dissimilar effects on the body and with different levels of oxygen supply. **Materials & Methodology-** 64 children (aged 8-14years) who are undergoing/ have undergone orthodontic treatment were included in this study. Assessment of tongue position, hyoid bone position, airway spaces and skeletal changes was carried by tracing the lateral cephalogram. **Results-** There was significant change in tongue position, hyoid bone position, airway spaces and skeletal landmarks. **Conclusion-** It is speculated that respiration is one factor predisposing to malocclusion of teeth due to the influence of tongue posturing, hyoid bone positioning, disturbance in airway spaces and skeletal abnormalities.

**KEYWORDS :** Mouth breathing, Respiration, Lateral cephalogram, Nasal breathers

## INTRODUCTION

The main physiological functions of the oral cavity are respiration, suckling, swallowing, mastication and speech. All these functions are balanced; the disturbance in one oral function results to an abnormal growth and development of bony and soft tissue structures of the craniofacial complex.[1]

Mouth breathing refers to the state of inhaling and exhaling through the mouth. The literature describes the prevalence of mouth breathing as ranging from 5 to 75% of tested children. The mouth does not usually contribute in respiration. Increased struggle to the flow of air through the nasal passage may be considered to be the key reason of mouth breathing. The habit to breathe through the mouth instead of the nose is becoming perennial these days. The clinical symptoms are diverse in respect of severity depending on mouth breathing duration.[2] If not treated developmental deficiencies progress and thereby the severity of structural changes in the body rises.

## MATERIALS AND METHODS

### Study Design

A retrospective aspect with simple randomized, parallel-group study with sample size of 64 children between age group of 8-14 years were taken.

The clinical clearance was obtained from the ethical committee of the institute.

### Inclusion Criteria

Children of 8 – 14 years of age undergoing/have undergone any orthodontic treatment.

### Exclusion Criteria

Marked intraoral soft tissue pathology.

### Methodology

Lateral cephalograms obtained with exposure at 80 kVp; 40 mA for 2 seconds from a fixed distance of 60 inches were analyzed.

The cephalogram was assessed for the tongue position, hyoid bone position, airway spaces, skeletal changes and compared with the standard normal values.

### Skeletal changes tracing (Figure 1) (Table 1):

### Landmarks:

**Table 1: Landmarks for Skeletal Analysis**

| Landmark | Definition |
|---|---|
| Sella (S) | The center of sella turcica |
| Nasion (N) | The most anterior point of the frontonasal suture |
| Point-A (A) | The innermost point on the contour of the maxilla between the anterior nasal spine and the incisor |
| Point-B (B) | The innermost point on the contour of the mandible between the incisor and the bony chin |
| Gonion (Go) | The point on the curvature of the angle of the mandible located by bisecting the angle formed by the lines tangent to the posterior ramus and the inferior border of the mandible |
| Pogonion (Pg) | The most anterior point on the chin |
| Menton (Me) | The most inferior point on the mandibular symphysis in the midline |
| Gnathion (Gn) | The lowest, most anterior midline point on the symphysis of the mandible (midway between the menton and the pogonion) |
| A to Y-axis distance | The vertical distance from point A to Y-axis |
| Pg to Y-axis distance | The vertical distance from point Pg to Y-axis |
| Mandibular plane (MP) | Extends from the gonion to the gnathion |
| Mandibular plane angle (MP-SN) | The angle between mandibular plane and SN |

1. SNA- Sella-Nasion Point A angle
2. SNB- Sella-Nasion Point B Angle
3. SN-Go Gn- Mandibular plane angle to anterior cranial base
4. SN-Occlusal plane
5. 1.NA- Distance from upper incisor to NA line
6. 1.NB- Distance from lower incisor to NB line

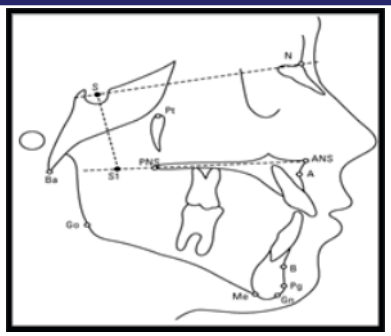


**Figure 1: Skeletal Analysis**

**Hyoid Triangle Tracing (Figure 2):**
**Landmarks:**

1. C3: antero-inferior angle of the third cervical vertebra.
2. RGn: retrognathion, the most posterior point of the mandibular symphysis.
3. H: hyoidale, the most superior and anterior point of the hyoid bone.
4. H1: a point resulting from the perpendicular projection of point H on the RGn–C3 line

**Figure 2: Hyoid Bone Analysis**

The hyoid triangle tracing was conducted on all the radiographs, according to where the cephalometric points RGn, H and C3 joined.

The plane: RGn–C3 plane. This is formed by joining the cephalometric point RGn (retrognathion) and C3 (third cervical bone). The position of the hyoid bone in relation to the vertebral column and the mandible is the following:

1. In the case of a normal cervical relationship, the vertical position of the hyoid bone should be under the RGn–C3 plane, which would give a positive triangular position.
2. The hyoid bone is in a normal position when it is situated up to 5 mm under the RGn–C3 plane, thus forming the hyoid triangle.
3. If there is any disturbance to the position of the hyoid bone the latter will be found over the RGn–C3 plane or above this, therefore forming a negative hyoid triangle.

The sides and the height of the triangle were also measured.

- Base of the triangle: C3–RGn
- Side 1 (S1): C3–H
- Side 2 (S2): H–RGn
- Height of the triangle

**Airway Space Tracing (Figure 3):**
**Landmarks:**

1. Superior posterior airway space (SPAS): It is the thickness of the airway behind the soft palate along a line parallel to the Go-B point plane.
2. Posterior airway space (PAS): It is the linear distance between a point at the base of the tongue and another point on the posterior wall of the pharynx, both measured by the extension of a line from point B to point Go.

**Figure 3: Airway Space Analysis**

**Tongue Position Tracing (Figure 4):**
**Landmarks:**

1. I – Incisal edge of lower incisors
2. Mc – Distal and Cervical third of Last erupted molar
3. V – Most caudal point on shadow of soft palate
4. IV line is bisected at point O which is the midline
5. 1 – Distance between soft palate and tongue
6. 2 to 6 - Distance between dorsum of tongue and roof of mouth
7. 7 – Distance between tongue and incisors

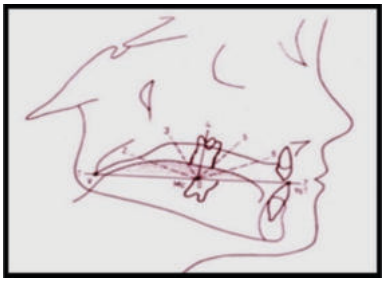

**Figure 4: Tongue Position Analysis**

- Measures of Rickets[3], Steiner[4] and McNamara[5] were considered for the cephalometric analysis (Table 2).
- All the collected data was statistically evaluated using software.

**Table 2: Comparative Values**

| S. No. | Parameter | Normal Value | Patient Value |
|---|---|---|---|
| | Skeletal Changes | | |
| 1. | SNA | 79 – 85 deg | |
| 2. | SNB | 76 – 82 deg | |
| 3. | SN-Go-Gn | 27 – 37 deg | |
| 4. | SN-O Plane | 17 – 27 deg | |
| 5. | 1.NA | 16 – 28 deg | |
| 6. | 1.NB | 18 – 32 deg | |
| | Tongue Position | | |
| 1. | 1 | 32.5 – 33.1 mm | |
| 2. | 2 | 20.85 – 21.8 mm | |
| 3. | 3 | 14.6 – 15.4 mm | |
| 4. | 4 | 10.3 – 11.1 mm | |
| 5. | 5 | 11.3 – 11.8 mm | |
| 6. | 6 | 14 – 14.7 mm | |
| 7. | 7 | 27.8 – 28.9 mm | |
| | Hyoid Bone Position | | |
| 1. | S1 | 29.8 – 36.6 mm | |
| 2. | S2 | 35 – 47 mm | |
| 3. | Base of Triangle | 65 – 80 mm | |
| 4. | Height of Triangle | 1.6 – 8.4 mm | |
| | Airway Space | | |
| 1. | SPAS | 9.1 – 13.1 mm | |
| 2. | PAS | 7.8 – 13.8 mm | |

## RESULTS

The comparison of traced data in relation to standard measurement was done.

The subjects were categorized as nasal breathers and mouth breathers based on the data & following findings were recorded (Table 3).

1. Comparison of the SNA, SNB, INA & INB between the two groups shows that all the values are higher in mouth breather group with a t value of -4.286, -3.266, -2.613 & -3.459 respectively and are statistically significant with a p value of <0.001.
2. Comparison of the SN-Go-Gn & SN-O plane between the two groups shows that both the values are higher in mouth breather group with a t value of -0.477 & -0.378 respectively and is statistically non-significant with a p value of 0.635 & 0.707 respectively.

**Table 3: Comparison Between Skeletal Parameters Of Nasal And Mouth Breathers**

| Skeletal parameters | Nasal Breather | Mouth Breather | t test | *p* Value |
|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | |
| SNA | 83.19±5.73 | 90.4±7.36 | -4.286 | 0.001* |
| SNB | 80.76±6.45 | 87.43±9.7 | -3.266 | 0.002* |
| SN-Go-Gn | 36.58±4.95 | 37.43±7.26 | -0.477 | 0.635ˢ |
| SN-O plane | 27.06±6.37 | 27.79±6.68 | -0.378 | 0.707ˢ |
| INA | 28.31±5.37 | 32.7±6.7 | -2.613 | 0.011* |
| INB | 28.33±6.12 | 33.63±5.57 | -3.459 | 0.001* |

ˢ NS = Non-significant (*p* value>0.05; Independent t test)

**p* value <0.001 = Significant; Independent t test)

The values compared in table 4 regarding airway spaces, concludes that:

1. Comparison of the SPAS & PAS between the two groups shows that both the values are higher in Nasal breather group with a t value of 6.375 & 2.843 respectively and are statistically significant with a p value of <0.001.

**Table 4: Comparison Between Airway Space Parameters Of Nasal And Mouth Breathers**

| Airway space parameters | Nasal Breather | Mouth Breather | t test | *p* Value |
|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | |
| SPAS | 9.69±0.6 | 8.21±1.25 | 6.375 | <0.001* |
| PAS | 11.14±1.74 | 9.54±2.28 | 2.843 | 0.006* |

**p* value <0.001 = Significant; Independent t test)

As shown in table 5, there are following fluctuations in hyoid bone positioning:

1. Comparison of the Base of triangle & S2 between the two groups shows that both the values are higher in Nasal breather group with a t value of 2.227 & 2.761 respectively and are statistically significant with a p value of 0.03 & 0.008 respectively.
2. Comparison of the Height of triangle & S1 between the two groups shows that both the values are higher in Mouth breather group with a t value of -0.412 & 0.099 respectively and is statistically non-significant with a p value of 0.682 & 0.922 respectively.

**Table 5: Comparison Between Hyoid Bone Parameters Of Nasal And Mouth Breathers**

| Hyoid bone Parameters | Nasal breather | Mouth breather | t test | *p* Value |
|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | |
| Base of triangle | 64.71±6.95 | 60.77±6.51 | 2.227 | 0.03* |
| Height of triangle | 8±4.22 | 8.51±4.78 | -0.412 | 0.682ˢ |
| S1 | 30.81±4.71 | 30.67±5.34 | 0.099 | 0.922ˢ |
| S2 | 36.83±5.89 | 33.13±4.58 | 2.761 | 0.008* |

ˢ NS = Non-significant (*p* value>0.05; Independent t test)

**p* value <0.001 = Significant; Independent t test)

The values compared in table 6 regarding tongue position, concludes that:

1. Comparison of the Tongue Position 1,2 & 7 between the two groups shows that all the values are higher in Mouth breather with a t value of -1.722, -1.724 & -0.99 respectively and are statistically non-significant with a p value of 0.09.
2. Comparison of the Tongue Position 3,4,5 & 6 between the two groups shows that all the values are higher in Mouth breather with a t value of -3.008, -2.763, -2.746 & -2.512 respectively and are statistically significant with a p value of 0.004.

**Table 6: Comparison Between Tongue Position Parameters Of Nasal And Mouth Breathers**

| Tongue position Parameters | Nasal breather | Mouth breather | t test | *p* Value |
|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | |
| Tongue Position 1 | 32.38±3.51 | 33.7±2.51 | -1.722 | 0.09ˢ |
| Tongue Position 2 | 21.79±3.51 | 26.19±11.4 | -1.724 | 0.09ˢ |
| Tongue Position 3 | 17.88±2.58 | 20.26±3.13 | -3.008 | 0.004* |
| Tongue Position 4 | 15.86±3.14 | 18.08±2.97 | -2.763 | 0.008* |
| Tongue Position 5 | 15.86±3.69 | 18.44±3.46 | -2.746 | 0.008* |
| Tongue Position 6 | 19.55±5.18 | 22.66±4.39 | -2.512 | 0.015* |
| Tongue Position 7 | 30.57±3.52 | 31.4±2.92 | -0.99 | 0.326ˢ |

ˢ NS = Non-significant (*p* value>0.05; Independent t test)

**p* value <0.001 = Significant; Independent t test)

## DISCUSSION

The mouth breather is a patient with multiple conditions and therefore requires comprehensive and multidisciplinary clinical look to early detect this syndrome, minimizing its deleterious effects.

According to Moss's theory,[6] normal nasorespiratory activity influences the development of craniofacial structures, promoting their harmonious growth and development in proper interaction with mastication, swallowing, and the other structures of the head and neck.

A modification in the breathing pattern that favours mouth breathing is accompanied by a series of functional transformations. William J (1980)[7] emphasized the importance and power of human habit and proceeded to draw a conclusion. It was noted that the laws of habit formation are unbiased; habits are capable of causing either good or bad actions.

A study was conducted by Isabel C, Paola B (2014)[8]to compare cephalometric values between nasal and oral breathing children and to measure the upper and lower airway space in

both groups. They concluded that the mouth breathing children showed a more retruded mandible (SNB), and a greater inclination of the mandibular plane (NS-Go Gn) and occlusal plane (NS-O Pl.), than the nose breathing children ($p < 0.05$). This study is in accordance to the present study.

Similarly, Faria P (2002)[9] indicated that changed mode of breathing was associated with maxillo-mandibular retrusion in relation to the cranial base in the mouth breathers and the Sn-Go-Gn (Sella-Nasion to Gonion-Gnathion) and N-S-Gn (Nasion-Sella to Gnathion) angles were greater in the mouth-breathing group. This study is in accordance to the present study.

Yadav N, Gupta S (2014)[10] assessed the posture of tongue in individuals with different skeletal patterns in vertical plane in order to understand the relationship between the tongue posture and the growth pattern of an individual. They concluded that the dorsum of the tongue was found to be higher in subjects with vertical skeletal pattern at all points. There was no significant difference in the distance between soft palate and root of the tongue. There was no significant difference in the position of tongue tip between the groups. This study is in accordance to the present study.

Isabel C, Paola B, (2018)[11] examined the hyoid bone position in patients with mouth breathing habit. They concluded that the hyoid bone was located above the RGn–C3 plane or at the same height; the hyoid triangle was in a higher or cranial position. This indicated that there may be some disturbance in the position of the hyoid bone. This study is not in accordance to the present study.

Regarding the measurements of Side1 (C3–H distance) Janicka A (2006)[12] found that it was more in the mouth breathing children and determined that the hyoid bone in patients with upper airway obstruction was more posteriorly located. This study is not in accordance to the present study.

A study was conducted by Jose E, Candace Y, Veronique I, Andrew B, Gerald R (2017)[13] to determine if anatomic dimensions of airway structures are associated with airway obstruction in obstructive sleep apnea (OSA) patients. The OSA group demonstrated a significantly longer MP-H distance (p z 0.009) and shorter nasal PAS diameter (p z 0.02). The PAS area was smaller (p z 0.002) and tongue volume larger in the OSA group (p z 0.004). The MP-H distance, PAS measurements, and tongue volume was of clinical relevance in OSA patients. A long MP-H distance, and small PAS diameters and area were significant anatomic measures in OSA. This study is in accordance to the present study.

The purpose of the present study was to ascertain that breathing mode is related to facial growth. The data of the present study showed no quantitative evidence that the subjects were, indeed, accurately classified by their predominant mode of respiration because sample selection was performed randomly. The presence of mouth breathing in pediatric patients is a relatively common fact and may result in a series of changes of facial skeleton.

## CONCLUSION

The statistical analysis indicated that there was a statistically significant difference ($p < 0.01$) for SNA and SNB angles. The maxilla and mandible were more retrognathic in the mouth-breathing group. In most of the children with mouth breathing the hyoid bone was placed in a position that was higher with regard to the cervical spine and mandible (above the RGn–C3 plane). The cephalometric measurements in the antero-posterior plane showed characteristic combination of craniofacial deformity. Low tongue posture and elongation of lower anterior facial height were apparent. Therefore, it is speculated that respiration is one factor predisposing to malocclusion of teeth due to the influence of tongue posturing and possibly even the positioning of the mandible, which was maintained downward and backward in the growth phase.

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