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EFFECTS OF MYOFUNCTIONAL THERAPY ON TONGUE POSTURE IN GROWING CLASS II DIVISION 1 MALOCCLUSION

Dental Science

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ABSTRACT

Introduction: Myofunctional therapy is the treatment of choice for class II division 1 growing individuals. In addition, the treatment may bring about changes both in the tongue position and oropharynx. **Objectives:** To measure and evaluate the Tongue Posture and the dimension of oro-pharyngeal airway in subjects before and after Twin-Block appliance therapy in Class II division 1 malocclusion. **Materials and methods:** Twenty-four subjects were selected within the age range of 10-14 years (average-12 years) and each subject was confirmed by taking into account the lateral cephalometric measurement, clinical evaluation, inclusion and exclusion criteria's before involving them in the group. Following the acquisition of each subject's lateral cephalogram, numerous landmarks, reference planes, and linear parameters were used to assess tongue position using the method outlined by Rakosi et al. Tongue and oro-pharyngeal airway measurements were measured using a template. **Results:** Pairwise t-test was used to evaluate pre and post therapy changes and to discover significant differences in different measurements in the group. The mean values and standard deviations of all variables before and after therapy are shown in tables. All of the measurements revealed significant differences present. **Conclusion:** Total tongue length increased from pre-treatment to post treatment with Twin-block therapy whereas partial tongue length decreased pre to post treatment at point 1-6 with the exception at point 7. The total tongue height decreased from pre-treatment to post treatment. Palate to dorsum of tongue dimension increased significantly from pre-treatment to post-treatment. The mean Pharyngeal Airway increased significantly from pre-treatment to post-treatment with a statistically significant.

KEYWORDS

Tongue posture, Oro-pharyngeal airway, Class 2 Division I malocclusion, Twin-Block

INTRODUCTION

Tongue is considered as a complex muscular organ. It is a highly specialised group of muscles and nerves that is capable of great freedom of movement.[1] The tongue, along with the nasopharyngeal airway, plays a critical role in the development of craniofacial tissues, especially the maxilla and mandible. Jaw disorders are frequently linked to a disruption in the dynamic balance between functional tongue motions and other muscles.[2]

In moulding the hard tissues, Graber claimed that muscle posture was more important than muscle function.[3] According to Brodie, a low-level tongue posture expands the lower dental arch, causing the upper arch to collapse.[4] According to Hovell, the size, shape, and position of the tongue were the most essential elements in the development of the dental arches.[5] Peng et al in their study have mentioned about the inappropriate positioning of the tongue as a major cause of relapse.[6]

Decreased space between the cervical vertebrae and the mandibular body is caused by a backwardly positioned tongue and soft palate in the majority of Class II malocclusions with significant mandibular insufficiency[7]. The uvulo-glosso-pharyngeal measurements are affected by the anteroposterior skeletal pattern, as the width of the oropharyngeal area has a substantial relationship with variations in ANB angle.[8,9] As the ANB decreases, the oropharyngeal region shrinks, increasing the likelihood of reduced respiratory activity during the day and possibly creating nocturnal difficulties such as snoring, upper airway resistance syndrome, and OSA (Obstructive Sleep Apnea). As a result, tongue position in Class II malocclusion patients with restricted tongue space can greatly increase the future risk of Obstructive Sleep Apnea. Inferiorly positioned tongue, results in a fan-like configuration of the lower face in the sagittal plane. As a result, both occlusion and craniofacial morphology tend to be affected by the tongue's static location.[10,11]

The functional space for the tongue, according to Balter's concept, is necessary for the appropriate development of the orofacial system He proposed that in a treatment plan, the location of the tongue should be carefully considered as it is responsible to cause certain types of malocclusions.[12]

Based on tongue's dominant role, Balters designed his appliance i.e., the Bionator to take advantage of tongue posture. The bionator's therapeutic premise is to adjust muscle function while removing irregular and potentially deforming external variables to promote normal development of the natural growth pattern.[12]

In patients with Class II Division I malocclusion, the mandible is positioned inferior and anterior during functional appliance therapy.[7] When it comes to the tongue and oropharynx, one of the consequences of functional appliance therapy is that it changes the tongue position and oropharynx .For Class II treatment, a range of functional appliances are currently being used to modify skeletal imbalances, arch shape, and oro-facial function.[8] Twin Block is the most widely used removable myo-functional appliances. This appliance was chosen for our analysis because it has been shown to have strong patient compliance, significant freedom in mandibular movements, and minimal speech disturbance.[11]

The current study was designed to assess the functional, positional and structural assessment of tongue as it is of utmost importance in Orthodontic diagnosis and treatment planning. The aims and objectives of this study was to measure and evaluate the Tongue Posture and the dimension of oro-pharyngeal airway in subjects before and after Twin-Block appliance therapy in Class II division 1 malocclusion.

MATERIALS AND METHODS

A prospective experimental study was conducted in our Department with the objective of assessing the changes in tongue posture in individuals treated with myo-functional Twin-Block appliance before and after treatment.

For sample size estimation, software G Power ver. 3.1.9.7 (Dusseldorf University, Dusseldorf, Germany) was used. The appropriate sample size was calculated based on p-values of < 0.05, a power of 95%, and an effect size of 0.4.

Twenty-four subjects within the age range of 10-14 years (average age 12 years), seeking orthodontic treatment for Class II division 1 malocclusions conducive for growth modulation were selected irrespective of socio-economic status, religion and sex. A brief explanation of the procedure to be performed was given to each subject who agreed to volunteer for the study and an informed consent was obtained. The study was reviewed by the members of the Institutional Ethics Committee and the ethical clearance was obtained preceding to the start of the study. [Protocol number (D.No.254/FM Dated 11/05/2019)]

Inclusion Criteria

Patients with skeletal Class II malocclusion with a normal maxilla, backwardly positioned mandible in growing age period, Class II molar and canine relationship with Over-jet equal to or greater than 4mm, ANB angle greater than 4.5 degrees and positive VTO on clinical evaluation were included in the study.

The Exclusion Criteria

Patients with Craniofacial syndromes or systemic disease, conditions like macroglossia, microglossia, ankyloglossia or paralysis of the tongue or lip.

Patients with history of trauma, pathology or congenital anomaly and drug intake influencing tone of the muscle were excluded from the study.

The study proceeded with collection of data of the included subjects. Data collection was done to assess and record the following-:

- Assessment of tongue posture and pharyngeal airway measured on lateral cephalometric radiographs
- Craniofacial measurements on lateral cephalometric radiographs.

Data was collected before starting of the treatment at T0 and at the end of active Treatment (7-8 months) at T1 (Active Phase).

Assessment of Tongue Posture

Lateral Cephalogram of each subject was taken by orienting them in the Natural Head Position to assess the dental, skeletal and soft tissues. The patient's head were balanced using head fixation with the Frankfurt horizontal plane parallel to the surface.

The participants were told to relax their tongue in order to obtain records in resting tongue position. [14] Furthermore, the centric occlusion and lips resting position[13] were clarified to the patients and to make the soft tissue outline of tongue more visible in radiograph, a radio-opaque material IOHEXOL INJECTION (Omnipaque [tm]) solution was coated on the dorsum of tongue from tip up to the most distal point. For coating the tongue, subjects were asked to protrude the tongue, and tongue was coated in the midline with the help of a brush. (Fig-1).[13]

Following the acquisition of each subject's lateral cephalogram, numerous landmarks, reference planes, and linear parameters were used to assess tongue position using the method outlined by Rakosi et al. (Fig-2 and Table 1 &2)[12]

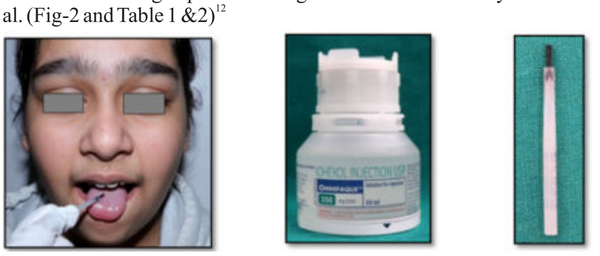

Figure 1 Procedure of tongue coating

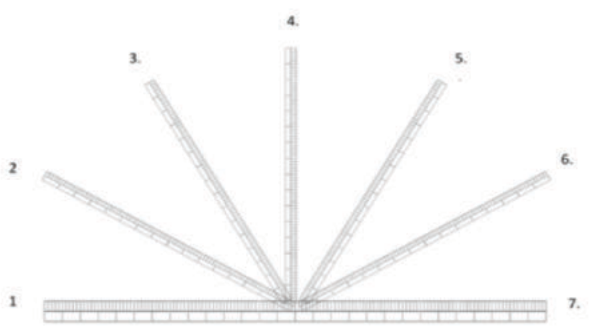

Figure 2 Grid for tongue size assessment

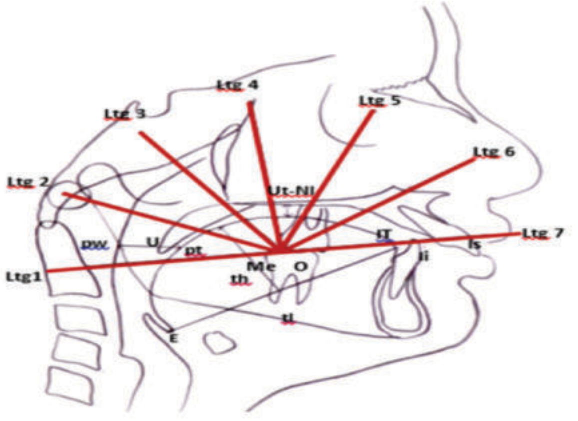

Figure 3 assessment of tongue posture in lateral cephalogram .

On the lateral cephalogram, a template was drawn with a horizontal line running through the lower central incisor's incisal edge and the distal third of the first molar extending posteriorly. Considering the distal third area of the first molar as the centre, angles were drawn at 30°, 60°, 90°, 120° and 150°. For measuring tongue length, height and the pharyngeal airway (Fig-2&3)

Statistical analysis:

The data was statistically analysed using the Statistical Package for Social Sciences (version 11.5) (Chicago: SPSS Inc). The data was subjected to descriptive analysis. The significance of differences in mean value before (T0) and after (T1) treatment was determined using the paired-t test. P-value <0.05 was considered significant.

Table-1: Reference Lines for Tongue Assessment

	REFERENCE LINES	DEFINITION
1.	Ltg l	A line that passes from point 0 and ii
2.	Ltg 2	A line measured on point 0 of the Mc-ii line, producing an angle of 30° with the Mc-ii line
3.	Ltg 3	A line measured on point 0 of the MC-ii line, producing an angle of 60° with the Mc-ii line
4.	Ltg 4	It is the perpendicular bisection line situated on point 0 to the Mc-ii line
5.	Ltg 5	A line establised on point 0 of the Mc-ii line, producing an angle of 120° with the Mc-ii line
6.	Ltg 6	A line constructed on point 0 of the Mc-ii line, producing an angle of 150° with Mc-ii line
7.	Ltg 7	A line through point 0 and U
8.	Me- ii	A line through the points ME AND II
9.	NL– nasal line	A line that connects the anterior nasal spine (ANS) and pterygomaxillary (Ptm) (Bjork, 1947)

Table-2: Variables for Pharyngeal Airway and Tongue Assessment

	VARIABLES	DEFINITION
1	Pt-pw	The distance between the tongue and the pharyngeal wall (Ingervall and Schmoker, 1990) is described as the linear distance between a point on the tongue's contour (pt) and a point on the pharyngeal wall (pw) measured on the occlusal line (OL).
2.	Ptl1	Rakosi (1982) defined partial tongue length as the linear distance between point 0 and the intersection point of the Ltgl line with the contour of the tongue.
3.	Ptl 2	Partial length of the tongue at Ptl 2 is the linear distance between point 0 and the intersection point of the Ltg2 line with the contour of the tongue (Rakosi, 1982)
4.	Ptl 3	Partial length of the tongue at Ptl 3 is the linear distance between point 0 and the intersection point of the Ltg3 line with the contour of the tongue (Rakosi, 1982)

5.	Ptl 4	Partial length of the tongue at Ptl 4 is the linear distance between point 0 and the intersection point of the Ltg4 line with the contour of the tongue (Rakosi, 1982)
6.	Ptl 5	Partial length of the tongue at Ptl 5 is the linear distance between point 0 and the intersection point of the Ltg5 line with the contour of the tongue (Rakosi, 1982)
7.	Ptl 6	Partial length of the tongue at Ptl 6 is the linear distance between point 0 and the intersection point of the Ltg6 line with the contour of the tongue (Rakosi, 1982)
8.	Ptl 7	Partial length of the tongue at Ptl 7 is the linear distance between point 0 and the intersection point of the Ltg7 line with the contour of the tongue (Rakosi, 1982)
9.	TH	Lowe et al (1986) described tongue height as the linear distance between the tongue dorsum and the perpendicular bisector of the E-TT line.
10.	TGL	Tongue length as the Linear distance between E and TT (Lowe et al, 1986)
11.	Ut – NL	Ingervall and Schmoker(1990) established Ut-Nl as the shortest distance between the dorsum of the tongue (from the point ut) and the maxillary plane (NL).

Table 3: Comparison of tongue length, height, oropharyngeal airway, palate to dorsum and partial tongue before and after treatment with Twin-Block appliance using Paired t test

Tongue length	Mean	Std. Deviation	Mean difference	t-test value	p-value
Pre-treatment	64.33	4.71	-4.09	-11.566	< 0.001*
Post-treatment	68.42	4.61			

Tongue height	Mean	Std. Deviation	Mean difference	t-test value	p-value
Pre-treatment	26.23	3.08	2.04	5.152	< 0.001*
Post-treatment	24.18	3.07			

Pharyngeal Airway	Mean	Std. Deviation	Mean difference	t-test value	p-value
Pre-treatment	15.73	3.78	-2.22	-6.974	< 0.001*
Post-treatment	17.94	3.92			

Palate to dorsum of tongue	Mean	Std. Deviation	Mean difference	t-test value	p-value
Pre-treatment	3.81	1.65	-3.07	-7.037	< 0.001*
Post-treatment	6.88	2.07			

		Mean	Std. Deviation	Mean difference	t-test value	p-value
Partial Tongue Length 1	Pre-treatment	26.96	3.07	2.42	11.795	< 0.001*
	Post-treatment	24.54	3.32			
Partial Tongue Length 2	Pre-treatment	18.38	2.70	1.47	3.708	0.001*
	Post-treatment	16.92	3.22			
Partial Tongue Length 3	Pre-treatment	14.20	2.76	1.27	4.440	< 0.001*
	Post-treatment	12.93	2.66			
Partial Tongue Length 4	Pre-treatment	13.12	2.56	1.64	8.574	< 0.001*
	Post-treatment	11.48	2.33			
Partial Tongue Length 5	Pre-treatment	13.73	2.54	1.94	7.398	< 0.001*
	Post-treatment	11.80	2.64			
Partial Tongue Length 6	Pre-treatment	17.75	3.52	1.79	3.781	0.001*
	Post-treatment	15.96	4.06			
Partial Tongue Length 7	Pre-treatment	24.57	5.00	-4.63	-11.244	< 0.001*
	Post-treatment	29.20	4.03			

Paired t-test *** Significant difference**

Table 4: Comparison of SNA (in degree), SNB, ANB, FMA, Maxillary length, Mandibular length, Overjet (in mm) and IMPA (in degree) between pre and post treatment using the Paired t-test

	Pre-treatment		Post-treatment			
	Mean	Std. Deviation	Mean	Std. Deviation	t-test value	p-value
SNA (in degree)	80.71	1.68	80.36	1.65	2.687	0.019
SNB	75.36	1.65	78.29	1.14	-11.951	< 0.001*
ANB	5.36	1.55	2.00	0.96	12.459	< 0.001*
FMA	19.86	2.11	22.00	1.84	-6.204	< 0.001*
Maxillary length	47.76	1.32	47.39	1.24	2.334	0.036
Mandibular length	68.11	1.57	70.44	1.12	-11.357	< 0.001*
Overjet (in mm)	8.50	1.95	2.21	0.80	12.837	< 0.001*
IMPA (in degree)	94.93	4.30	98.93	5.05	-9.539	< 0.001*

RESULTS:

The analysis was performed by interpreting the **changes in tongue length, tongue height ,palate to dorsum of tongue, partial tongue length, pharyngeal airway and craniofacial changes before and after treatment.** To evaluate pre and post therapy changes and to discover significant differences in different measurements in the group, the Pairwise t-test was used. Table shows the mean values and standard deviations of all variables before and after therapy. All of the measurements revealed significant differences.

The result shows that the **mean Tongue length** increased significantly from pre-treatment (64.33mm) to post-treatment (68.42mm) with a mean difference of 4.09mm (at p value < 0.001) and the **mean Tongue height** decreased significantly from pre-treatment (26.23mm) to post-treatment (24.18mm) with a mean difference of 2.04mm (at p value< 0.001). The **mean distance from Palate to the dorsum of tongue** increased significantly from pre-treatment (3.81mm) to post-treatment (6.88mm) with a mean difference of -3.07mm (at p value< 0.001).

When the **partial tongue length** was compared between pre and post treatment, it shows that the mean partial tongue length at the region 1, 2, 3, 4, 5 and 6 decreased significantly from pre-treatment to post-treatment whereas the mean Partial Tongue Length at point 7 increased significantly from pre-treatment to post-treatment with the mean difference of 2.42, 1.47, 1.27, 1.64, 1.94, 1.79, and -4.63 (at p value <0.001) respectively.

For **Pharyngeal Airway** the mean was compared between pre and post treatment and shows that it increased significantly from pre-treatment (15.73) to post-treatment (17.94) with a mean difference of -2.22 (p value < 0.001).

For **craniofacial changes,** the mean SNA (in degree), SNB, ANB, FMA, Maxillary length, Mandibular length, Overjet (in mm) and IMPA (in degree) was measured between pre and post treatment using the Paired t-test. A decrease in ANB (correction of 2.93 ° was observed), decrease SNA and Maxillary length by 0.35° and 0.37mm respectively. There were increase in FMA and Mandibular length by 2.14° and 2.33 respectively. Reduction of Overjet by 7.29 mm and increase IMPA by 4° from pre to post treatment was observed. (Refer Table 3 &4)

DISCUSSION

The growth of each compartment of the craniofacial system is interconnected , and coordinated development of the craniofacial complex is linked to the growth and function of the tongue, nasal cavities, nasopharynx, and oropharynx.[1] In most cases, myofunctional appliances are used to treat Class II malocclusions with mandibular deficiencies in developing individuals. These appliances are expected to enhance mandibular growth and location, alter dental and muscular relationships, and probably increase airway dimension. The Twin-

Block Appliance helps to encourage mandibular growth while also addressing the vertical aspect of malocclusion.

The changes brought about by this appliance in the skeletal and dentoalveolar structures has been well documented in the literature.[7] In this study it was seen that there were decrease in SNA and Maxillary length measurements which were not statistically significant whereas a statistically significant decrease in ANB, FMA and Mandibular length were observed. Reduction of Overjet from pre to post treatment was also observed which was statistically significant and this shows that proclination of lower incisors, increment of mandibular length and reduction of ANB could be the reason for reduction of overjet. These results were in accordance with the findings in the study which was done to check and evaluate the treatment effects of myofunctional appliances.[7] In this study it was also observed that the treatment effects of twin block appliance consequently had an effect on the tongue posture after treatment.[8]

The tongue is active during mastication and deglutition as well as at rest, and it has an effect on dentofacial morphology.[15, 16] The buccinator system is commonly disrupted by tongue posture and function, and it plays a role in the aetiology of malocclusion, open bite, and other stomatognathic problems.[2]

The relationship between different skeletal malocclusions and tongue location, function, and posture, as well as the clinician's ability to alter them, has been a subject of interest in orthodontics. Tongue retropositioning is recognised as one of the common physiological trait in growing patients with Class II division 1 malocclusion and mandibular retrusion.

Several studies have been conducted on the relationship between tongue posture and various malocclusions. Class II malocclusions are caused by the tongue being pushed upwards, obstructing the respiratory system and resulting in mouth breathing. Gupta et al [17] theorised that class III symptoms are caused by the tongue being in a more forward position. There is a link between cranio-cervical angulation and both facial and dentoalveolar proportions, according to Solow and Tallgren's studies. It has been suggested that a forward head position on the neck is associated with a low Mandible relative to the Maxilla and a low tongue posture.[18] The age factor must be recognised in tongue position studies, as children have a higher dorsal height than adults, according to a cephalometric analysis by Peat et al. [19]

For evaluating the changes of tongue posture in our study, measurements were taken from the pre and post treatment records of each subjects and were compared using paired t-test. TGL is the tongue length and for evaluation of tongue length (TGL), the result of the present study showed that there was an increased in tongue length as the mandible moved forward from class 2 to class 1 normal occlusion.

This result indicates forward and flattening of tongue following treatment with myofunctional appliance, the tongue repositions forward significantly as the mandible moved forward with decrease in the ANB angle and reduction of overjet. These results were in agreement with results of Zhou's study.[20] Yassei et al in his study also indicate that the tongue reposition significantly forward with functional appliance.

The tongue moves forward with age.[21] However, according to Ordoubazari [22] who studied amongst 9-14 and 18-30 age groups, the forward repositioning of tongue with age was minor.

Because the genioglossus muscle originates on the inner surface of the mandibular symphysis and inserts into the tongue, acting as the main protruder of the tongue as well as an accessory respiratory function, causing advancement of the base of the tongue and dilation of the upper airway, the reason for forward positioning of the tongue could be due to muscle attachments.[14,23] As a result, it's possible to conclude that treatment with the Twin-Block appliance causes the tongue to move significantly forward.

Tongue height, in the present study it showed that as the mandible moved from retruded to forward position, there was a decrease in the height of the tongue significantly. Tongue, hyoid, and mandible work as an integrated unit so the tongue height changed with the mandibular posture. Other investigations have indicated that the resting tongue posture of skeletal Class II patients is higher than that of Class I and III subjects.

Palate to dorsum of the tongue. In this study the mean Palate to dorsum of tongue increased significantly from pre-treatment (3.81 mm) to post-treatment (6.88mm) with a mean difference of 3.07 mm and it was statistically significant. According to the findings of Kumar et al[24], the position of the tongue moved significantly downward after treatment with functional appliances, which supports our findings, but this was in contrast to the findings of S Yassei et al[8] who found no significant downward movement of the tongue after treatment with functional appliances.

The partial length of the tongue (ptl1 and ptl2) (Rakosi, 1982)[12]- When patient with Class II Div 1 malocclusion is treated using Myofunctional appliance, the partial length of this region was found to be decreased from pre to post treatment. This was because after the treatment with myofunctional appliance there was flattening of the tongue because of forward movement of the mandible. As the mandible moved forward, the posterior region of dorsum of tongue moved antero-inferiorly in the Angle Class I normal group. This showed that in Angle Class II Div 1 malocclusion, tongue was backwardly placed. As the root of the tongue was attached to mandible and hyoid bone, any growth and spatial displacement of the adjoining skeletal components governs the position and size of the tongue.

Partial length of the tongue (ptl3 and ptl4) – this part of dorsum of tongue was greater in the pre-treatment group. The partial length of tongue in these regions decreased after treatment with myofunctional appliance. This indicates that forward movement of the mandible causes dropping of the tongue downward. This finding was supported from the study of Rakosi [25] in which he found that dorsum was higher in Angle Class II Division 1 malocclusion as compared to the Angle Class I normal group but also stated that the changes shown by the dorsum of the tongue were less as compared to the root of the tongue and the tip of the tongue.

Partial length of the tongue (ptl5 and ptl6) – The measurement in this region was more in patient with retruded mandible. The most typically observed physiological trait in growing children with Class II Div 1 malocclusion and mandibular retrusion is tongue retroposition.[25]

Partial length of the tongue (ptl7) is the anterior part of the tongue, the measurement of this part of the tongue significantly increased from pre to post treatment. This was because the mandible moves forward after Twin-Block therapy from its retruded position which in turn caused forward positioning of the tongue and increases its partial length in the anterior part. When compared to Class I occlusion, in most cases in Class 2 malocclusion with mandibular deficiency, there is a tendency for the tongue to have less space, resulting in curvature of the posterior aspect of the tongue and anterior tongue retraction, so when the mandible is repositioned forwardly, the tongue flattens and the anterior part of the tongue lengthens. Similar findings were also observed by Rakosi [25] that the tip of the tongue was already more retracted in the Class II Division 1 malocclusion. TBA therapy resulted in considerable alterations in posture in the posterior and middle portions of the tongue, according to Erum et al[26].

In this study, comparison was done pre and post treatment with regards to oro-pharyngeal airway and the mean pharyngeal airway value was found to have increased significantly from pre to post treatment. The orthopaedic consequence of Twin-Block therapy to displace the mandible forward, resulting to a positive effect on the posterior pharyngeal airway via the anterior displacement of the tongue, could account for this increase in dimension.[21]

The forward advancement of the mandible and mesial movement of mandibular dentition, which may have affected alterations in tongue posture, were primarily responsible for a beneficial effect in oropharyngeal airway dimensions and the therapeutic significance of Twin-Block with this device.

The findings revealed that the tongue's posture changed as the mandible's posture changed.[1] One of the causes of malocclusion and post-treatment relapse is an abnormal tongue position.[27] Normalizing tongue posture can help to break the cycle of unbalanced muscular activity, resulting in more balanced jaw growth patterns and stable occlusion. [27,28]. Myofunctional therapy for a retrognathic mandible can help to eliminate the risk factors for Obstructive Sleep Apnea (OSA) and avoid the need for complex treatment options later in life.

Limitations

The sample size was small, further trials can be carried out on larger sample size.

The examination of tongue posture using a two-dimensional imaging approach. Furthermore, muscular forces and tongue volume are crucial elements that can alter skeletal pattern and arch shape, but they were not included in this study. The use of 3D CBCT may provide more information in this aspect. A long-term follow-up is required to ensure that the tongue's adaptation to a new position is stable.

CONCLUSION

1. Total tongue length increases from pre-treatment to post treatment with myofunctional appliance therapy with mean value of 4.09 mm and it was statistically significant.
2. Partial tongue length decreases pre to post treatment at point 1-6 whereas it increases at point 7, statistically significant difference was observed.
3. The total tongue height increased from pre-treatment (26.23) to post treatment (24.18) with a statistically significant mean difference of 2.04 mm.
4. The mean Palate to dorsum of tongue increased significantly from pre-treatment (3.81) to post-treatment (6.88) with a mean difference of 3.07 mm and it was statistically significant.
5. The mean Pharyngeal Airway increased significantly from pre-treatment (15.73) to post-treatment (17.94) with a statistically significant difference of 2.22 mm.

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