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# Post-treatment cephalometric evaluation of the hyoid bone position and pharyngeal space in skeletal class II adolescent patients

[1]Dr. M. Khais Nazar, MDS, Department of Orthodontics and Dentofacial Orthopedics, Yenepoya Dental College, Yenepoya University, Mangalore, India

[2]Dr. Subramanya Shetty, MDS, Professor, Department of Orthodontics and Dentofacial Orthopedics Yenepoya Dental College, Yenepoya University, Mangalore, India

[3]Dr. Kevin Joseph, MDS, Senior Lecturer, Department of Orthodontics and, Dentofacial Orthopedics, Yenepoya Dental College, Yenepoya University, Mangalore, India

**Corresponding Author:** Dr. Kevin Joseph, MDS, Senior Lecturer, Department of Orthodontics and, Dentofacial Orthopedics, Yenepoya Dental College, Yenepoya University, Mangalore, India

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**Conflicts of Interest:** Nil

## Abstract

**Background:** Backward placement of the mandible forces the tongue to rest more posteriorly, decreasing the distance between the cervical vertebrae and the mandibular corpus and causing a retro-displacement of the tongue and hyoid bone, possibly reducing upper airway volume. This study aimed to analyze changes in the position of the hyoid bone and pharyngeal space after myofunctional appliance in skeletal class II adolescent patients.

**Method:** A retrospective cephalometric study was conducted. The sample consisted of pre-and post-treatment lateral cephalograms of twenty-eight patients who had undergone myofunctional appliance therapy. Each patient's pre- and post-treatment lateral cephalograms were taken and traced manually. The following skeletal, dental, and soft tissue landmarks are identified for the study. Four planes (SN plane, CHL, CL, Go-Me), seven linear measurements (Hy-B, Hy-M, Hy-Cl, Hy-Go Me, Hy-CHL, the width of the upper pharynx, and the lower pharynx), and four angles (Ba N –Hy, SN-Hy, ANS-PNS-Hy, and ANB angle) were constructed. The pre-treatment and post-treatment lateral cephalograms of the patients were compared and evaluated.

**Result:** The study result showed statistically significant differences in the linear measurement between the pre and post-cephalograms after myofunctional appliance treatment for the parameters Hy-B, Hy-M, Hy-Go Me, the upper pharynx's width, and the lower pharynx's

width. For angular values, Ba-N-Hy, SN-Hy, and ANS-PNS-Hy showed no statistically significant difference between pre-treatment and post-treatment except for the ANB angle proving mandibular advancement after myofunctional appliance therapy.

**Conclusion:** The study's outcome revealed no significant changes in hyoid bone position in the horizontal dimension. The Hyoid bone was shifted upward in the vertical dimension. Following therapy with myofunctional equipment, the width of the upper pharynx was increased. The width of the lower pharynx changed significantly.

**Keywords:** Pharynx; Retrospective study; Retrognathia; Myofunctional Therapy; Hyoid bone

## Introduction

Changes in normal airway function during the active craniofacial growth period can profoundly influence its growth and development. Since altered breathing function could affect facial growth and morphology, respiratory function and upper airway morphology play an important role in orthodontic diagnosis and treatment planning. [1]

Backward placement of the mandible forces the tongue to rest more posteriorly, decreasing the distance between the cervical vertebrae and the mandibular corpus and decreasing the total available space for the tongue and pharyngeal airway space may, in turn, impair respiratory functions. Functional appliances are the treatment of choice during the pubertal growth spurt for stimulating the sagittal growth of the mandible. [2] These appliances alter the various muscles' activity, influencing the mandible's function and position to transmit forces to the dentition and the basal bone. Ozbek revealed a relationship between functional appliance treatment and the airway in 1997, stating that respiratory function affects mandibular, tongue, hyoid bone, head, and neck posture, and nasal airway preservation provides an important physiological basis for functional appliance therapy. The hyoid bone's position regulates the tongue's position and serves as a primary anchoring for the tongue muscles. [3] The backwardly positioned mandible causes the tongue and hyoid bone to move backward, possibly reducing upper airway volume. [4] Owing to their mutual interaction, mandibular deficiency, hypertrophic soft palate, and posteriorly postured tongue were identified as the major anatomical and physiological factors that significantly decrease upper and lower airway dimensions.

This study was designed to evaluate the changes in the position of the hyoid bone and the pharyngeal spaces after myofunctional appliance therapy in skeletal class II adolescent patients.

## Methodology

A retrospective cephalometric study was conducted. A convenience sampling method was followed. The sample consisted of pre-and post-treatment lateral cephalograms of 28 patients who had undergone myofunctional appliance therapy, irrespective of the type of appliance used, between January 2015 and December 2020. The records were sourced from the Department of Orthodontics and Dentofacial Orthopedics, ####### Dental College, #####. The inclusion criteria included patients aged 10-14 years, skeletal class II pattern, patients who had undergone myofunctional appliance therapy, and patients with no significant asymmetries and congenital anomalies. Patients with significant asymmetries, congenital anomalies, pathologies in the neck and head region, enlarged tonsils, and adenoids were excluded. Each patient's pre- and post-treatment lateral cephalograms were traced manually, and the skeletal, dental, and soft tissue landmarks were identified for the study.

The statistical package for social sciences (SPSS version 12) was used for data analysis. Descriptive statistics were calculated for different parameters, including frequency distributions, means, and standard deviations. To determine if any of the parameters were statistically related, the mean was subjected to paired t-test. The reliability of the measurements was evaluated by performing two repeated determinations of 28 radiographs randomly selected from the samples at 25-day intervals by the same operator and comparing the first and second determinations using the paired t-test.

The following parameters were used:

Hard tissue landmarks (Figure 1)

1. Sella (S)- The midpoint of the hypophyseal fossa.
2. Nasion (N) – The anterior most point of frontonasal suture.
3. Subspinale (point A)- The deepest midline point on the premaxilla between the anterior nasal spine and prosthion.
4. Supramentale (point B)- The deepest midline point on the mandible between Infradentale and pogonion.
5. Menton (Me)- Most caudal points in the outline of the mandible. It is regarded as the lowest point of the mandible.
6. Hyoidale (Hy)- The most anterior-superior point on the body of the hyoid bone.
7. Gonion (Go)- the lowest, posterior, and lateral point on the angle of the mandible.
8. Od - The most posterior point of the odontoid process of the second cervical vertebra.
9. C4p- The most posterior inferior point of the fourth cervical vertebra.

Planes (Figure 2)

1. Sella–nasion plane (S–N plane)- The plane extending from Sella to nasion.
2. Cervical horizontal line (CHL)- Perpendicular line from Od to cervical line.
3. Cervical line (CL)- Line connecting Od and C4p.
4. Mandibular plane (Go-Me)- The plane extending from gonion to menton.

Linear measurements (Figure 3)

1. Hyoidale-Supramentale (Hy–B)- Distance from Hyoidale to Supramentale.
2. Hyoidale-menton (Hy–Me)- Distance from Hyoidale to menton.
3. Hyoidale-cervical line (Hy–CL) Perpendicular distance from Hyoidale to the cervical line.
4. Hyoidale-mandibular plane (Hy–Go-Me)- Perpendicular distance from Hyoidale to mandibular plane.
5. Hyoidale–cervical horizontal line (Hy–CHL)- Perpendicular distance from Hyoidale to the cervical horizontal line.
6. Width of the upper pharynx- Measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall. This measurement is taken on the upper half of the soft palate outline.
7. Width of the lower pharynx- Measured from the intersection of the tongue's posterior border and the mandible's inferior border to the closest point on the posterior pharyngeal wall.

Angular measurements (Figure 4)

1. Ba-N-Hy- Angle between basion, nasion, and hyoid.
2. S-N-Hy- Angle between Sella nasion and hyoid.
3. ANS-PNS-Hy- Angle between the anterior nasal spine, posterior nasal spine, and hyoid.
4. ANB - Angle between points A, nasion, and B.

## Results

On comparing the linear measurement between the pre- and post-treatment lateral cephalograms after myofunctional appliance therapy, parameters Hy-B, Hy-M, Hy-Go Me, the width of the upper pharynx, and the width of the lower pharynx showed statistical significance differences indicating there was a change in the width of pharyngeal space and lengthening of the mandible. (Table 1) (Graph 1)

The angular measurements, ANS-PNS-Hy, and ANB angle showed statistically significant differences. (Table 2) (Graph 2)

## Discussion

According to the Functional Matrix theory, "growth and development of the craniofacial region are controlled by the functional activity of surrounding soft tissues." Respiration is a critical function that significantly impacts normal craniofacial growth and development. As a result, the pharyngeal airway space and craniofacial configuration are directly related, and any abnormalities in the airway space may affect the position of the surrounding skeleton. The airway assessment is an essential diagnostic factor guiding orthodontic and orthognathic treatment modalities. [5]

Skeletal Class II is the most prevalent malocclusion, representing one-third of cases worldwide. Most patients with this type of malocclusion have a component of mandibular deficiency with a vertical growth pattern, usually associated with difficulty in breathing. [6] [7] This cephalometric study evaluated the position of the hyoid bone and the change in pharyngeal space following treatment with myofunctional appliances. The age group of 10-14 years was included in this study since it represented a period of active craniofacial complex growth and development.

**Forward mandibular positioning away from the hyoid bone** was evident from the parameters Hy-B, Hy-M, and Hy-Go Me. The hyoid bone is displaced superiorly and posteriorly from a normal position in Class I and II malocclusions. Dentofacial orthopedics is commonly employed to encourage mandibular growth in skeletal Class II cases with mandibular deficiency. Functional orthopedic treatment in such patients increases oral airway dimensions, lowering the risk of future respiratory difficulties. Because the hyoid bone is connected to the mandible by muscles, changes in mandible position also affect the hyoid bone. Angle's Class II malocclusion has a predisposition for a compromised oropharyngeal airway, with the hyoid bone being the anterior boundary of this airway; hence its position in therapy must be defined. [8]

Hy-Me and Hy-B reflect the anteroposterior movement of the hyoid bone in regard to the mandible, whereas Hy-CL represents the movement in relation to the cervical vertebrae. Increasing Hy-Me and Hy-B levels indicate that the mandible moves anteriorly from the hyoid bone. Because the relative anterior movement of the mandible was greater than that of the hyoid bone after functional appliance therapy, Hy-Me and Hy-B were increased significantly. Values of Hy–CHL, Hy-CL, Ba N- Hy, and SN –Hy decreased in post myofunctional cephalogram. Because the geniohyoid, mylohyoid, and anterior belly of digastric muscles join to the hyoid bone, these muscles are responsible for the mandible's downward movement; therapy with a functional appliance produces hyperactivity of these muscles. As a result, the balance between the suprahyoid and infrahyoid muscles is disrupted, causing the hyoid bone to shift higher, whereas functional appliance therapy produces forward mandibular displacement.

In this study, the upper pharyngeal and lower pharyngeal widths were increased. Treatment with a myofunctional appliance was related to mandibular advancement and forward tongue posture, which reduced soft palate pressure, increased oropharyngeal dimension, and improved airway permeability. To enhance facial aesthetics and expand pharyngeal airway space while retaining a good hyoid bone position, myofunctional appliances are utilized to correct skeletal class II malocclusions. As a result, the probability of developing obstructive sleep apnoea may be reduced. [8]

This study limits the fact that lateral cephalograms provide only a two-dimensional view of the airway. More expansion of pharyngeal space is in the transverse plane compared to the sagittal plane, and the transverse changes cannot be measured through the lateral view.

**Conclusion**

The study concluded with significant outcomes. The Hyoid bone showed no displacement in the horizontal dimension. In the vertical plane, the Hyoid bone showed an upward displacement. The width of the upper pharynx and lower pharynx increased after treatment, and ANB was significantly decreased.

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**Legend Figures and Tables**

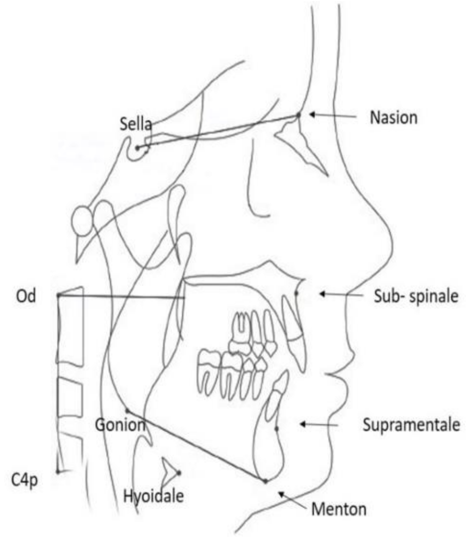



Figure 1: Hard Tissue Landmarks

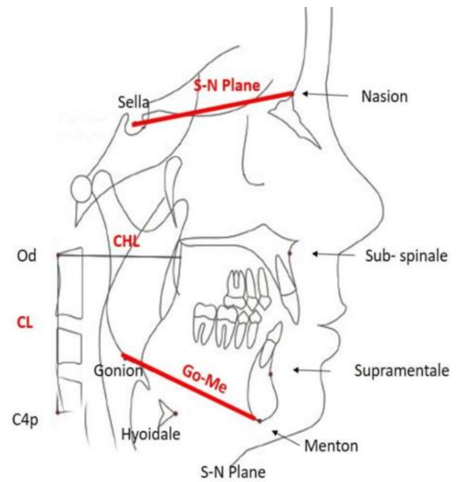



Figure 2: Constructed Planes

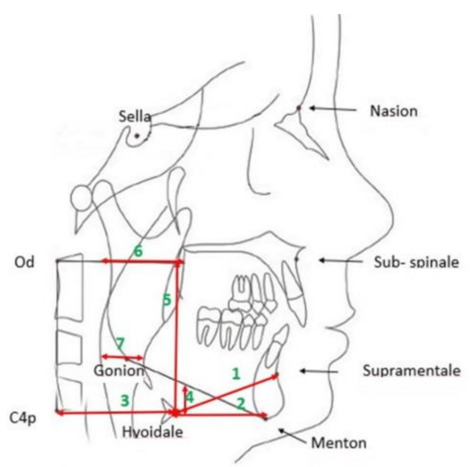



Figure 3: Linear Measurements

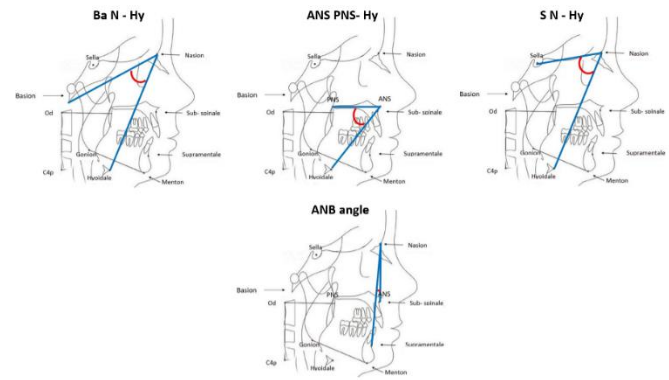
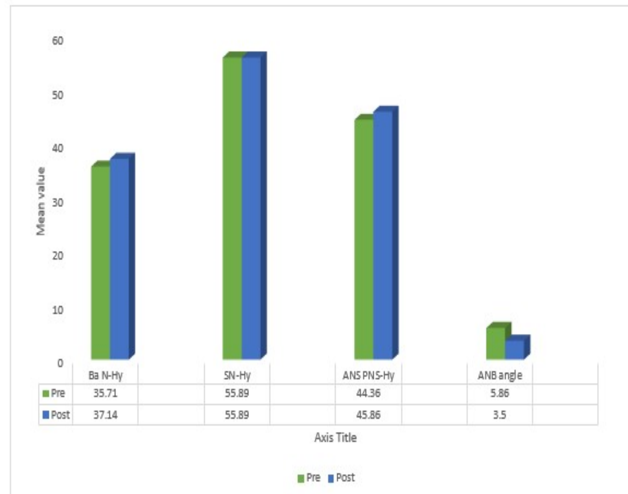
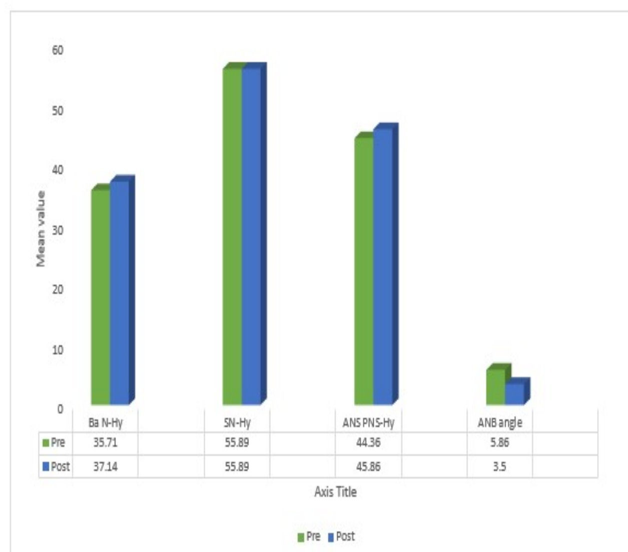



Figure 4: Angular measurements




Graph 1: Comparison of Linear values




Graph 2: Comparison of angular measurements

Table 1: Comparison of linear parameters

| Variables | Groups | Mean | Std. Deviation | t value | p-value |
|---|---|---|---|---|---|
| Hy-B | Pre | 41.07 | 6.146 | 14.532 | <0.001 |
| | Post | 44.54 | 6.535 | | |
| Hy-M | Pre | 36.00 | 7.278 | 9.586 | <0.001 |
| | Post | 40.93 | 7.746 | | |
| Hy-CL | Pre | 46.11 | 7.613 | 1.697 | 0.101 |
| | Post | 48.86 | 9.835 | | |
| Hy-Go Me | Pre | 11.807 | 5.6402 | 4.273 | <0.001 |
| | Post | 14.418 | 7.2188 | | |
| Hy-CHL | Pre | 46.82 | 10.531 | 0.105 | 0.917 |
| | Post | 46.68 | 14.208 | | |
| Width of the upper pharynx | Pre | 11.61 | 2.872 | 3.316 | 0.003 |
| | Post | 15.18 | 5.901 | | |
| Width of the lower pharynx | Pre | 8.82 | 2.919 | 6.034 | <0.001 |
| | Post | 10.36 | 2.805 | | |

$p<0.05$ is considered significant.

Table 2 : Comparison of angular parameters

| Variables | Groups | Mean | Std. Deviation | t value | p-value |
|---|---|---|---|---|---|
| Ba N-Hy | Pre | 35.71 | 4.988 | 1.734 | 0.094 |
| | Post | 37.14 | 7.184 | | |
| SN-Hy | Pre | 55.89 | 5.043 | 0.000 | 1.00 |
| | Post | 55.89 | 6.039 | | |
| ANS PNS-Hy | Pre | 44.36 | 4.039 | 2.478 | 0.020 |
| | Post | 45.86 | 4.519 | | |
| ANB angle | Pre | 5.86 | 1.458 | 9.512 | <0.001 |
| | Post | 3.50 | 1.171 | | |

$p<0.05$ is considered significant.