ORIGINAL RESEARCH

Assessment of Soft Tissue, Airway Dimension and Hyoid Bone Position in Class II Patients Treated by PowerScope Class 2 Corrector

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Abstract

Aim: This study aims to assess the changes in the soft tissue, pharyngeal airway dimensions, and hyoid bone position in patients treated with PowerScope Class 2 corrector to correct the skeletal Class II pattern.

Materials and methods: This study was conducted on a sample of 20 cases diagnosed with Class II malocclusion. The lateral cephalograms were taken before (T1) and after functional appliance therapy (T2) and were traced. The outcomes were compared for the mean changes in soft tissue, airway way dimension, and hyoid bone position. The paired *t*-test was used for the data comparisons wherein $p < 0.05$ was kept for statistical significance.

Results: The mean values before and after treatment for H angle, mentolabial angle, lower lip E-line, upper lip S-line, lower lip S-line, and lip strain were 19.88 ± 2.77 vs 17.13 ± 1.659, 94.09 ± 12.164 vs 101.75 ± 11.28, –2.47 ± 1.213 vs –1.38 ± 0.976, 3.99 ± 0.19 vs 2.64 ± 0.32, 9.01 ± 0.247 vs 9.43 ± 0.238, 10.24 ± 0.510 vs 10.64 ± 0.52, respectively, which were statistically significant ($p < 0.05$). All airway spaces (except for lower pharyngeal space) and hyoid bone parameters were significantly improved posttreatment.

Conclusion: The facial convexity, upper E-line, Z-angle, nasolabial angle, and lower pharyngeal space did not show statistically significant changes. The rest of the soft tissue parameters, oropharyngeal air spaces, and hyoid positioning measured in the study showed significant improvement after treatment with the PowerScope appliance in Class II patients.

Clinical significance: Class II malocclusion is the most common dental anomaly with a high degree of prevalence in the population. This study will help the clinician in understanding the improvement of soft tissue, airway dimension, and hyoid bone position changes on treatment with a fixed functional appliance for the correction of Class II cases, thereby ensuring the greater success of orthodontic therapy in the future.

Keywords: Hyoid bone, Malocclusion, Oropharyngeal air spaces, PowerScope Class 2 corrector, Soft tissue.

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Introduction

The treatment planning of Class II malocclusion is one of the major daily faced challenges in orthodontic practice. It is either a dental Class II or it may possess a skeletal component as well, sometimes hidden needing diagnostic tests.[1] The management of Class II malocclusion depends on the age at which the initial treatment is planned and its severity at the time of diagnosis. Mandibular retrusion is often found in these patients, the functional appliance-based treatment for mandibular advancement is recommended.[1–4] The choice of functional appliance may be removable type (Frankel, Twin block, activator, and bionator) and is used in those who are still in the adolescent growth spurt. The fixed functional appliances [Eureka Spring, Jasper jumper, Herbst, Universal bite jumper, Ritto appliance, fixed twin-block, and Forsus fatigue resistant device (FRD)] are ideal for the post-pubertal age groups or later stages of growth[1,5] The PowerScope is a direct derivative of the Herbst Type II appliance, and in this regard, is one of the commonly used novel innovation in Class II corrections.[1,5] This appliance addresses the treatment needed along with acceptable patient comfort. The extensive range of motion and simple installation make it more friendly in clinical settings.

The success of orthodontic therapy after the use of suitable functional appliances (such as the PowerScope) is often evaluated by the measurement of standard cephalometric indices.[1,4,5] The soft tissue parameters (such as facial Convexity, H-angle Z-angle Nasolabial/Mentolabial angle) have a role in determining the treatment outcomes[1,3,5] apart from sex determination[6] and outlining esthetic.[7] Likewise, the sagittal lip positions were found to be associated with the skeletal malocclusion pattern. In skeletal Class II cases, the upper lips can be more protrusive, and the lower lips are retrusive than the other types of skeletal classes.[8] There is sound evidence that treatments (without or without extractions) for Class II malocclusions may alter the soft tissue profile as measured by linear lip parameters.[9]

The presence of reduced air pharyngeal space in Class II malocclusion is one of the common observations. The narrowest lower pharyngeal airway is reported in Class II division 1 case

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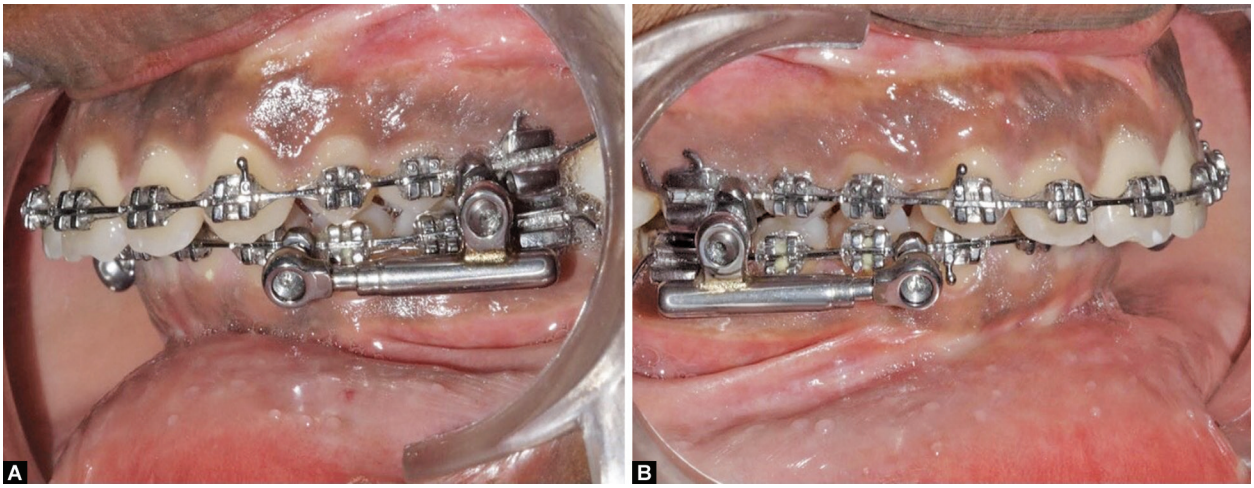


Figs 1A and B: Intraoral picture showing placement of the PowerScope — (A) on the left side; (B) on the right side

as opposed to Class I and III cases.[10,11] The treatment with the functional appliance is reported to have the potential to maximize the pharyngeal airway and to display changes in tongue and hyoid position.[10] The oropharyngeal airway dimensions are affected by the hyoid bone's positional/postural changes after the occurrence of dentoalveolar changes in treated Class II malocclusion cases in reduced airway space. The estimation of these serves in the prognostication of treated cases.[5,10–13] There are fewer reports from Indian studies which had explicitly evaluated the PowerScope device for cases among the 13–17 years age groups. The current study is aimed to assess the soft tissue parameters, pharyngeal airway dimensions, and hyoid bone position in Skeletal Class II (Dental class II division 1) patients treated using PowerScope Class 2 correctors.

Materials and Methods

Study Settings

This is a Prospective study, conducted at the Department of Orthodontics, Saveetha Dental College, Saveetha University, Chennai, Tamil Nadu, India for 6 months from January 1, 2022 to July 1, 2022. This study was approved by the Institutional Scientific Review Board [reference number SRB/SDMDS12ORT19], Saveetha Dental College, Saveetha University.

Sample Size

The sample size of 20 was estimated based on a report by Tarvade SM et al., wherein, a total of 12 patients[13] were required to obtain a power of 95% and an alpha error of 0.05. The patients aged 13–17 years, having Skeletal (ANB > 4°) and dental Class II division 1 malocclusion with mandibular retrusion (SNB < 80°) and increased overjet (>4 mm) and were in CVMI stages 4 and 5 and with good quality lateral cephalograms at the beginning (after alignment) and at the end of fixed functional appliance therapy, were included in the study. Those cases with congenital anomalies that may cause changes in airway dimensions with a history of known respiratory problems/upper airway surgery, and those cases with poor image quality were excluded from the study.

Intervention and Outcomes

The methodology involved was briefly explained to all the participants of the study procedure after obtaining informed consent from them. The intervention was the routine fixed orthodontic therapy using 0.022 MBT prescription (3M Unitek). Initial leveling and aligning was done which was sequentially carried out up to 19 × 25 SS wire in all the patients. To prevent the proclination of mandibular incisors, 6° negatively torqued mandibular incisor brackets were used, and archwires were cinched distal to mandibular molars. PowerScope was kept in place for 6 months (Fig. 1).

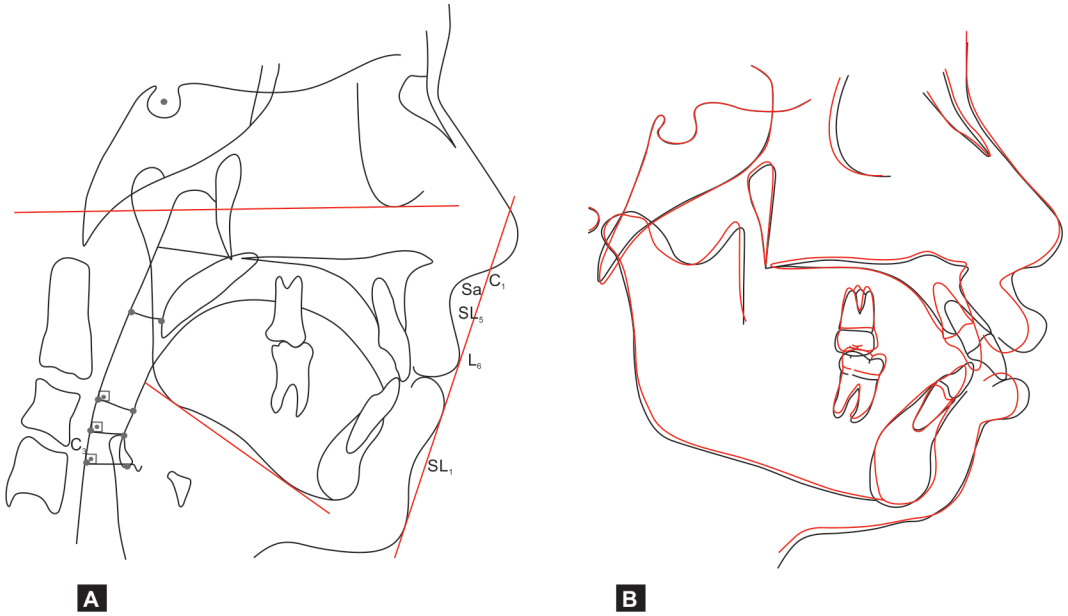
Diagnostic records were taken, namely, the extraoral photographs, intraoral photographs, study models, and lateral cephalograms. These were taken before the placement of the fixed functional appliance (T1) and after the fixed functional appliance therapy (T2) (Figs 2 and 3). The cephalograms taken at T1 and T2 were traced and the outcomes were compared for the stated objectives of the study, that is, the changes in soft tissue, airway dimension, and hyoid bone position (Fig. 4). About 18 landmark measurements were made on the lateral cephalograms for assessing the changes in soft tissue, airway dimension, and hyoid bone position. These include (1) Facial Convexity, (2) H-Angle, (3) Z-Angle, (4) Nasolabial angle, (5) Mentolabial angle, (6) Upper lip-Line, (7) Lower lip-Eline, (8) Upper lip-S Line, (9) Lower lip-S Line, (10) Lip strain, (11) Superior Posterior Airway space, (12) Middle Airway space, (13) Inferior Airway space, (14) Upper pharynx, (15) Lower pharynx, (16) Hyoid to mandible, (17) C3 – H, (18) H – RGn (Fig. 4).

Statistical Analysis

Data were compiled and analyzed using Statistical Package for Social Sciences [(SPSS) Version 22.0 for Windows, IBM Corporation, Armonk, NY: IBM Corp]. and Microsoft Excel. Continuous variables are represented in mean ± standard deviation (SD) form and categorical variables are represented by a frequency table. The intergroup means were compared by the paired *t*-tests, keeping a $p \leq 0.05$ for statistical significance.

Results

The mean pretreatment values of soft tissue angular parameters comprising the facial convexity, H-angle, Z-angle, Nasolabial angle, and Mentolabial angle were 96.71 ± 8.828, 19.88 ± 2.77, 104.14 ± 6.28, 107.6 ± 9.01 and 94.09 ± 12.164, respectively, while the posttreatment values were at 92.6 ± 7.405, 17.13 ± 1.659, 105.4 ± 6.24, 112.2 ± 9.43, and 101.75 ± 11.28, respectively.



Figs 2A and B: Lateral cephalogram tracing (A) Normal landmarks measured; (B) Superimposed image during comparisons

Figs 3A and B: Clinical pictures of case 1 — (A) Preoperative profile view; (B) Postoperative profile view

Figs 4A and B: Clinical pictures of case 2 — (A) Preoperative profile view; (B) Postoperative profile view

Table 1: Intergroup comparisons of various soft tissue (Angular) parameters

Soft tissue (Angular)	*Pre/ posttreatment*	*Mean ± SD*	*p-value*
Facial convexity	T1	96.71 ± 8.828	0.0639
	T2	92.6 ± 7.405	
H angle	T1	19.88 ± 2.77	0.0034*
	T2	17.13 ± 1.659	
Z angle	T1	104.14 ± 6.28	0.270
	T2	105.4 ± 6.24	
Nasolabial angle	T1	107.6 ± 9.01	0.062
	T2	112.2 ± 9.43	
Mentolabial angle	T1	94.09 ± 12.164	0.025*
	T2	101.75 ± 11.28	

T1, pretreatment; T2, posttreatment *$p < 0.05$ is statistically significant; test used: paired *t* test

Table 2: Intergroup comparisons of various soft tissue (Linear) parameters

Soft tissue (Linear)	*Pre/ posttreatment*	*Mean ± SD*	*p-value*
Upper lip-E line	T1	0.5 ± 1.38	0.20
	T2	0.13 ± 1.358	
Lower lip-E line	T1	–2.47 ± 1.213	0.002*
	T2	–1.38 ± 0.976	
Upper lip-S line	T1	3.99 ± 0.19	0.00001*
	T2	2.64 ± 0.32	
Lower lip-S line	T1	9.01 ± 0.247	0.00001*
	T2	9.43 ± 0.238	
Lip strain	T1	10.24 ± 0.510	0.014*
	T2	10.64 ± 0.52	

T1, pretreatment; T2, posttreatment *$p < 0.05$ is statistically significant; test used: paired *t* test

On intergroup comparison, it was observed that H-angle ($p = 0.003$) and Mentolabial angle ($p = 0.025$) showed significant differences after exposure while the facial Convexity, nasolabial angle, and Z-angle did not show significant differences in this regard (Table 1).

Likewise, the mean pretreatment values of the soft tissue linear parameters comprising Upper lip-E line, Lower lip E-line, Upper lip S-line, Lower lip S-line, lip strain were 0.5 ± 1.38, -2.47 ± 1.213, 3.99 ± 0.19, 9.01 ± 0.247, 10.24 ± 0.510, respectively, while the post-treatment values were at 0.13 ± 1.358, -1.38 ± 0.976,2.64 ± 0.32, 9.43 ± 0.238 and 10.64 ± 0.52, respectively. On intergroup comparison, it was observed that Lower lip E-line ($p = 0.02$), upper lip S-line ($p < 0.00001$), Lower lip S-line ($p < 0.00001$), and lip strain ($p = 0.014$) showed statistically significant difference except for the upper lip E-line which was not significant ($p = 0.20$) (Table 2).

Measuring the airway two-dimensionally from lateral cephalogram, there is a positive effect in the oropharyngeal airway dimension after fixed functional appliance therapy using PowerScope appliance. Considering the airway spaces and hyoid position, the mean pretreatment values of the Superior Posterior Airway space, Middle Airway space, Inferior Airway space, Upper pharynx, Lower pharynx space, Hyoid to mandible, C3 – H, H – RGn were 10.64 ± 0.58, 11.67 ± 0.58, 10.23 ± 0.15, 11.27 ± 2.50, 8.03 ± 1.212, 16.33 ± 2.266, 30.39 ± 1.704, 39.89 ± 0.797, respectively, whereas the posttreatment values were at 12.6 ± 0.64, 13.22 ± 0.52, 10.71 ± 0.17, 12.32 ± 2.14, 8.54 ± 1.08,19.8 ± 3.247, 32.1 ± 1.862, 41.56 ± 0.943, respectively. On intergroup comparison, it was observed that the Superior Posterior Airway space ($p < 0.00001$), Middle Airway space ($p < 0.00001$), Inferior Airway space ($p < 0.00001$), Upper pharynx ($p = 0.09$), Hyoid to the mandible ($p = 0.0002$), hyoid angles (C3-H; $p = 0.027$) and (H– RGn; $p < 0.0001$) showed significant differences after the use of PowerScope device, while there were no significant differences for the Lower pharynx space ($p = 0.08$) after the appliance therapy (Table 3).

Table 3: Intergroup comparisons of Oropharyngeal airway and hyoid position

Oropharyngeal airway and hyoid position (Linear)	*Pre/ posttreatment*	*Mean ± SD*	*p-value*
Superior Posterior Airway space	T1	10.64 ± 0.58	0.00001*
	T2	12.6 ± 0.64	
Middle Airway space	T1	11.67 ± 0.58	0.00001*
	T2	13.22 ± 0.52	
Inferior Airway space	T1	10.23 ± 0.15	0.00001*
	T2	10.71 ± 0.17	
Upper pharynx space	T1	11.27 ± 2.50	0.0907
	T2	12.32 ± 2.14	
Lower pharynx space	T1	8.03 ± 1.212	0.089*
	T2	8.54 ± 1.081	
Hyoid to mandible	T1	16.33 ± 2.266	0.0002*
	T2	19.8 ± 3.247	
C3 – H	T1	30.39 ± 1.704	0.0027*
	T2	32.1 ± 1.862	
H – RGn	T1	39.89 ± 0.797	0.00001*
	T2	41.56 ± 0.943	

T1, pretreatment ; T2, posttreatment *$p < 0.05$ is statistically significant; test used: paired *t*-test

Discussion

The current study was conducted on a sample of 20 participants, wherein the changes in soft tissue parameters, airway dimensions, and hyoid bone position were evaluated for differences before and after treatment with PowerScope Class 2 corrector in Class II malocclusion patients.

Changes in Soft Tissue

The soft tissue angular measurement, namely, facial Convexity, H-angle, Nasolabial angle, and Mentolabial angle showed significant differences after treatment.[14] The Z-angle did not show significant differences in this regard. A recent case report by Ansari A et al.[15] evaluated the soft tissue parameters after treatment with PowerScope had reported findings that favored the device.[15] The H-angle, Nasolabial angle, lip strain, Upper E-line, and lower E-line were insignificant ($p > 0.05$), but the desired significant results were shown in terms of the mentolabial angle [from 96.7 ± 17.78 pretreatment to 115.9 ± 12.31 posttreatment; ($p = 0.012$)]. However, the lower E-line, upper S-line, Lower S-line, and lip strain showed statistically significant differences in the current study. A significant

improvement in facial profile owing to the increase in the mentolabial angle happened in line with the current study.

The soft-tissue measurements, reported from another similar Indian study on post-pubertal subjects with non-extraction class II malocclusion cases by Malhotra A et al.,[16] showed a significant reduction of H-angle and lip strain by 1.09° and 1.8 mm, respectively, which is similar with the results of the current study findings. The Upper lip E-line increased significantly by 1.05 mm in the same study, whereas the same was insignificant in the current study.[16] Antony et al. in a clinical study in class II patients using PowerScope appliance had shown that a decrease in E line measurements is reported to have occurred as a result of retrusion of the upper lip, maxillary incisors that have undergone lingual tipping, and the anterior standing of soft-tissue pogonion posttreatment.[17] There was a statistically insignificant increase in the nasolabial angle. The lower lip protrusion was found to be statistically insignificant, but the increase in the mentolabial angle was noted, as found in the current study. This is related to improvement in the facial profile.[18]

Changes in Airway

The FFRD is reported to bring changes in pharyngeal airway dimensions and hyoid bone position following Class II correction.[19] The same was reported with the use of PowerScope in the current study. The Superior Posterior, middle, and inferior airway spaces showed a highly statistically significant change with minor but significant changes in the Upper pharynx, hyoid angles (C3-H and H – RGn) after treatment in the current study. These observations are supported by a systematic review and meta-analysis by Xiang M et al. which polled data that the superior pharyngeal space (mean = 1.73 mm/year, 95% CI, 1.13-2.32 mm), middle pharyngeal space (mean = 1.68 mm/year), and inferior pharyngeal space (mean = 1.21 mm/year) showed a highly significant change.[20] The results of the Systematic Review[20] showed that Functional appliance can enlarge the upper airway dimensions, in subjects with skeletal Class II malocclusion which is in line with the results of our study. The other functional appliances (Herbst or activator) may have roles in specific cases for the Class II corrections in children. The duration of treatment may be longer for the Class II elastics, but they are ideal alternatives to PowerScope as per a study. The study by Kamoltham K et al. reported that skeletal (increased mandibular length, midfacial length, and mandibular plane angle) and dental changes are significantly more than the PowerScope when elastics were used.[21]

Changes in Hyoid Bone Position

The changes in hyoid bone position mirror the changes in the tongue and mandible. Treatment with PowerScope appliance showed that hyoid bone shifted significantly forward by 3.47 ± 0.98 mm. Displacement of the hyoid bone to a more forward position can also be attributed to the adaptation of tongue posture to the dentoalveolar mesialization obtained by PowerScope appliance.

The facial convexity, upper E-line, Z angle, nasolabial angle, and lower pharyngeal air space did not show statistically significant changes in the current study, but the rest showed significant improvement posttreatment. The findings of the study demonstrated an improvement in the soft tissue profile as well as in the airway dimensions with the forwarding position of the hyoid bone. Previous studies have proved that the treatment with PowerScope appliance produces more dentoalveolar changes, majorly by the forward movement of the mandibular dentition which could influence the tongue posture. The improvement in oropharyngeal dimensions can affect and influence the hyoid bone position as a consequence of dentoalveolar changes. In the present study, sample size was small, population was restricted to South Indian origin and two-dimensional cephalometric evaluation has its own limitations. The future directions include long-term studies with larger perspectives that can provide better validation of each parameter measured.

Conclusion

The facial convexity, upper E-line, Z-angle, and nasolabial angle did not show statistically significant changes. The rest of the soft-tissue parameters, oropharyngeal air spaces (except for lower pharyngeal space), and hyoid positioning measured in the study showed significant improvement posttreatment. Overall, the soft tissue profile in Class II malocclusion treated with PowerScope appliance had shown promising results as per the results of the study. The beneficial effects of the appliance can be considered in Skeletal Class 2 cases with narrow airway dimensions and for the improvement of soft tissue parameters.

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