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RESEARCH ARTICLE

Evaluation of Upper and Lower Pharyngeal Airway and Hyoid Bone Position in Skeletal Class II Patients Treated with Forsus and Powerscope Appliance: A Prospective Study

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Abstract

Objectives: To assess and compare the change in pharyngeal airway dimensions and hyoid bone position also to evaluate the skeletal and dental effects of Forsus and Powerscope appliance in skeletal Class II malocclusion patients with obstructive sleep apnea subjected to 6 months fixed functional appliance therapy. **Methods:** 30 patients with skeletal class II malocclusion having day-time somnolence associated with snoring requiring fixed functional orthodontic treatment were selected and randomly divided into Forsus and Powerscope groups. Patients were treated with MBT 0.022-slot and aligned till 19x25 SS. Fixed functional appliance was installed. Digital Lateral cephalograms were traced for Skeletal, Dental, Airway Measurements and Hyoid bone position at pre-treatment (T1), before start of fixed functional therapy (T2) & at end of fixed functional therapy (T3) analysed using Dolphin software. **Findings :** Skeletal correction achieved was same for both Forsus and Powerscope. Forsus showed significant improvement in sagittal correction whereas Powerscope produced dentoalveolar changes. Airway dimensions showed significant increase Pre & Post treatment for both groups. Whereas Hyoid Bone moved more mesial and superior with fixed functional therapy. Change in airway dimensions was similar for both the groups. Fixed functional appliance produced significant increase in airway dimension however no difference seen between Forsus and Powerscope. **Novelty:** The study revealed that correction

of mandibular retrusion using mandibular advancement appliances in skeletal class II malocclusion with obstructive sleep apnoea increased the airway dimensions and improved nasal breathing. The dimension of upper and lower airway increased significantly.

Keywords: Fixed Functional Appliance; Forsus; Powerscope; Hyoid Bone; Airway

1 Introduction

Mutual interaction between pharyngeal structures and skeletal relationship is subject of interest for the Orthodontists recently as it alters patient's facial profile. Growth modification is the best way to correct a jaw discrepancy as it allows the grow out of the skeletal disharmony. Sleep disorder is a commonly used term for patients suffering from Obstructive Sleep Apnea. It is characterized by prolonged increased upper airway resistance, partial upper airway obstruction, or complete obstruction that disrupts pulmonary ventilation, oxygenation, or sleep quality[(1)]. The patients with mouth breathing in younger age develop craniofacial abnormalities, such as speech disorders, facial deformities, abnormal body posture and inadequate positioning of the teeth later in life[(2,3)].

Fixed functional appliance therapy have commonly been advocated by clinicians to correct skeletal class II malocclusions by altering the position of mandible or mandibular dentition in post pubertal patients[(1,4)]. Forsus & Powerscope are commonly used fixed functional appliances[(5)]. Mandibular retrusion is one of the most common characteristics among different dental and skeletal combinations that can create a Class II malocclusion along with sleep disorder. In such cases mandibular growth is stimulated by its forward positioning, various removable and fixed functional appliances are commonly used to alter the position of mandible. The stimulation of mandibular growth, distal movement of the upper dentition, and mesial movement of the lower dentition contributes to the correction of Class II malocclusion with the use of fixed functional appliances. Very few studies, have assess the effect of Forsus and Powerscope appliance on oropharyngeal airway and hyoid bone position in post pubertal patients. Hence, this study was undertaken to evaluate the changes in upper and lower pharyngeal airway and hyoid bone position in Skeletal Class II patients treated with Forsus and Powerscope Appliance.

2 Methodology

The study is prospective clinical study with a sample of 30 patients, mean age of 15 years diagnosed with skeletal class II and Cervical Vertebral Maturation Index (CVMI) stage IV at the end of alignment and levelling phase of fixed mechanotherapy. As mentioned, the patients who are in post-pubertal growth stage were selected using CVMI by tracing C2, C3, C4 and the data was co-related with the chart provided by Indian Council for Medical Research also all were having class II malocclusion with retrognathic mandible and mean SNA of 81.5° and SNB was 75° in both groups. At- home version of polysomnography was used to diagnose obstructive sleep apnoea by measuring airflow, breathing patterns, blood oxygen levels, possibility of limb movements and snoring intensity were selected for the study. All the patients were having history of night-time mouth breathing, irregular sleeping patterns, day-time somnolence associated with snoring with reduced airway dimensions with positive VTO.

Total of 30 samples consisting of 16 male and 14 female patients divided into three groups of 10 patients each using closed envelope method for control, Powerscope and Forsus therapy. All the participants in three treatment groups were treated by the same investigator with an MBT prescription 0.022-inch slot pre-adjusted edgewise appliance

(AO). Alignment and levelling were done up to 0.019”x 0.025”stainless steel wires, and then the fixed functional appliance was installed as per the group chosen in the patient’s envelope. Digital copy of lateral cephalogram was obtained at two-time interval: pre-treatment and post fixed functional therapy. Pharyngeal airway dimensions, Hyoid bone position and skeletal and dental parameters was assessed using the Dolphin Imaging software 11.9 version. [Table 1] These parameters were compared with the data obtained from patients of control group. The data was tabulated using Microsoft Excel and subjected to statistical analysis.

Table 1. Parameters assessed in the study

Sr. No.	Landmarks	Description
1.	Gonion (Go)	Most posterior and inferior point on the mandibular angle
2.	Menton (Me)	Most caudal point in the outline of the mandible. It is regarded as the lowest point of the mandible
3.	Hyoidale (Hy)	The most anterio-superior point on the body of hyoid bone
4.	C4p	The most posterior–inferior point of the fourth cervical vertebra
5.	Mandibular plane (Go-Me)	The plane extending from gonion to menton
	Parameter	Description
1	Pharyngeal Airway Dimension	
a.	Upper Airway	It is measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall
b.	Lower Airway	It is measured from the point of intersection of the posterior border of the tongue and its inferior border of the mandible to the closest point on posterior pharyngeal wall.
2.	Hyoid Bone Position	
a.	Hyoidale–menton (Hy–Me)	Linear distance from hyoidale to hard tissue Menton (Me)
b.	Hy-C4p	Linear distance from hyoidale to C4p
c.	Hy-GoMe	Perpendicular distance from Hyoid to Mandibular (GoMe) plane

2.1 Sample Size Estimation

Tests - Means: Difference between two independent means (two groups

Analysis: A priori: Compute required sample size
Input: Tail(s) = One
Effect size d = 1.5694767
α err prob = 0.05
Power (1-β err prob) = 0.95
Allocation ratio N2/N1 = 1
Output: Non centrality parameter δ = 3.5094566
Critical t = 1.7340636
Df = 18
Sample size group 1 = 10
Sample size group 2 = 10
Sample Size group 3 = 10
Total sample size = 30
Actual power = 0.9580335

3 Results and Discussion

The data was tabulated using Microsoft Excel of the three groups. The mean and standard deviation was calculated, and control group was compared to Forsus and Powerscope group. Independent t test was used to assess the change in parameters between Control group and Forsus and Powerscope group respectively. Paired t test was used to evaluate the change in parameters pre-treatment and post fixed functional therapy for both Forsus and Powerscope group.

Statistical analysis showed a highly significant difference in increase in oropharyngeal airway dimensions and hyoid bone position between Control group and Forsus and Powerscope group respectively. The study also showed a highly significant difference in oropharyngeal airway dimensions' pre-treatment and post-treatment for both the cases groups. Also, when compared between Forsus and Powerscope there was no statistically significant difference with the increase in oropharyngeal airway and change in position of hyoid bone.

Table 2. Intergroup comparison of change between control and Forsus group

Variable	Group	Mean	SD	p value
Upper airway	Control	0.58	0.21	0.001*
	Forsus	4.44	1.80	
Lower airway	Control	0.42	0.24	0.001*
	Forsus	5.10	1.53	
Hy-C4p	Control	0.90	0.44	0.001*
	Forsus	8.27	3.09	
Hy-Me	Control	1.44	0.84	0.001*
	Forsus	6.89	2.75	
Hy-GoMe	Control	0.05	0.62	0.001*
	Forsus	-2.33	0.82	

Independent t test; * indicates significant difference at $p \leq 0.05$

The study was conducted on the prospective cephalometric data of three groups: Control group, Forsus group and Powerscope group of 10 each. Dolphin digital software was used to assess the change in oropharyngeal airway dimensions and position of hyoid bone after the fixed functional appliance therapy. The results stated that there is increase in upper and lower airway dimensions' post fixed functional therapy for both Forsus and Powerscope when compared with the control group. As the study was done in post pubertal patients the study indicates that there hardly any increase in upper and lower dimensions and hyoid bone position after the growth is completed. Mandibular advancement has shown to significant increase the airway dimensions. When compared between Forsus and Powerscope both the appliances resulted in highly significant increase in the oropharyngeal airway dimensions suggesting the forward displacement of mandible with the fixed functional therapy. These results are in accordance with the study conducted by Prajwal et al. [6] who assessed the effect of Forsus and Powerscope on hard and soft tissue in class II patients and concluded that Powerscope showed a significant increase in airway dimensions. Similar results were obtained by Abdalla, Brown and Sonnesen [7], they conducted a study on effect of fixed functional appliance on upper airway and concluded that there is significant increase in upper airway and that ANB angle and mandibular inclination can be significant indicator for positive change in airway. The hyoid bone moves in more forward and superior direction after the fixed functional therapy for both the appliances. This can be indicative of more mesial movement of mandible seen in both the appliances. Kaur R et al. in [8] conducted e retrospective cephalometric study using Twin Block Therapy and Fixed Functional Appliance therapy on Pharyngeal Airway Space in Skeletal Class II Patients where they concluded that even though positive effect on the hyoid bone, positioning it more favorably in forward direction Functional appliances can't be solely relied upon to improve the restricted airway which partially favours results in this study that repositioning the mandible in forward direction and increasing the dimensions of the airway.

Pasupureddi Keerthana, Gunjan Negi, Prasad Chitra [9] stated Airway assessment is an important consideration in orthodontic diagnosis. AdvanSync2 Class II corrector in combination with fixed orthodontic appliances enhances the quality of life in Class II patients by enhancing airway dimensions. This approach can be useful in the management of mild to moderate Class II malocclusions associated with mandibular retrognathism and airway constriction. Gayatri Ganesh and Tulika Tripathi [10] concluded that majority of the present studies report a positive impact of the fixed functional appliances on the dimensions of the oropharyngeal and hypopharyngeal airways. Yet the effects on the nasopharyngeal airway with the use of these appliances are minimal.

According to the existing literature the continuous positive airway pressure (CPAP) therapy remains the treatment of choice for most of the patients with obstructive sleep apnoea (OSA), its efficacy is often limited by intolerance and poor adherence. The need for a reliable method for simultaneous correction of OSA along with the mandibular advancement in skeletal class II patients with mandibular retrognathism can be fulfilled using fixed mandibular advancement devices like Forsus and Powerscope. Here in this study, we compared Forsus and Powerscope, where both the appliances resulted in highly significant increase in the oropharyngeal airway dimensions with forward displacement of mandible using fixed functional appliance therapy. This could be superior option than surgical, CPAP line of treatment in treating OSA and mandibular retrognathism.

Table 3. Intergroup comparison of change between Control and Power scope group

Variable	Group	Mean	SD	p value
Upper airway	Control	0.58	0.21	0.001*
	Powerscope	5.09	1.59	
Lower airway	Control	0.42	0.24	0.001*
	Powerscope	4.87	1.29	
Hy-C4p	Control	0.90	0.44	0.001*
	Powerscope	5.86	2.39	
Hy-Me	Control	1.44	0.84	0.001*
	Powerscope	6.01	2.23	
Hy-GoMe	Control	0.05	0.62	0.001*
	Powerscope	-3.50	0.74	

Independent t test; * indicates significant difference at $p \leq 0.05$

4 Conclusion

This study concludes that correction of mandibular retrusion by using mandibular advancement appliances in Class II malocclusion subjects with obstructive sleep apnoea increases the airway dimensions and improves nasal breathing. The hyoid bone was found to adopt a more anterior and lower position at the end of treatment. The dimension of upper and lower airways increases significantly in the treatment group subjects compared to the control group.

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