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Original Research Article

Comparative evaluation of treatment effects of two different commercially available fixed functional appliances for correction of class II malocclusion – A clinical study

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Abstract

Introduction: Functional appliances are used to stimulate mandibular growth by forward posturing of the mandible to correct class II skeletal and occlusal disharmony.
Aims and objectives: To evaluate the skeletal, dental and soft tissue effects of Power Scope and Leone Class II Corrector for correction of class II malocclusion.
Materials and Methods: Twenty four subjects were divided on the basis of fixed functional appliance therapy given for correction of class II malocclusion into two groups: Group I treated with Power Scope (n=12) and Group II treated with Leone Class II Corrector (n=12). Lateral cephalogram was taken for all the subjects and various skeletal, dentoalveolar and soft tissue; linear and angular measurements were done and data obtained statistically analysed using independent t-tests.
Results: Statistically significant differences ($p>0.05$) were found on intergroup comparison of pre-treatment and posttreatment values in both the groups treated for class II correctors. Both the fixed functional appliances were effective in the correction of skeletal Class II malocclusion with statistical insignificant changes were seen in the mean differences ($p<0.05$) in skeletal, dento alveolar as well as soft tissue.
Conclusion: Both PowerScope and Leone's Class II Corrector are effective in correcting Class II malocclusion.

Keywords: Class II malocclusion, Power Scope, Leone class II corrector, Fixed functional appliance

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1. Introduction

The term functional appliance refers to a variety of orthodontic appliances designed to induce a change in activity of the various muscle groups that influence the function and position of the mandible in order to transmit forces to the dentition and the basal bone. Altering the sagittal and vertical mandibular position generates these changes in muscular forces and results in orthopedic and orthodontic changes.[1] The appliance is tooth-borne and exerts its effects via teeth to the underlying bone by transmitting the forces developed due to continuous forward posturing of the lower jaw.

Through advancements in technology and increasing knowledge, several appliances, aiming to be the most efficient and effective, have been developed in order to correct these malocclusions. From tubes and plunger telescopic mechanism as in Herbst appliance to Hybrid fixed functional appliances, fixed functional appliances has undergone a massive transformation. A wide range of functional appliances used to stimulate mandibular growth by forward posturing of the mandible is available to correct class II skeletal and occlusal disharmony. The mechanisms by which these appliances work vary considerably, and therefore their effects are significantly different.[2]

This study was designed to evaluate the effects of Powerscope and Leone Class II Corrector that are the latest innovations as Class II corrector. Powerscope, a descendant of Herbst type II appliance, was developed by Dr. Andy Hayes, who worked in conjunction with American

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Orthodontics. It is a semirigid telescopic mechanism with a Ni-Ti internal spring system which stands on the desired treatment planning of the orthodontist which includes patient comfort and acceptance, extensive range of motion and simple installation.[3]

Leone Class II Corrector is a new non-compliance device for Class II correction. The small size of the device allows for optimum patient comfort while the constant and light force is delivered by the spring located inside the plunger that would stimulate the mandibular advancement.[4]

There are various studies in the literature that focus on the evaluation of fixed functional appliances. But only few studies in the literature are available that have evaluated and compared the treatment effects of PowerScope and Leone Class II Corrector. Hence the aims and objectives of the study were to evaluate the skeletal, dental and soft tissue effects of Power Scope and Leone Class II Corrector.

2. Materials and Methods

The present study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics. Twenty four subjects were selected on the basis of Daniel sample size calculation method from the patients visiting the department for seeking orthodontic treatment. Informed consent was taken from the patient, parent or guardian. Ethical approval was taken from the research institutional ethical committee prior to commencing the study (vide no. hdc/ethical/ortho2020/13).

The subjects were included in the study on the basis of the following inclusion criteria; detailed medical and dental history was taken to rule out any systemic disease, skeletal Class II malocclusion with the molars in Class II or end on relationship, post pubertal patients with CVM stage 4-5, Retrognathic mandible ,Overjet not less than 5mm, Horizontal to average growth pattern ,Positive pre-treatment Visual Treatment Objective (VTO) (**Figure 1**) and both upper and lower incisors should be upright on the basal bone and minimum or no crowding in the dental arches requiring no extraction of any permanent teeth. Exclusion criteria includes patients with trauma or craniofacial anomalies, congenitally missing or impacted teeth in the anterior segment. ,subjects with severe proclination and crowding of anterior teeth, subjects with skeletal class I and class III malocclusion and cleft lip and palate patients.

The patients were divided into two groups based on the type of appliance used:

1. **Group I:** Class II correction with PowerScope (n=12)
2. **Group II:** Class II correction with Leone Class II Corrector (n=12)

Bonding was done for each patient and they were treated with preadjusted edgewise appliance system (MBT 0.022 x 0.028inch). Transpalatal arch (TPA) was fabricated and cemented on the first maxillary molar, and that was to counteract the buccal forces exerted by the fixed functional appliance; TPA was spaced from the palatal mucosa by 1 to 2 mm to avoid ulceration or impingement into the soft tissue as a result of the intrusive forces of the fixed functional appliance. The wire sequence was followed according to the MBT (0.022 x 0.028inch) straight wire mechanics.

After initial levelling and alignment in all the patients, 0.019 x 0.025inch stainless steel arch wires were placed in both maxillary and mandibular arches. To ensure that the wires are passive, they were left in place for at least 4 weeks. A lingual crown torque of 10˚ in the lower anterior segment was placed in all the patients to avoid any undesirable flaring of the lower incisors because of the fixed functional appliance. The fixed functional appliance was then installed in both the groups as shown in **Figure 3** and **Figure 4**. The mandibular archwire was cinched distal to the molars in both the groups.

The patients were observed at 4-week intervals and appliances were activated as needed. The patients were asked to report to the department immediately in case they experienced any breakage of the appliance before the next follow-up visit. Appliance was kept in mouth until class II occlusion was overcorrected to an edge-to-edge incisor relationship and class I molar relation was obtained as shown in **Figure 4** & **Figure 5**. Thereafter, fixed appliances were maintained in order to finalize the occlusion on the average for a period of six months.

Lateral cephalograms were taken prior to the placement of fixed functional appliance (T1), and after the removal of the appliance (T2). Various linear and angular measurements were done to assess the skeletal, dental and soft tissue changes in the treatment outcomes of Class II correction using the two appliances as shown in **Figure 6** and **Figure 7**. To determine the intraexaminer reliability,[5]cephalograms were traced by the investigator. The intraexamminar reliability was found to be 90%. All measurements were within 1mm range with an average discrepancy of 0.4 mm. All the data of the two groups was collected and tabulated and was analysed using SPSS software (Statistical Package for Social Sciences).

3. Results

The Shapiro Wilk test was used to check the normality of data. The data were subjected to descriptive analysis for proportion, mean, and standard deviation. Independent t-tests were used for parametric data to compare the means between groups. On the intragroup comparison of pre-treatment and post-treatment mean values of the parameters in Group I and Group II using Independent t-tests showed various skeletal , dentoalveolar and soft tissue statistical significant changes ($p<0.05$) in both the groups as shown in **Table 1** and **Table 2**. Further on the intergroup comparison of pre-treatment and post-treatment mean differences of the parameters in Group I

and Group II statistically insignificant (p>0.05) results were obtained respectively as shown in **Table 3.**

Table 1: Intragroup comparison of pre-treatment and post treatment mean values of the parameters in Group I (Powerscope)

Parameters	Pre-treatment	Post treatment	t	p
	Mean ± S.D.	Mean ± S.D.		
Skeletal Angular				
N-S-ar	129.10 ± 3.78	128.40 ± 3.66	4.583	.001
SNA	80.70 ± 3.23	79.80 ± 3.12	3.857	.004
SNB	75.80 ± 3.12	77.40 ± 3.41	-7.236	.000
ANB	4.90 ± 0.74	2.40 ± 0.52	11.180	.000
FMA	23.20 ± 3.33	25.40 ± 3.03	-8.820	.000
N Ba-Ptm Gn	88.20 ± 2.90	89.70 ± 2.54	-6.708	.000
Skeletal linear				
N ⊥ Point A	4.90 ± 2.42	6.40 ± 2.84	-6.708	.000
N ⊥ Pog	15.00 ± 4.24	11.20 ± 3.36	7.125	.000
Co-A	95.50 ± 7.65	94.40 ± 7.73	6.128	.000
Co-Gn	117.40 ± 7.00	119.00 ± 6.91	-9.798	.000
Co Gn-Co A	21.90 ± 4.61	24.60 ± 4.30	-10.371	.000
AO-BO	5.00 ± 1.63	2.50 ± 1.18	8.135	.000
ANS-Me	68.20 ± 8.23	70.20 ± 7.79	-9.487	.000
Dental Linear				
U6-PtV	15.90 ± 5.51	14.30 ± 5.60	7.236	.000
Overjet	9.60 ± 2.55	2.80 ± 0.42	9.350	.000
Overbite	5.50 ± 1.27	2.80 ± 0.42	6.821	.000
Dental Angular				
U1-SN	111.80 ± 6.80	108.50 ± 6.11	11.000	.000
U1-NA	29.00 ± 4.67	27.00 ± 4.29	7.746	.000
L1-NB	23.20 ± 3.71	29.30 ± 3.86	-12.658	.000
IMPA	92.10 ± 5.72	99.80 ± 5.37	-12.893	.000
U1-L1	119.50 ± 7.71	115.30 ± 7.23	7.875	.000
Soft Tissue				
ULP	5.70 ± 1.70	3.50 ± 1.18	8.820	.000
LLP	2.20 ± 1.75	3.80 ± 1.87	-9.798	.000
Mentolabial sulcus	7.70 ± 1.34	5.40 ± 1.17	7.667	.000
Nasolabial angle	103.60 ± 11.88	106.60 ± 12.12	-8.216	.000

p<0.05 statistically significant; p>0.05 statistically insignificant.

Table 2: Comparison of pre-treatment and post treatment mean values of the parameters in group II (Leone Class Ii Corrector)

Parameters	Pre-treatment	Post treatment	t	p
	MEAN ± S.D.	MEAN ± S.D.		
Skeletal Angular				
N-S-ar	128.80 ± 3.99	128.00 ± 4.03	6.000	.000
SNA	81.70 ± 2.98	80.70 ± 2.75	6.708	.000
SNB	76.50 ± 3.47	78.20 ± 3.01	-6.530	.000
ANB	5.20 ± 1.14	2.50 ± .53	10.371	.000

FMA	23.00 ± 3.16	24.70 ± 3.13	-11.129	.000
N Ba-Ptm Gn	88.30 ± 6.11	90.70 ± 5.85	-7.060	.000
Skeletal Linear				
N ⊥ Point A	4.90 ± 2.28	5.70 ± 2.23	-9.000	.000
N ⊥ Pog	15.70 ± 4.30	11.80 ± 3.49	10.301	.000
Co-A	95.00 ± 6.36	93.80 ± 6.60	6.000	.000
Co-Gn	117.70 ± 8.71	119.30 ± 8.69	-9.798	.000
Co Gn-Co A	22.60 ± 5.40	25.40 ± 5.30	-11.225	.000
AO-BO	6.30 ± 1.89	2.90 ± 1.29	12.750	.000
ANS-Me	69.00 ± 7.66	70.30 ± 7.35	-8.835	.000
Dental Linear				
U6-PtV	17.20 ± 5.22	16.20 ± 5.14	9.000	.000
Overjet	9.00 ± 1.41	2.70 ± 0 .48	15.917	.000
Overbite	6.00 ± 1.41	2.60 ± 0.52	7.965	.000
Dental Angular				
U1-SN	109.70 ± 6.82	106.00 ± 5.85	6.871	.000
U1-NA	27.30 ± 4.32	25.00 ± 4.21	7.667	.000
L1-NB	23.40 ± 4.53	26.00 ± 4.35	-15.213	.000
IMPA	95.80 ± 5.29	99.00 ± 4.40	-7.668	.000
U1-L1	124.10 ± 8.53	120.40 ± 6.98	6.195	.000
Soft Tissue				
ULP	6.20 ± 1.81	3.70 ± 1.06	9.303	.000
LLP	2.90 ± 2.42	4.60 ± 2.27	-7.965	.000
Mentolabial sulcus	8.00 ± 1.33	5.10 ± 0.99	16.155	.000
Nasolabial angle	99.60 ± 13.56	101.80 ± 13.43	-8.913	.000

$p<0.05$ statistically significant; $p>0.05$ statistically insignificant.

Table 3: Interrgroup comparison of mean differences of the parameters in Group I (Power scope) And Group Ii (Leone Class Ii Corrector)

Parameters	**Group**		**T**	**p**
	Group 1	**Group 2**		
	Mean diff	**Mean diff**		
Skeletal Angular				
N-S-ar	0.70	0.80	.232	.819
SNA	0.90	1.00	-.684	.503
SNB	-1.60	-1.70	-.556	.585
ANB	2.50	2.70	-.429	.673
FMA	-2.20	-1.70	.509	.617
N Ba-Ptm Gn	-1.50	-2.40	-.496	.629
Skeletal Linear				
N ⊥ Point A	-1.50	-0.80	.263	.796
N ⊥ Pog	3.80	3.90	-.392	.700
Co-A	1.10	1.20	.187	.854
Co-Gn	-1.60	-1.60	-.085	.933
Co Gn-Co A	-2.70	-2.80	-.371	.715
AO-BO	2.50	3.40	-.725	.478
ANS-Me	-2.00	-1.30	-.325	.749
Dental Linear				
U6-PtV	1.60	1.00	-.582	.568
Overjet	6.80	6.30	.493	.628
Overbite	2.70	3.40	.949	.356
Dental Angular				
U1-SN	3.30	3.70	.934	.363
U1-NA	2.00	2.30	1.051	.307
L1-NB	-6.10	-2.60	1.051	.307

IMPA	-7.70	-3.20	-.054	.957
U1-L1	4.20	3.70	-1.639	.119
Soft Tissue				
ULP	2.20	2.50	-1.605	.126
LLP	-1.60	-1.70	-.399	.695
Mentolabial sulcus	2.30	2.90	-.859	.402
Nasolabial angle	-3.00	-2.20	.617	.545

$p<0.05$ statistically significant; $p>0.05$ statistically insignificant.

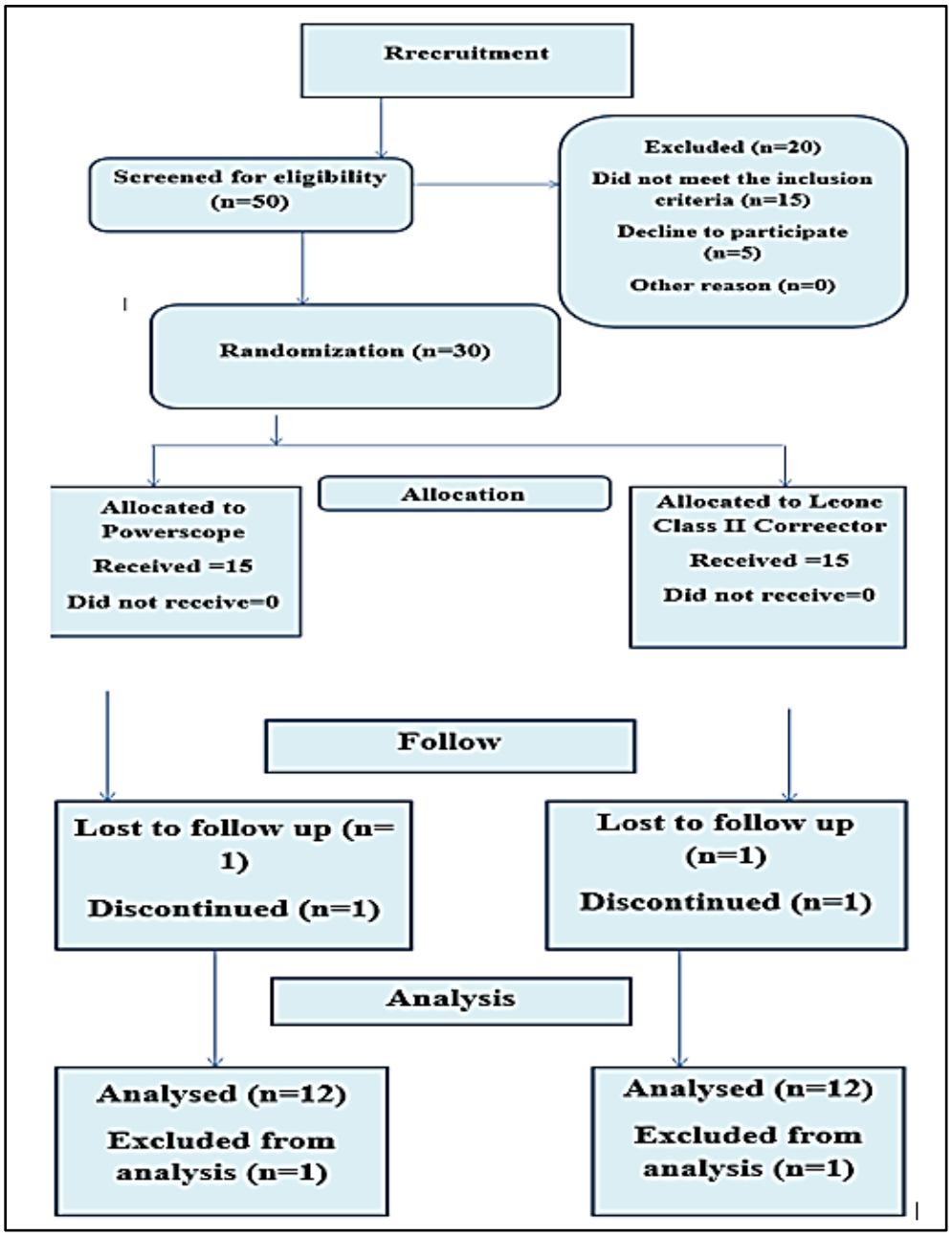

Figure 1: Consort - consolidated standards of reporting trials flow diagram

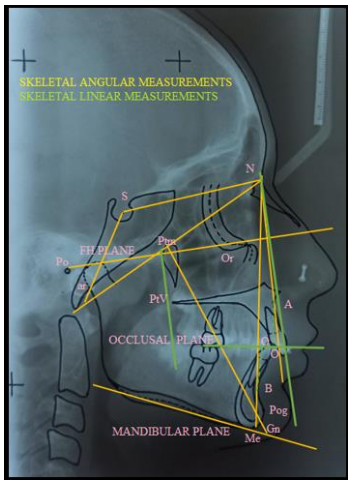

Figure 2: Lateral cephalogram showing angular and linear skeletal parameters.

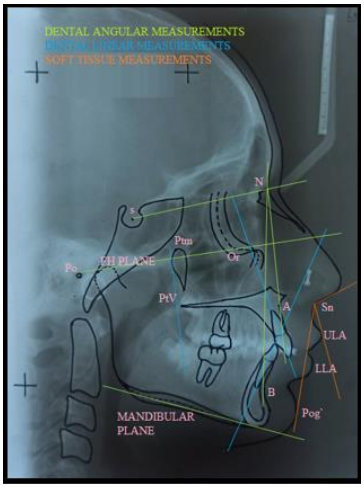

Figure 3: Lateral cephalogram showing dental linear, dental angular and soft tissue parameters

Figure 4: VTO of the patient

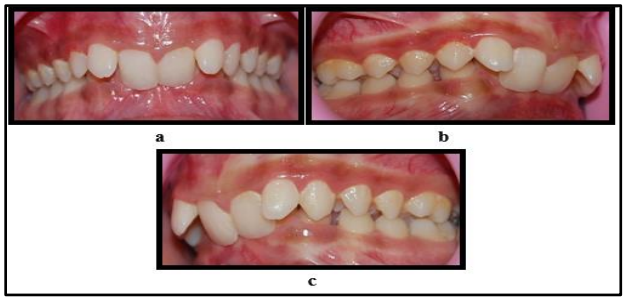

Figure 5: Pre-treatment intra oral photographs of patient treated class ii correctors

Figure 6: Intra oral photographs of patient with powerscope (Group I)

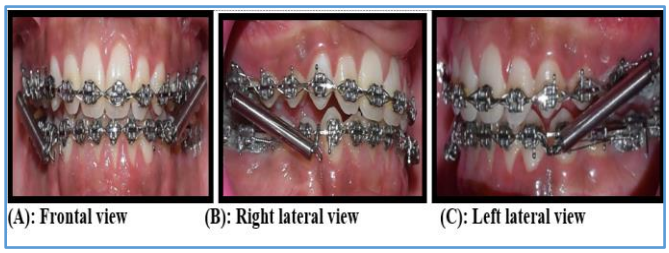

Figure 7: Intra oral photographs of patient with leone Class II corrector (Group II)

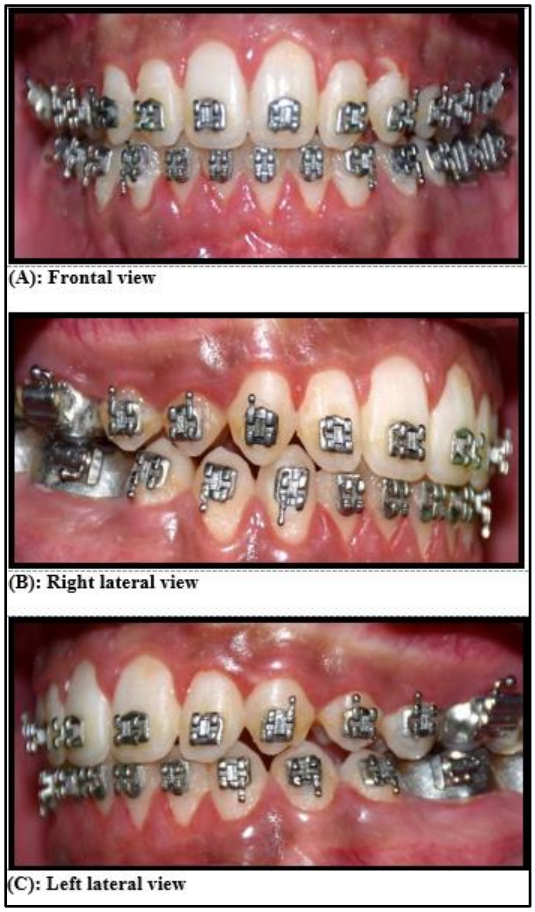

Figure 8: Post-treatment intra oral photographs of patient treated with class ii correctors

4. Discussion

The functional appliances used to stimulate mandibular growth by forward posturing of the mandible is available to correct class II skeletal and occlusal disharmony. The mechanisms by which these appliances work vary considerably, and therefore their effects are significantly different. Hence the aims and objectives of the study were to evaluate the skeletal, dental and soft tissue effects of PowerScope and Leone Class II Corrector. The results of the present study showed that on intragroup comparison of Saddle angle in Group I PowerScope and Leone Class II Corrector showed statistically significant difference ($p<0.05$) as shown in **Table 1** and **Table 2**. This decrease was due to anterior positioning of the mandible and forward displacement of the articular portion of temporal bone. This leads to positional change of mandibular jaw which contributes to the correction of facial convexity. These results were in accordance with the study done by Patel HP et al (2016),[6] Savana K et al (2016).[7]

Further, the results showed a significant decrease in SNA angle in both the groups which might be because of restraining effect of fixed functional appliance on maxilla as shown in Table I and II. This was in accordance to the study done by Cope JB et al (1994)[8] and Weiland FJ et al (1995).[9]

Moreover, there was a significant increase in SNB angle in both the groups. This change was due to the forward positioning of the mandibular base that brought the position of Point B forward. This was in accordance to the study done by Pancherz H (1979) [10]and Arora V et al (2018).[5]

Further, the results showed a significant decrease in ANB angle due to forward position of the mandibular base using the PowerScope appliance and Leone Class II Corrector appliance in Group I and II respectively that brought the position of Point B forward. This change in ANB angle is in accordance with the study done by Mittal K et al (2017)[11] and El-Hossainy H et al (2022).[12] Moreover, there was a significant increase in FMA angle in both the groups which was due to the reason that fixed functional appliance cause forward and downward displacement of mandible producing a bite opening effect. This bite opening effect produced a change in the mandibular plane, thus increasing the FMA angle. Significant extrusion of mandibular first molars along with retrusion of maxillary incisors and protrusion of mandibular incisors resulted in clockwise rotation of occlusal plane. Similar results were shown by study done by Cope JB et al (1994).[8]

Further, statistically significant increase in N Ba-Ptm Gn angle in both groups which might be due to change in anteroposterior position of mandible in treatment with PowerScope appliance and Leone Class II Corrector appliance that brought the position of point Gn forward. This were in accordance to the study done by Mittal K et al (2017).[11] There is increase in N Point A distance in both the groups because of the change in positioning of Point A due to maxillary restraining effect by fixed functional appliance. These results were in accordance to the study done by Franchi L et al (2011).[13]

Moreover, the results showed decrease in Co-A distance in both the groups that might be because of the effect of distal force to the maxilla and the maxillary teeth which has been often observed with the use of fixed functional appliances, and it is reported to be a ‘‘headgear effect” which helps to correct the Class II relationship. The results of our study were in accordance with the study done by Guimarães Jr CH et al (2013).[14]

Further there was a significant increase in Co Gn-Co A in both groups and is attributed to the change in positioning of the mandibular base and maxillary head gear effect using the PowerScope appliance and Leone Class II Corrector appliance in group I and II respectively. In both groups, the value was positive, indicating that the mandible outgrew the maxilla. These changes in Co Gn-Co A were in accordance with the study done by Arora V et al (2018).[5] here was a significant increase in ANS-Me distance in both groups and attributed to the clockwise rotation of the occlusal plane that in turn might be related to the dental changes produced by the functional appliances. This clockwise rotation of the occlusal plane results in a downward and backward mandibular

movement leading to increase in lower anterior facial height. These changes were in accordance with the study done by Fontes FP et al (2020)[15] and Singh DP et al (2018).[16]

Further, the results of the present study showed that that there was a significant decrease in U6-PtV distance in both the groups which might be because of distal movement of the maxillary dentition. This shows that more reciprocal force acted distally on the maxillary dental arch when the mandible was postured forward by the PowerScope and Leone Class II Corrector. These changes were in accordance with the study done by Franchi L et al (2011).[13]

Moreover the overjet correction was through a combined maxillary and mandibular orthopedic effect with maxillary incisor palatal tipping and mandibular incisor labial tipping. Reduction in overjet was due to proclination in mandibular arch and retroclination in maxillary arch. Some of this reduction was also due to forward posturing of the mandible. The mandibular anterior movement of the buccal segments, a greater labial tip of the mandibular incisors which is a common fixed–functional appliance effect and dental compensation, associated with maxillary anterior restriction, helps to correct the maxillomandibular discrepancy of Class II malocclusion. These changes were in accordance with the study done by Malhotra A et al (2018).[17]

There was a significant decrease in overbite in both the groups due to combined effect produced by downward and backward rotation of occlusal plane and proclination of mandibular incisors. These changes were in accordance with the study done by Pancherz H (1979).[10]

Further, there was a significant decrease in U1-SN in both the groups which was due to the distal movement of maxillary dentition. These changes were in accordance with the study done by Guimarães Jr CH et al (2013)[14].

The results of the present study showed that there was a significant increase in L1-NB in both the groups which was due to the dentoalveolar effects on the lower dental arch produced by both appliances. These dentoalveolar effects were mesial movement of the lower molars and proclination of the lower incisors and were a result of the downward and forward application of force on the mandibular dentition. These changes were in accordance with the study done by Malhotra A et al (2018).[17]

Further there was a significant increase in IMPA in both the groups which was due to the proclination of lower incisors as a result of fixed functional appliance therapy and were a result of the downward and forward application of force on the mandibular dentition. Fixed functional appliance resulted in forward and downward displacement of mandible producing a bite opening effect. This bite opening effect produced a change in the mandibular plane. These changes were in accordance with the study done by El-Hossainy H et al (2022).[12]

Furthermore, there was a significant decrease in upper lip protrusion in both the groups. This could be attributed to that fact that lower jaw comes in a forward position with the functional appliance therapy along with a slight retroclination of the upper incisors. Retroclination of maxillary incisors resulted in backward movement of upper lips thereby reducing the lip strain significantly. These changes were in accordance with the study done by Shetty P et al (2021).[18] Further there was a significant increase in lower lip protrusion in both the groups. This could be attributed to that fact that lower jaw comes in a forward position after mandibular advancement with the functional appliance along with proclination of the lower incisors. These changes were in accordance with the study done by Marchi PG et al (2022).[19]

The significant decrease in mentolabial sulcus in both the groups depicted a greater mesial dentoalveolar change in the mandible on protrusion. This finding could be justified by the alteration in posture and tonus of the perioral muscles and by the overjet improvement. These changes were in accordance with the study done by Shetty P et al (2021).[18] There was a significant increase in Nasolabial angle in both the groups. This could be attributed to the fact that a reciprocal distal force acted on the maxillary arch when the mandible was postured forwardly in both the appliances. Further, an increase in nasolabial angle may be caused by the upper lip retrusion, which is provided by the upper incisors retrusion induced by the fixed functional appliance therapy. These changes were in accordance with the study done by Pancherz H et al (1994).[20]

Hence the results of the present study showed that Leone Class II Corrector has got definite advantages over Power Scope as proclination of lower anteriors was less in Leone Class II Corrector Group as compared to Power Scope Group. This could be attributed to small size of the device that allows for optimum patient comfort while the constant and light force delivered by Leone Class II Corrector whereas increased force delivery by PowerScope to stimulate mandibular advancement might be responsible for more mandibular incisor proclination.

Though the study was done on small sample size and for relatively short follow-up period of 6 months this could be the limitation of the study. Hence further studies incorporating a larger sample size and an untreated control group are required. Long-term follow-up is essential to study the stability of the fixed functional appliance therapy.

Conclusions

1. The treatment effects of the PowerScope in Class II correction were a combination of skeletal and dentoalveolar effects, similar to other fixed functional appliances.
2. When compared with Leone's Class II Corrector, the PowerScope had less skeletal effects on the

mandible and more dentoalveolar effects that contributes to Class II correction.

Ethical approval was taken before the start of the study from the Research institutional ethical committee (vide no. hdc/ethical/ortho2020/13).

Informed consent was taken from each subject before commencing the orthodontic treatment.

5. Source of Funding

None.

6. Conflict of Interest

None.

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