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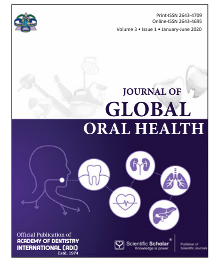

Research Article

Dentoskeletal and soft-tissue changes concurrent to use of PowerScope appliance in treatment of Class II malocclusion – A retrospective study

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Received: 21 March 2023
Accepted: 27 July 2023
EPub Ahead of Print: 10 January 2024
Published:

DOI
10.25259/JGOH_15_2023

Quick Response Code:

ABSTRACT

Objectives: The most frequently encountered malocclusion in our daily clinical practice is Class II malocclusion with mandibular retrognathism. Treatment modalities for Class II malocclusion correction depend on numerous factors such as the severity of the malocclusion and the age at which the patient reports for the treatment. One of the innovations in Class II treatment is the PowerScope appliance. The objectives of this study were: (1) To evaluate dentoskeletal changes with the use of PowerScope appliance in the treatment of Class II division I malocclusion using lateral cephalograms in late adolescents. (2) To evaluate the soft-tissue changes with the use of PowerScope appliance in the treatment of Class II division I malocclusion using lateral cephalograms in late adolescents. **Materials and Methods:** This retrospective and cross-sectional study was done using pre- and post-treatment lateral cephalograms of 15 patients treated with PowerScope appliance who were under decelerated growth phase as assessed by cervical vertebrae maturation index (Stages 4, 5, and 6). All the lateral cephalograms were hand traced and measured by same investigator. **Results:** A highly statistically significant difference was observed between the pre-and post-angle formed by sella nasion plane and nasion to point B line (SNB), angle formed by nasion to point A line and nasion to point B line (ANB), condylion to point gnathion (Co–Gn), and distance between point A to nasion perpendicular (N perpendicular to Point A) to Pog skeletal parameters. It was found that a highly significant difference was noted for parameters upper molar to palatal plane (U6-PP), lower incisor to nasion to point B line (L1-NB), lower incisor to nasion to point B line (L1-NB*), lower incisor to mandibular plane angle (IMPA), and upper molar to pterygoid vertical line (U6-PTV). A significant difference was present for parameters upper incisor to nasion to point A line (U1-NA), while no difference was observed for upper incisor to sella nasion plane (U1-SN) and upper molar to pterygoid vertical line (U6-PTV). A significant statistical difference was observed between the pre-and post-lower lip to E line parameter. **Conclusion:** PowerScope caused significant skeletal changes by forward repositioning of the mandible as well as by an increase in the length of the mandible. There was significant retrusion of upper incisors and a highly significant increase in lower incisor protrusion, lower molar mesialization, and upper molar intrusion. Soft-tissue lower lip protrusion was significant.

Keywords: PowerScope, Class II malocclusion, Cephalometric analysis

INTRODUCTION

The most frequently encountered malocclusion in our daily clinical practice is Class II malocclusion with mandibular retrognathism as one-third of the population seeking orthodontic treatment are affected by it.[1]

Treatment modalities for Class II malocclusion correction depend on numerous factors such as the severity of the malocclusion and the age at which the patient reports for the treatment. Craniofacial growth does not stop in young adulthood but Behrents[2] from his growth studies has stated that it is a continuous process even into later ages.

During the pubertal growth phase, skeletal Class II malocclusion can be treated with growth modulation through the use of various removable functional appliances such as a bionator, activator, Twin block, and Frankel functional regulator. On the other hand, during the deceleration phase, fixed functional appliances such as Fixed Twin block,[3] Eureka spring,[4] Herbst appliance,[5,6] Jasper Jumper, and Forsus Fatigue-resistant device[7] which are not dependent on patient cooperation are used.

One of the innovations in Class II treatment is the PowerScope appliance, manufactured by American Orthodontic Corporation in 2014. The objectives of this study were to evaluate dentoskeletal and soft-tissue changes with the use of PowerScope appliances in the treatment of Class II malocclusion.[8]

MATERIALS AND METHODS

This retrospective and cephalometric study was conducted using lateral cephalograms of 15 patients to assess the skeletal, dentoalveloar, and soft-tissue changes in Class II malocclusion patients treated with PowerScope. The investigated cases were selected primarily based on the presence of skeletal Class II malocclusion and were later specifically screened based on inclusion and exclusion criteria [Figure 1].

Sample size estimation

The sample size was determined using the following formula:

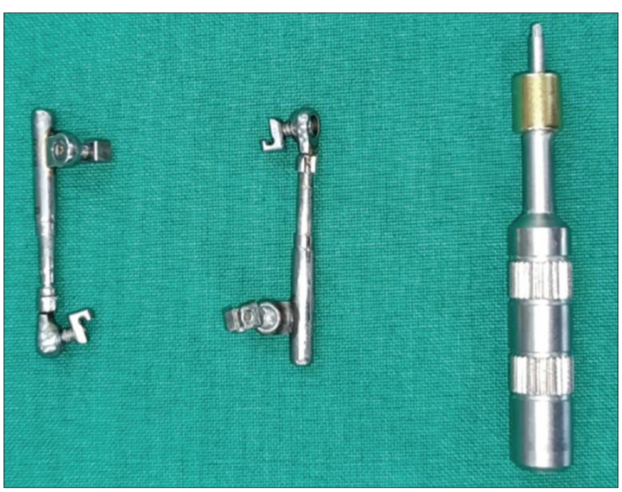


Figure 1: PowerScope.

$$n = \frac{Z_{\alpha}^{2}\sigma^{2}}{\left(X_1 - X_2\right)^2}$$

Where, Z_α = 1.96 (constant), σ = pooled standard deviation, X_1 = Mean of Group 1, X_2 = Mean of Group 2, n = Sample size, σ = 1.18, X_1-X_2 = 0.86.

Thus, on calculating,

$$= \frac{(1.96)^2 \times (1.18)^2}{(0.86)^2} = 7.30$$

Hence, the sample size is approximately 8. Cervical vertebral maturation index (CVMI) Stage 4 to CVMI Stage 6 was also used as it corresponds to the post-peak pubertal growth period and the stages were determined using lateral cephalograms.

- Lateral cephalograms were taken just before the placement of PowerScope (T1) and after its removal following the attainment of a Class I molar relationship (T2) were used for this study. These cephalograms were analyzed for dentoskeletal and soft-tissue changes from T1 to T2 using various cephalometric parameters [Table 1 and Figures 2 & 3].

Statistical test

- Standard descriptive statistics including mean, standard deviation, and standard error of mean were calculated.

Table 1: Cephalometric parameters used in the study.

Skeletal parameters	Dental parameters	Soft-tissue parameters
SNA (°)	U1-NA (°)	H-angle (°)
SNB (°)	U1-SN (°)	Upper-lip/E-line (mm)
ANB (°)	U6-PP (mm)	Lower-lip/E-line (mm)
Co-A (mm)	U6-PTV (mm)	
Co-Gn (mm)	L1-NB (mm)	
SN-Go-Gn (°)	L1-NB (°)	
SN-OP (°)	IMPA (°)	
N perpendicular to Point A	L6-PTV (mm)	
N perpendicular to Pogonion		

SNA: Angle formed by sella nasion plane and nasion to point A line, SNB: Angle formed by sella nasion plane and nasion to point B line, ANB: Angle formed by nasion to point A line and nasion to point B line, Co-A: Condylion to point A, Co-Gn: Condylion to point gnathion, SN-GoGn: Sella Nasion plane to gonion gnathion plane angle, SN-OP: Sella Nasion plane to occlusal plane angle, U1-NA: Upper incisor to nasion to point A line, U1-SN: Upper incisor to Sella Nasion plane, U6-PP: Upper molar to palatal plane, U6-PTV: Upper molar to pterygoid vertical line, L1-NB: Lower incisor to Nasion to point B line, L1-NB*: Angle formed between lower incisor to Nasion to point B line, IMPA : Lower incisor to mandibular plane angle, L6-PTV: Lower molar to pterygoid vertical line, H angle: Holdaway angle, E-line: Esthetic line

- Paired *t*-test was used to assess the difference in the parameters from T1 to T2 stage.
- The intraclass correlation coefficient test was used for calculating a measure of agreement between first and repeat readings for each study parameter.

RESULTS

Comparative evaluation of the difference between the pre-and post-skeletal parameters. A highly significant statistical difference was observed between the pre-and post-SNB, ANB, Co-Gn, and N perpendicular to Pog skeletal parameters. No significant difference was found among the rest of the parameters [Table 2 and Graph 1].

Comparative evaluation of the difference between the pre-and post-dental parameters. It was found that a highly significant difference was noted for parameters U6 PP, L1 NB, L1 NB*, IMPA, and L6 PTV. A significant difference was present for parameters U1 NA, while no difference was observed for U1 SN and U6 PTV [Table 3 and Graph 2].

Comparative evaluation of the difference between the pre-and post-soft-tissue parameters. There was no

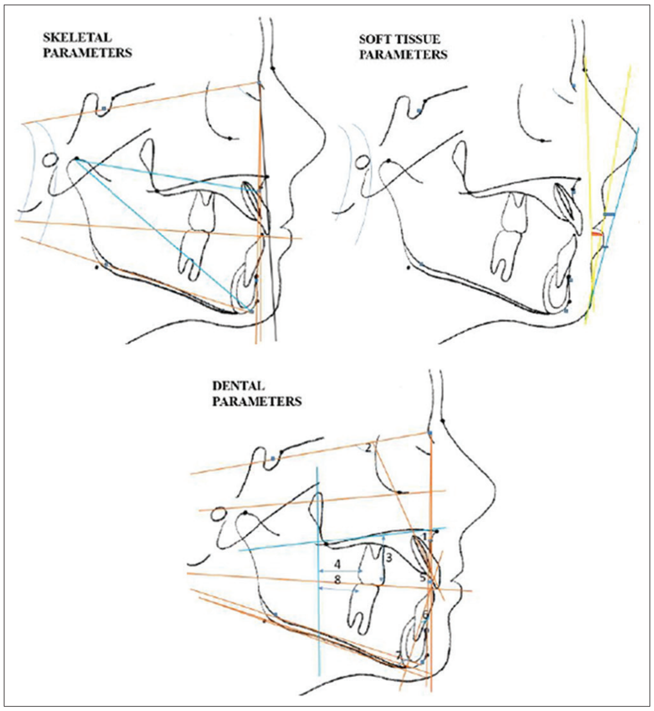


Figure 2: Cephalometric parameters used in the study, 1: U1-NA(angle), 2: UI-SN(angle), 3: U6-PP(mm), 4: U6-PTV(mm), 5: L1-NB(mm), 6: L1-NB(angle), 7: IMPA(angle), 8: L6-PTV(mm).

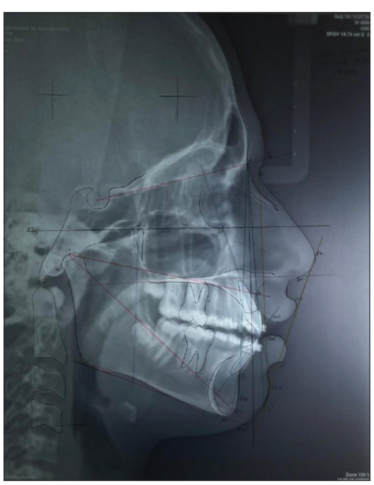
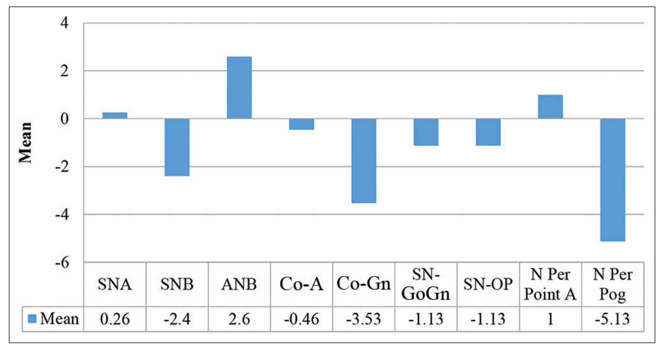
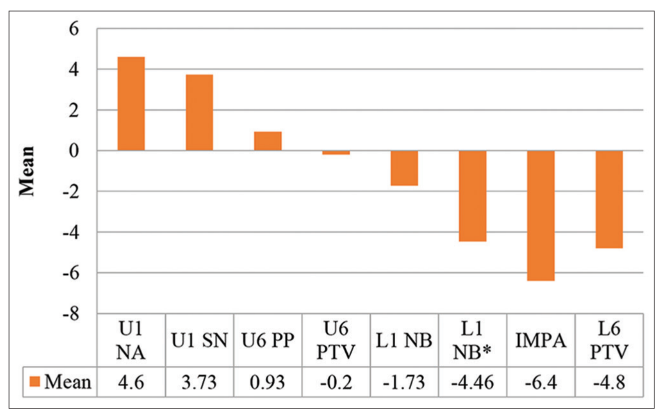


Figure 3: Cephalometric tracing used in the study.



Graph 1: Comparative evaluation of the difference between pre-and post-skeletal parameters. SNA: Angle formed by Sella Nasion plane and nasion to point A line, SNB: Angle formed by Sella Nasion plane and nasion to point B line, ANB: Angle formed by Nasion to point A line and Nasion to point B line, Co-A: Condylion to point A, Co-Gn: Condylion to point gnathion, SN-GoGn: Sella Nasion plane to gonion gnathion plane angle, SN-OP: Sella Nasion plane to occlusal plane angle, N Per Point A: N perpendicular to Point A, N Per Point A: N perpendicular to pogonion.



Graph 2: Comparative evaluation of the difference between pre-and post-dental parameters, U1-NA: Upper incisor to nasion to point A line, U1-SN: Upper incisor to Sella Nasion plane, U6-PP: Upper molar to palatal plane, U6-PTV: Upper molar to pterygoid vertical line, L1-NB: Lower incisor to Nasion to point B line, L1-NB*: Angle formed between Lower incisor to Nasion to point B line, IMPA: Lower incisor to mandibular plane angle, L6-PTV: Lower molar to pterygoid vertical line.

Table 2: Comparative evaluation of difference between the pre- and post-skeletal parameters.

Parameter	Mean	Standard deviation	Standard error	Sig. (2-tailed)
Pre-SNA –Post-SNA	0.26	0.79	0.2	0.21
Pre-SNB–Post-SNB	−2.4	1.05	0.27	0.000**
Pre-ANB–Post-ANB	2.6	0.98	0.25	0.000**
Pre-Co-A–Post-CO-A	−0.46	2.13	0.55	0.41
Pre-Co-GN–Post-Co-Gn	−3.53	2.41	0.62	0.000**
Pre-SN-GOGN–Post-SN-GoGn	−1.13	2.38	0.61	0.08
Pre-SN-OP–Post-SN-OP	−1.13	3.04	0.78	0.17
Pre-N Per Point A–Post-N Per Point A	1.00	2.32	0.6	0.11
Pre-N Per Pog–-Post-N Per Pog	−5.13	3.18	0.82	0.000*

*Significant difference, **Highly significant difference, SNA: Angle formed by Sella Nasion plane and nasion to point A line., SNB: Angle formed by Sella Nasion plane and nasion to point B line, ANB: Angle formed by Nasion to point A line and Nasion to point B line, Co-A: Condylion to point A, Co-Gn: Condylion to point gnathion, SN-GoGn: Sella Nasion plane to gonion gnathion plane angle, SN-OP: Sella Nasion plane to occlusal plane angle, N Per Point A: N perpendicular to point A

Table 3: Comparative evaluation of difference between the pre- and post-dental parameters.

Parameter	Mean	Standard deviation	Standard error	Sig. (2-tailed)
Pre-U1 NA–Post-U1 NA	4.6	6.36	1.64	0.01*
Pre-U1 SN–Post-U1 SN	3.73	6.8	1.75	0.052
Pre-U6 PP– Post-U6 PP	0.93	0.79	0.2	0.000**
Pre-U6 PTV–Post-U6 PTV	−0.2	2.27	0.58	0.73
Pre-L1 NB–Post-L1 NB	−1.73	1.83	0.47	0.003**
Pre-L1 NB*–-Post-L1 NB*	−4.46	5.55	1.43	0.008**
Pre-IMPA–Post-IMPA	−6.4	7.37	1.9	0.005**
Pre-L6 PTV–Post-L6 PTV	−4.8	2.54	0.65	0.000**

*Significant difference, **Highly significant difference, U1-NA: Upper incisor to nasion to point A line, U1-SN: Upper incisor to Sella Nasion plane, U6-PP: Upper molar to palatal plane, U6-PTV: Upper molar to pterygoid vertical line, L1-NB: Lower incisor to Nasion to point B line, L1-NB*: Angle formed between lower incisor to Nasion to point B line, IMPA: Lower incisor to mandibular plane angle, L6-PTV: Lower molar to pterygoid vertical line

statistically significant difference between the pre-and post-soft-tissue parameters – Holdaway angle (H angle) and upper lip (U lip). A highly significant statistical difference was observed between the pre-and post-L lip to esthetic line (E line) [Tables 4 and 5, Graph 3].

Table 4: Comparative evaluation of difference between the pre- and post-soft tissue parameters.

Parameter	Mean	Standard deviation	Standard error	Sig. (2-tailed)
H angle	1.93	7.43	1.91	0.33
U lip	0.13	1.55	0.4	0.74
L lip	−2.46	1.76	0.45	0.000*

*Significant difference, H angle: Holdaway angle, U lip: Upper lip to esthetic line, L lip: Lower lip to esthetic line

Table 5: Reliability.

Parameter	Mean	Minimum	Maximum	Cronbach's alpha
Pre-dental	28.77	−3.2	106	0.713
Post-dental	30.15	−3.2	106.2	0.735
Pre-skeletal	44.04	−10.2	110.4	0.278
Post-skeletal	44.88	−5.2	113.8	0.47
Pre-soft tissue	4.22	−3.2	21.4	0.035
Post-soft tissue	4.98	−3.2	21.6	0.738

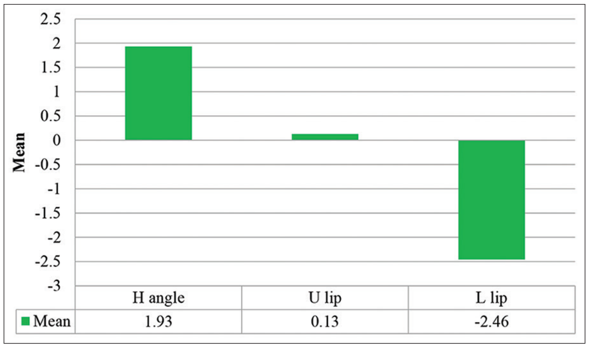
DISCUSSION

Treating Class II malocclusion using removable functional orthopedic appliances has a long history. Depending on the patient's need, clinicians can choose from a multitude of appliances to achieve the best possible outcome.

Knowledge about the mode of action of the appliance may help in its selection pertaining to the patient's need. PowerScope is the new addition to the fixed functional category for reparation of Class II malocclusion. Due to the paucity of scientific data with regard to changes occurring with the use of PowerScope, this study was undertaken.

Skeletal parameters

The results showed a decrease in SNA, N perpendicular to Point A, and effective maxillary length (Co-A) at the post-functional phase, but none of these values were found to be statistically significant, indicating that there may be a mild



Graph 3: Comparative evaluation of the difference between pre-and post-soft-tissue parameters. H angle: Holdaway angle, U lip: Upper lip to esthetic line, L lip: Lower lip to esthetic line.

restraining effect on the maxilla. This was in accordance with the study done by Malhotra *et al.*,[9] Nishanth *et al.*,[10] and Antony[11] *et al*. Hence, it is evident that PowerScope induces no change in the maxillary skeletal parameters. According to the previous study mentioned by Malhotra *et al.*,[9] statistically significant changes were observed in SNB and effective mandibular length. However, it was not in congruence with studies done by Nishanth *et al.*,[10] and Antony *et al.*[11] The statistically significant change in N perpendicular to pog showed the anterior repositioning of the mandible. These similar results were observed in the study conducted by Antony *et al.*[11] Post-functional increase in mandibular length that is seen can be attributed to growth in condyle due to forward positioning of the mandible, which was in accordance to study done by Kamoltham and Charoemratrote.[12] Statistically significant decrease in ANB was seen post-functional, which may be attributed to decrease in SNA and increase in SNB values. Similar findings were seen in studies done by Malhotra *et al.*,[9] Nishanth *et al.*,[10] and Antony *et al.*[11] Hence, these finding suggests improvement in ANB with PowerScope. The comparison of vertical relationship parameters showed no statistically significant changes with functional occlusal plane angle (SN-OP) and mandibular plane angle (SN-Go-Gn). This was not in accordance with the study done by Malhotra *et al.*[9]

Dentoalveolar parameters

A statistically significant decrease was seen with respect to U1-Na indicating uprighting of the maxillary incisors; this was similar to a headgear-like effect and similar results were seen in a study done by Malhotra *et al.*,[9] but in this study, the results were highly significant. There was no statistically significant decrease seen with respect to U1-SN pre-treatment and post-functional. These results are in accordance with findings reported by Nishanth *et al.*[10] Moreover, the results were not in congruence with the study by Malhotra *et al.*[9] The U6-Palatal plane showed decreased values post-functional, which indicates intrusion of the upper molar. This was in accordance with the findings of Nishanth *et al.*[10] Similar results were not seen in the study done by Malhotra *et al.*[9] U6-PTV showed no statistically significant changes, similar results were seen in the study done by Malhotra *et al.*[9] The fixed functional appliances exert a distal and intrusive force on maxillary molars, yet clinically significant distalization was not seen in our study but an intrusive effect was seen. Both the linear and angular values of the lower incisor to NB line showed statistically significant increases in pre-treatment and post-functional. According to Malhotra *et al.*,[9] Nishanth *et al.*,[10] similar results were seen post-functional, while Kamoltham and Charoemratrote[12] also reported increased values but they were not significant. A statistically significant increase in IMPA was seen. This was similar to results found in a study by Malhotra[9] *et al.*, and a study by Kamoltham and Charoemratrote[12] showed an increase in post-functional value but it was not statistically significant. As reported with other functional appliances, there was a marked proclination of mandibular incisors. This side effect was observed despite cinching of the archwire distal to mandibular molars. This might have been due to the telescopic mechanism of PowerScope which exerts a mesially directed force on mandibular anterior. This unfavorable outcome of fixed functional appliances cannot be prevented as the point of force application in the mandibular anterior region is above the center of resistance of the dentoalveolar unit. The molar relationship showed significant improvement from Class II to Class I relationship. This was primarily due to the mesialization of the lower dentoalveolar segment. There were significant changes seen with lower molar to PTV.

Soft-tissue parameters

The values of the H angle that measures upper lip prominence or retrognathism of the soft-tissue chin were found to be not statistically significant, which is not in accordance with the observations seen in studies by Malhotra *et al.*[9] Upper lip retrusion was seen with respect to E line but the values were not statistically significant, which is similar to the observations seen in studies by Nishanth *et al.*,[10] Antony *et al.*,[11] and Kamoltham and Charoemratrote.[12] Changes in the lower lip to E line were seen and there was statistically significant lower lip protrusion, similar to the observations seen in studies by Malhotra *et al.*,[9] Kamoltham and Charoemratrote.[12]

CONCLUSION

PowerScope caused significant skeletal changes by forward repositioning of the mandible as well as by an increase in the length of the mandible. There was significant retrusion of upper incisors and a highly significant increase in lower incisor protrusion, lower molar mesialization, and upper molar intrusion. Soft-tissue lower lip protrusion was significant. These findings indicate that PowerScope is an effective appliance for treating late adolescent patients with Class II skeletal base with mandibular retrognathism.

Ethical approval

Institutional Ethical commitee approval is taken, number 2020-21/1388 dated 9.2.2021.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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How to cite this article: Sajjan S, Naik VR, Naik S. Dentoskeletal and soft-tissue changes concurrent to use of PowerScope appliance in treatment of Class II malocclusion – A retrospective study. J Global Oral Health. doi: 10.25259/JGOH_15_2023