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THREE-DIMENSIONAL EVALUATION OF POWERSCOPE APPLIANCE ASSISTED WITH LOW-LEVEL LASER THERAPY ON MANDIBULAR CHANGES IN THE TREATMENT OF SKELETAL CLASS 2 MALOCCLUSIONS: A PROSPECTIVE CLINICAL STUDY

Amr Khairy El-Morsy[1*], Ramadan Yusuf Abu-Shahba[2], El-Hassanein Hussein El-Hassanein[3], Ali Mohamed Saafan[4]

ABSTRACT

Objectives: to evaluate PowerScope appliance assisted with Low-Level Laser Therapy on mandibular changes in the treatment of skeletal class 2 malocclusions. **Subjects and methods:** The current study was conducted on 24 orthodontic female patients with an age range from 14- to 16-year-old who were collected from the outpatient clinic at Orthodontic Department, Faculty of Dental Medicine, Boys, Al-Azhar University, Cairo, Egypt. They were randomly divided into 2 groups, each consisted of 12 patients, Group A (Laser group) were treated with PowerScope appliance and Low-Level Laser Therapy (LLLT), Group B (Control group) were treated with PowerScope only. **Results:** There were statistically significant changes in skeletal and dentoalveolar measurements. **Conclusion:** PowerScope appliance provides an effective tool for the treatment of Class II division 1 malocclusion in adolescent patients. The PowerScope appliance promotes restriction of anterior maxillary displacement with significant forward mandibular repositioning which reduces skeletal convexity. Effects of PowerScope appliance with or without LLLT were mainly dentoalveolar with little skeletal effects

KEYWORDS: PowerScope appliance, Low-Level Laser Therapy, Skeletal Class 2, Cone Beam Computed Tomography.

INTRODUCTION

Patients with Class 2 skeletal relation is one of the most frequent orthodontic problems(1). A lot of factors can contribute to the development of skeletal class 2 malocclusion. Among these factors is mandibular retrognathism which is the most frequent encountred factor(2). Many treatment options were introduced for class 2 malocclusion such as orthognathic surgery, camouflagic treatment, removable and fixed functional appliance, and elastics. All these strategies were selected according to the severity of the case, the age of the patient, and the origin of the problem which will direct the operator to select the suitable treatment modalities(3,4).

1. Master Candidate, Department of Orthodontics, Al-Azhar University Cairo Boys
2. Associate professor, Department of Orthodontics, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University.
3. Associate professor, Department of Orthodontics, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University.
4. Professor, Department of Dental Laser Applications, National Institute of Laser Enhanced Sciences, Cairo University

• ***Corresponding author*:** amrkhairy14@gmail.com

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Emil Herbst has introduced fixed functional appliances (FFA) due to a lack of patient cooperation in wearing removable functional appliances. Fixed functional appliances diver from removable functional appliances in working hours, optimal treatment timing, and direction of remaining growth, which was classified as; Rigid, flexible, and hybrid fixed functional appliance [5,6].

PowerScope is considered a step forward in Class 2 correction which is a type of hybrid FFA that was invented by Andy Hayes due to its 1-comfortability to the patient, 2-simplicity in installation, 3-without laboratory steps, 4-has a universal size that suits all situations, and 5-it is wire to wire installation that eliminates the need of bands. [7,8].

The appliance is attached to the wire by a nut with a hexagonal screw, it contains a ball and socket joint to increase the lateral movement of the mandible which increases patient comfort. The appliance has an 18 mm telescoping mechanism that consists of the inner shaft, middle and outer tubing, pushrod, and nickel-titanium that produces 260g of force, and contains finally the crimpable shims activate the appliance initially or during treatment [9,10] .

Recently, the bio-stimulation of Low-Level Laser Therapy (LLLT) has proved to be very useful for orthodontists in condylar growth, mandibular advancement, and stimulation of tooth movement by increasing the amount of Adenosine Tri Phosphate (ATP), blood circulation, and osteoblastic and osteoclastic activity[11,12] .

PATIENTS AND METHODS

Study design:

The study design was a prospective clinical study, was done on 24 orthodontic patients which were divided into two groups, group A (Laser group) and group B (Control group).

Sample size calculation:

The sample size for this study was done according to previous studies [7,13] depending on:

1. Acceptable level of significance $p<0.05$ (Type I or α error=5%). This means that we are ready to accept that the probability that the observed difference "false positive" due to chance is 5%.
2. Power of the study =0.80 The "power" of the study then is equal to $(1 -\beta)$. This means that we are ready to accept a 10% failure to detect a difference when there is a difference "false negative", i.e. Type II or β error=10%).
3. Expected effect size=1.195
4. Standard deviation is the measure of dispersion or variability in the data. The sample size=24 patients: 12 for each group.

Ethical consideration:

An informed consent form that explains every step in the research will be given and discussed carefully with the patients or the parents before participation in the study and should be signed freely. The objectives of the study will be discussed and explained with the patients and/or guardians as well. (EC Ref No: 103/114/03-19)

Participants:

This study was done on 24 orthodontic female patients who were collected from the outpatient clinic at the Orthodontic Department, Faculty of Dental Medicine, Boys, Al-Azhar University, Cairo, Egypt.

They were randomly divided into two groups: each consisted of 12 patients as follows:

The first group consisted of 12 patients, who received PowerScope fixed functional appliance therapy assisted with Low-Level Laser Therapy (LLLT), the second group consisted of 12 patients, who received PowerScope fixed functional appliance therapy.

The patients included in the study fulfilled the following criteria: Age ranges from 14–16-year-old, patients with skeletal class 2 due to mandibular

retrognathism, patients with good oral hygiene and no previous orthodontic or orthopedic treatment, healthy female patients at post-pubertal growth phase with no systemic nor genetic diseases that could interfere with orthodontic treatment.

The patients were excluded from the study if they had the following: patients with a skeletal open bite or Temporomandibular Joint disorder, patients with craniofacial anomalies, history of trauma or poor oral hygiene, patients with a history of previous orthodontic treatment.

Intervention:

For each patient in the study, the following orthodontic records were taken before treatment:

Preoperative:

Case history and clinical examination:

A complete diagnostic sheet was done for each patient, including a detailed case history, extra-oral, and intra-oral examinations. Additionally, a thorough medical history was taken carefully from each patient to exclude any systemic disease that could interfere with orthodontic treatment and the patients were checked to meet the inclusion criteria previously mentioned.

Patients' records:

Routine orthodontic records: For each patient, a set of four extra-oral and five intra-oral photographs were taken, Panoramic radiograph, standardized lateral cephalometric radiograph, and orthodontic study cast model.

Research-related records: To fulfill the objectives of the current study. The following records were obtained for each patient before and upon completion of the period of mandibular advancement: Extra-oral and intra-oral photographs.

For each patient, two lateral cephalometric radiographs scans were obtained; one pre-installation of the appliance and another immediately after the removal of the appliance.

PowerScope installation:

PowerScope appliance *(PowerScope2, American orthodontics, USA) were installed after leveling and alignment on 0.019" x 0.025" (.022 slot) cross section for maximum fit and stability of the appliance by placing it mesial to the maxillary first molar in the maxillary arch and distal to mandibular canine in the mandibular arch then the screw is tightened using hex head driver and activated by different sizes of crimpable shims which are added to the shaft. [9]

Low-Level Laser Therapy (Laser Biomodulation)

LLLT (PHOTON, Photon,Egypt) was applied on the center of condyle 1 cm away from the skin bilaterally. Exposure was a total of 9 min on each condyle for 3 sessions a week for 4 weeks in a continuous-wave mode with wavelength of 870nm, Power-output 300mW, the diameter of fiber handpiece was 0.36 cm^2 and energy 162 J.

Operative procedures:

Transpalatal arch (TPA): transpalatal arch was fabricated to avoid buccal flaring of the molars and counteract the intrusive force of the PowerScope appliance by using separators mesial and distal to the upper 1^{st} permanent molar for five days and then selecting the proper band size, an alginate impression material was taken (Chromapan, Promedica Company, Italy), pouring with dental stone (Bredent dental stone, Bredent medical, Germany) after band adjusting, TPA (9mm st.st. wire soldered to the band) was fabricated and cemented on maxillary first molars by glass ionomer cement.

Brackets: The maxillary and mandibular teeth were bonded (Grengloo for metal brackets, Ormco, Co 1717 West Collins Av,USA) with 0.022×0.028-inch slots Roth brackets (Grengloo for metal brackets, Ormco, Co 1717 West Collins Av,USA).

Archwire: After direct bonding of the brackets (Discovery Smart, Dentaurum, Germany), installation of Nickel-Titanium (Ni-Ti) arch wire (Dentaurum, Germany) for leveling and alignment of teeth starting from 0.012" up to stainless steel (St.St.) archwire 0.019" ×0.025" in diameter.

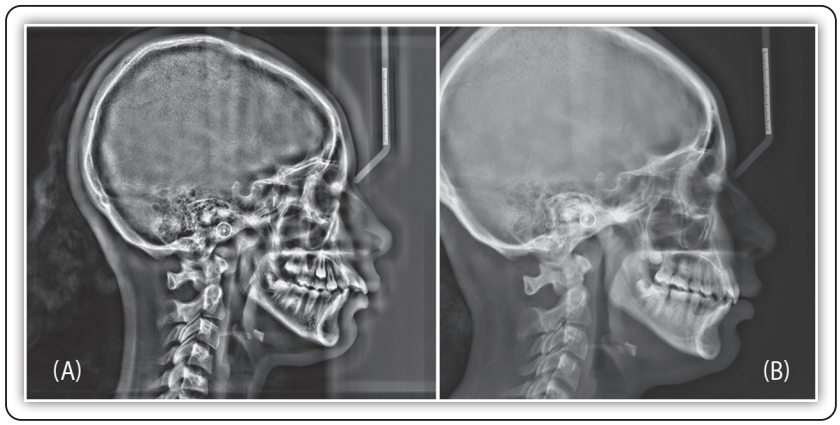

FIG (1) (A): Pre-operative lateral cephalometric radiograph, (B): Post-operative lateral cephalometric radiograph

Statistical analysis

Numerical data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed normal (parametric) distribution except for the following measurements: U Lip to E-Line, L Lip to E-Line, Overbite, Glenoid fossa volume, Posterior joint space, AP Condylar position, Geo differences as well as amounts of change in all measurements data which showed non-normal (non-parametric) distribution. Data were presented as mean, standard deviation (SD), median and range values. For parametric data, repeated measures ANOVA test was used to study the changes by time within each group as well as to compare between the two groups. Bonferroni's post-hoc test was used for pair-wise comparisons when ANOVA test is significant. For non-parametric data, Wilcoxon signed-rank test was used to study the changes within each group. Mann-Whitney U test was used to compare between the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

RESULTS

TABLE (1): Mean, standard deviation values and results of repeated measures ANOVA test for the changes in sagittal angular measurements within each group

Measurement (°)	Group	Pre-treatment		Post-treatment		*P*-value	*Effect size (Partial Eta Squared)*
		Mean	SD	Mean	SD		
SNA	Laser	85.05	6.91	84.56	6.97	0.003*	0.375
	Control	81.63	1.63	80.91	1.59	<0.001*	0.678
SNB	Laser	76.44	7.19	78.58	7.35	<0.001*	0.853
	Control	74.47	1.5	76.34	1.63	<0.001*	0.878
ANB	Laser	8.61	1.6	5.98	1.31	<0.001*	0.849
	Control	7.16	1.58	4.57	1.51	<0.001*	0.898
Facial angle	Laser	88.25	3.55	89.98	3.05	<0.001*	0.621
	Control	86.56	3.28	88.08	2.75	<0.001*	0.673

Changes within each group

In Laser group; there was a statistically significant decrease in ANBº post-treatment. There was statistically significant change in SNAº, SNBº as well as facial angle post treatment.

In control group; there was a statistically significant decrease in ANBº post-treatment. There was statistically significant change in SNAº, SNBº as well as facial angle post treatment (Table 2).

Changes within each group

In both groups; there was a statistically significant increase in LAFH measurements post treatment in both groups (Table 3).

Changes within each group

In Laser group; there was a statistically significant decrease in U1-SN measurements post-treatment. There was a statistically significant increase in IMPA measurements post-treatment.

In control group; there was a statistically significant decrease in U1-SN measurements post-treatment. There was a statistically significant increase in IMPA measurements post-treatment.

TABLE (2): Mean, standard deviation values, and results of repeated measures ANOVA test for the changes in linear measurements within each group

Measurement (mm)	Group	Pre-treatment		Post-treatment		*P*-value	*Effect size (Partial Eta Squared)*
		Mean	SD	Mean	SD		
LAFH	Laser	61.18	2.06	62.86	2.66	0.004*	0.354
	Control	62.29	2.94	63.45	3.23	0.011*	0.294

TABLE (3): Mean, standard deviation values, and results of repeated measures ANOVA test for the changes in angular dental measurements within each group

Measurement (º)	Group	Pre-treatment		Post-treatment		*P*-value	*Effect size (Partial Eta Squared)*
		Mean	SD	Mean	SD		
U1-SN	Laser	110.29	10.38	104.31	9.11	0.001*	0.43
	Control	107.15	6.06	100.66	5.55	<0.001*	0.591
IMPA	Laser	103.05	8.25	112.51	9.08	<0.001*	0.589
	Control	103.89	4.94	112.54	6.82	<0.001*	0.661

DISCUSSION

Regarding skeletal measurements:

Change in SNA, SNB angles:

The present study recorded statistically significant decrease between pre and post measurements of both SNA and SNB angles in both groups which do not agree with Arora et al [14] and Nishanth et al [7] who reported non significance value of both measurements after using PowerScope appliance and in agreement with Kaur et al [15] and Shendy et al [16] who reported significant decrease in SNA angle and significant increase in SNB after using PowerScope appliance.

Change in ANB angle:

As for ANB angle it produced clinically and statistically significant decrease in ANB angle in laser and control group (-2.64°) and (-2.58°) which agrees with the results of Kaur et al [15] and Shendy et al.[16] who reported a significant decrease in ANB angle (-3.2°) and (-3.8°) respectively after treating class 2 cases with age ranging from 11-16 year old of both genders using PowerScope, but it disagrees with Shetty et al.[17] who recorded no significant difference between pre and post skeletal measurements after using PowerScope in class 2 cases depending on lateral cephalometric radiographs for evaluation.

Change in Facial Angle:

This study reported a significant increase in facial angle between the pre and post-measurements in both groups which agrees with Shendy et al [16] who reported significant increase in facial angle after using PowerScope for both genders with lateral cephalometric radiographic evaluation and did not coincide with Kaur et al (15) who recorded a decrease in facial angle measurement after using PowerScope appliance.

Change in Lower Facial Height (LAFH):

The present study recorded statistically significance increase between pre and post-measurements of LFH in both laser and control groups which did not agree with Shendy et al[16] who recorded a non statistically significant value between pre and post measurements of LAFH.

Regarding dental measurements:

Change in U1-SN angle:

This present study reported statistically significant difference between pre and post-measurement of U1-SN angle for both laser and control groups (-5.98°) and (-6.5°) respectively which coincides with Shendy et al [16] who reported a statistically significant decrease (-15.6°) in U1-SN angle. And vary from Kalra et al [18], Arora et al [14], and Kaur et al [15] who reported statistically not significant difference between pre and post measurements after using PowerScope.

Change in IMPA angle:

This study reported statistically significant increase between pre and post measurements of IMPA angle in laser and control groups (9.46°) and (8.65°) respectively which agrees with Kaur et al [15] and Nishanth et al[7] and disagrees with Kalra et al[18] and Shetty et al[17]

CONCLUSION

The present study was conducted to compare the changes induced by PowerScope appliance with and without the assist of Low-Level Laser Therapy (LLLT) in the correction of class II malocclusion.

Based on the current study results and with the limitations of the present study, the following conclusions could be drawn:

1. PowerScope appliance provides an effective tool for the treatment of Class II division 1 malocclusion in adolescent patients.
2. The PowerScope appliance promotes restriction of anterior maxillary displacement with significant forward mandibular repositioning which reduces both skeletal.
3. Effects of PowerScope appliance with or without LLLT were mainly dentoalveolar with little skeletal effects.

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