International Journal of Pharmaceutical and Medicinal Research

Journal homepage: www.ijpmr.org

Original Research Article

COMPARISON OF DENTAL, SKELETAL AND SOFT TISSUE CHANGES IN CLASS II PATIENTS TREATED WITH FORSUS FATIGUE RESISTANT DEVICE AND POWERSCOPE APPLIANCE: A CEPHALOMETRIC STUDY

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ARTICLE INFO:

Article history:
Received: 10 October, 2018
Received in revised form: 30 October, 2018
Accepted: 25 November, 2018
Available online: 30 December, 2018

Keywords:
Forsus fatigue
Resistance device
Powerscope appliance
Class II corrector
Fixed functional appliance

ABSTRACT

Objectives: The objective of the study was to compare the skeletal, dental, and soft tissue changes in class II malocclusion corrected with Powerscope and Forsus fatigue resistant device. Material and methods: A total of 14 females and 10 males with mean age of 13.99±1.50 years growing Class II malocclusion cases with mandibular retrognathism were treated with pre-adjusted edgewise appliance with MBT prescription 0.022" slot followed by fixed functional appliance therapy.Student t-test was used to compare the cephalometric changes produced from insertion of appliance (T0) to 6 months after the treatment with this appliance (T1). Results: Both the treatment protocols (Powerscope and Forsus) were effective in the correction of Maxillomandibular relationship with significant lengthening of the mandible. However, Powerscope appliance caused more restraining effect on maxilla which resulted in more improved soft-tissue profile as compared to the Forsus appliance.

1. Introduction

Class II malocclusion is one of the most commonly encountered malocclusion, which affects approximately one-third of the patients seeking orthodontic treatment[1-2]. According to Kharbanda *at el.* prevalence in New Delhi is 14.6 %[3]. The prevalence of Class II malocclusion in North India is much higher when compared to South India where it is around 5%[4]. Class II malocclusion is not a single diagnostic entity but rather can result from numerous combinations of skeletal and dentoalveolar components. It can be due to maxillary prognathism, mandibular retrognathism or a combination of both. According to McNamara, mandibular retrusion is the most common characteristic of this malocclusion[5].

Various treatment approaches to correct skeletal Class II malocclusion are growth modification in growing patients, orthodontic camouflage and surgical repositioning of jaws in adult patients[6]. Functional appliances, as exemplified by the Andreson activator, Bionator or Frankel appliance, attempts to correct sagittal abnormality by posturing the mandible forward. The main objective of these functional appliances involves "unloading" of the condyles, with the research-supported expectation of enhanced condylar growth in more favorable direction. However, results with these appliances depend highly on patient compliance. To overcome this limitation, a new generation of fixed functional appliances has become popular which are also known as "non-compliant Class II correctors". These appliances are designed to be used 24 hours a day including meal times which means that there is a continuous stimulus for mandibular growth. These are smaller in size thus, permitting better adaptation to functions such as mastication, swallowing and speech. These appliances can be used along with active phase of fixed orthodontic therapy resulting in reduced treatment duration. They are given during late phase of growth spurt and hence little growth left can be utilized. Since, the success of removable functional appliance depends mainly on patient cooperation and compliance, therefore fixed functional appliance have been chosen by numerous clinicians, in order to accelerate mandibular growth.

Since then, many appliances like Jasper Jumper, adjustable bite corrector, Eureka spring, mandibular advancement repositioning appliance etc have been introduced. Presently, the most popular fixed functional appliance is Forsus fatigue resistance device. Forsus fatigue resistance device was introduced in the European market in 2002[7]. The Forsus fatigue resistance device is a fixed functional hybrid device with three-piece (L pin module) composed of a telescoping spring that gets attached at the upper first molar and a push

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rod linked to the lower arch wire, either distal to the canine or first premolar bracket. The Forsus Fatigue resistant device spring and rod creates an equal and opposite force on the maxillary and mandibular dentition. The appliance is relatively well accepted by the patients who may experience initial discomfort and functional limitations that generally diminish with time[8]. According to Lorenzo et al the FRD protocol is effective in correcting Class II malocclusion with a combination of skeletal (mainly maxillary) and dentoalveolar (mainly mandibular) modifications[9].

Powerscope is a new hybrid fixed functional appliance introduced by American Orthodontics in 2012. It is also indicated for treating Class II malocclusion during orthodontic treatment in both growing and non-growing patients. It is an 18 mm telescopic device having a locking nut attachment. It exerts 260 gm of force and has an internal spring mechanism. Its advantage over Forsus fatigue resistant device is that it's a one size fits all appliance, preassembled with attachment nuts for quick and easy chair side application. It has a ball and socket joint, which allows mandibular lateral movements for improved patient comfort and maintenance[10]. Also, it is easily installed and activated.

The Powerscope represents a new evolution in the use of intermaxillary Class II appliances. The clinical experience accumulated through decades of use of fixed functional appliances allowed the development of a device that can eliminate many difficulties found in the past during Class II treatment. The aims and objectives of the study was to compare the skeletal, dental and soft tissue changes in Class II maloclusion patients corrected with Powerscope and Forsus fatigue resistant device

2. Materials and method

This study was performed on the growing Class II malocclusion patients who came to the Department of Orthodontics and Dentofacial Orthopaedics, Himachal Institute of Dental Sciences, Paonta Sahib (H.P) seeking orthodonte treatment.

A total of 24 non-extraction growing Class II malocclusion cases with mandibular retrognathism and those who fulfilled the selection criteria were selected from the patients undergoing orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopaedics.

All the subjects were treated with nonextraction preadjusted edgewise appliance with MBT prescription 0.022" slot followed by fixed functional appliance therapy. These were further divided randomly into two groups based on fixed functional appliance used.

Group 1: 12 patients (07 females and 05 males; mean age - 14.33 ± 1.07 years) Powerscope appliance [American orthodontics].

Group 2: 12 patients (05 females and 07 males; mean age - 13.66 ± 1.30 years) Forsus fatigue resistant device [3M].

2.1 Case preparation

In both the groups 0.022" slot M.B.T. prescription brackets (Sapphire from Modern Orthodontics) were bonded on all teeth. In the lower anterior segment, -6° torque incisor brackets were used. Bands were placed on 1st and 2nd molars and transpalatal arch was fabricated on first molars for maxillary arch and lingual arch for mandibular arch. Initial leveling and alignment was done by using light superelastic NiTi and stainless-steelwires as prescribed by MBT[11]. After the initial leveling and alignment, rectangular wires were inserted till 0.019"×0.025"stainless steel. Both the arches were consolidated with the help of ligature wire in 'figure of 8'fashion. In order to prevent flaring of lower incisors, mandibular archwire was actively cinched back to the distal to the second molars.

After the case preparation, they were randomly divided for both the fixed functional appliances (powerscope and Forsus FRD) and were subsequently assigned in Group I and Group II.

2.2 Inclusion criteria

1. Skeletal and dental Class II malocclusion due to mandibular retrusion (SNB<78° and ANB>4°)
2. Overjet larger than 5mm
3. Normal or low-angle growth pattern (SN-MP<38°)
4. Permanent dentition with no extraction or hypodontia except third molars.
5. No clinical signs or symptoms of temporomandibular disorder.

2.3 Exclusion criteria

1. Patients with missing teeth
2. Patients with appliances other than Forsus fatigue resistant device or Powerscope.
3. Patients with previous history of orthodontic treatment.

2.4 Various parameters selected for the study

Lateral cephalograms were manually traced using acetate tracing sheet and 3H lead pencil and were evaluated for changes in these parameters. Total of 26 parameters with 9 angular and 17 linear measurements[12] were taken as shown in figure.

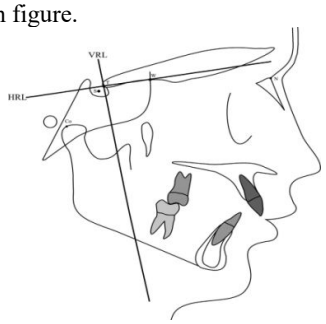

Figure No. 1: Reference planes used in the study: A line passing through the tuberculum sella and wing point was used as a horizontal reference line (HRL) and a perpendicular passing through tuberculum sella as the vertical reference line (VRL).

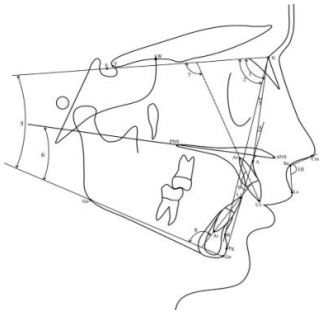

Figure No. 2: Angular measurements used in the study: (1). SNA (2). SNB (3). ANB (4). Convexity (5). SN-MP (6). PP-MP (7). U1-SN (8). IMPA (9). U1-L1 (10). Nasolabial angle.

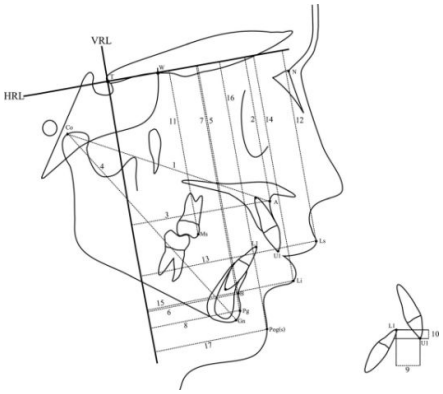

Figure No. 3: Linear measurements to be used in the study (mm): (1). Co-A (2). A-HRL (3). A-VRL (4). Co-Gn (5). B-HRL (6). B-VRL (7). Pog-HRL (8). Pog- VRL (9). Overjet (10). Overbite (11). Ms-HRL (12). Ls-HRL (13). Ls-VRL (14). Li-HRL (15. Li-VRL (16). Pog(s)-HRL (17). Pog(s)-VRL.

Several linear and angular measurements were made to evaluate and compare the skeletal, dentoalveolar and soft tissue effects of appliances using hand tracing on lateral cephalograms.

2.4.1 Maxillary parameters

1. SNA (°) –Angle between Sella, Nasion and Point A.
2. Co –A (mm) –Effective maxillary length.
3. A –HRL (mm) –Distance between Point A and horizontal reference line.
4. A –VRL –Distance between Point A and vertical reference line.

2.4.2 Mandibular parameters:

1. SNB (°) –Angle between Sella, Nasion and Point B.
2. Co –Gn (mm) –Effective length of mandible.
3. B –HRL (mm) –Distance between point B and horizontal reference line.
4. B –VRL (mm) –Distance between point B and vertical reference line.
5. Pog–HRL (mm) –Distance between pogonion and horizontal reference line.
6. Pog–VRL (mm) –Distance between pogonion and vertical reference line.

2.4.3 Maxillomandibular Parameters

1. ANB (°) –Angle between point A, Nasion and Point B.
2. Angle of Convexity (°) –Angle formed by intersection of a lines from Nasion to Point A and Point A to Pogonion.

2.4.4 Vertical

1. SN –MP (°) –Angle formed between SN plane and mandibular plane.
2. MP –PP (°) –Angle formed between palatal plane and mandibular plane.

2.4.5 Dental

1. U1 –SN (°) –Inclination of maxillary incisors with respect to cranial base.
2. IMPA (°) –Angle formed by intersection of the long axis of lower incisor with the mandibular plane.
3. U1 –L1 (°) –Angle formed between long axis of upper and lower incisors.
4. Overjet (mm) –Horizontal overlap of upper and lower incisors.
5. Overbite (mm) –Vertical overlap of upper and lower incisors.
6. U6 –HRL (mm) –Vertical distance from horizontal reference line to mesiobuccal cusp tip of maxillary first molar.

2.4.6 Soft tissue

1. Nasolabial angle (°) –Relationship between lower border of nose and upper lip.
2. Ls-HRL(mm) –Vertical distance between horizontal reference line and labrale superioris.
3. Ls-VRL(mm) –Horizontal distance between vertical reference line and labrale superioris.
4. Li-HRL(mm) –Vertical distance between horizontal reference line and labrale inferioris.
5. Li-VRL(mm) –Horizontal distance between vertical reference line and labrale inferioris.
6. Pog (s)-HRL(mm) –Vertical distance between horizontal reference line and soft tissue pogonion.
7. Pog (s)-VRL(mm) –Horizontal distance between vertical reference line and soft tissue pogonion.

Dental, skeletal and soft tissue changes were analyzed and compared on lateral cephalograms taken at the start of treatment **(T0)** and immediately after the completion of fixed functional therapy **(T1).**

Data collected was statistically analyzed.

3. Result and observation

In the present study, lateral cephalograms were taken before the placement of fixed functional appliance T0 and immediately after removal of appliance T1. Various skeletal, dental and soft tissue parameters were statistically analyzed in both the groups. In our study, all measurements showing a negative (-) sign are synonymous with distal, backward or intrusive movement to relevant reference line, while a positive (+) value indicated forward, mesial or extrusive movement**[11-13].**

Table 1 represents the descriptive data of the patients included in Group I and Group II. The mean age, gender distribution and duration for group I (powerscope) was 14.33±1.07, 5/7 (male/female) and 6.1 months respectively whereas for group II (Forsus) was 13.66±1.30, 7/5 (male/female) and 6.1. The results have shown that there is no statistically significant difference in the mean age, gender distribution and duration of fixed functional therapy in both the groups.

Table 1: Descriptive data of the patients included in group I and group II.

Group	Mean Age	Female/Male	Duration
Powerscope (n=12)	14.33±1.07	7/5	6.12
Forsus (n=12)	13.66±1.30	5/7	6.10
p-value	0.185 (NS)[a]	0.414 (NS)[b]	0.945(NS)[c]

[a] Result of Student's t-test; [b] Result of Chi-square test

Initial pre-treatment cephalometric comparison between two groups. There was no statistically significant difference found on the initial cephalometric values of group 1 and group 2.

On the comparison of the initial (T0) and final (T1) cephalometric mean values of group 1 (Powerscope). In the present study, results have shown that the class II correction was mainly achieved by increase in the mean SNB, IMPA, Li VRL and Pog VRL value and decrease in mean value of U1-SN which was statistically significant.

On the comparison of initial measurements (T0) and final measurements (T1) cephalometric mean values of group II (Forsus Fatigue Resistant Device) results have shown that the Class II correction in Group II (Forsus) was mainly achieved through mandibular changes which was depicted by increase in the mean SNB, IMPA, Li-VRL, and Pog-VRL value and decrease in mean value of U1-SN & ANB, which was statistically significant.

On comparison of Group I (Powerscope) and Group II (Forsus), results have shown that both the appliances have nearly similar skeletal and dental effects except few parameters CO-A, A-HRL, B-HRL,U6-HRL and Ls-HRL, which were statistically significant as shown in Table 2.

Table No. 2: Statistical evaluation of changes obtained in group-I (Powerscope) & group-II (Forsus)

MEASUREMENTS	T0		T1		
	MEAN	SD	MEAN	SD	P value
MAXILLARY					
SNA(^{0})	81.1667	3.713	80.1667	3.761	0.111
CO-A(mm)	83.6667	7.511	82.7500	8.236	0.059
A-HRL(mm)	56.5000	4.145	56.5000	4.123	1.000
A-VRL(mm)	50.5833	10.849	50.2500	10.367	0.438
MANDIBULAR					
SNB(^{0})	75.8333	2.691	77.4167	3.117	**0.000**
CO-GN(mm)	102.5000	8.469	103.333	8.731	0.241
B-HRL(mm)	87.6667	3.550	87.3333	4.097	0.529
B-VRL(mm)	37.5000	13.760	38.5000	13.727	0.111
Pog-HRL(mm)	97.2500	8.645	97.8333	7.284	0.477
Pog-VRL(mm)	38.2500	14.416	39.0833	14.138	0.096
MAXILLOMANDIBULAR					
ANB	5.9167	1.311	3.3333	1.614	**0.000**
CONVEXITY	8.333	4.313	4.916	4.521	**0.001**
VERTICAL					
SN-MP	30.8333	7.883	30.6667	7.499	0.820
MP-PP	23.0000	6.835	22.3333	7.773	0.526
DENTAL					
U1-SN(^{0})	111.5000	6.626	104.500	4.316	**0.002**
IMPA(^{0})	98.0000	6.605	102.583	5.806	**0.001**
U1-L1 (^{0})	123.9167	13.507	120.833	5.605	0.338
OVERJET (mm)	6.0000	2.132	2.1667	0.389	**0.000**
Overbite(mm)	5.5833	1.928	1.8333	0.389	**0.000**
U6-HRL (mm)	64.9167	5.124	64.5833	4.420	0.438
SOFT-TISSUE					
Nasolabial angle (^{0})	108.6667	9.257	113.416	8.826	**0.000**
Ls-HRL(mm)	68.0000	4.651	68.4167	4.100	0.295
Ls-VRL(mm)	66.0833	11.057	65.7500	11.616	0.394
Li-HRL(mm)	83.3333	5.741	83.8333	5.718	0.309
Li-VRL	56.0000	13.928	57.5833	13.433	**0.035**
Pog-HRL	98.2500	6.890	99.3333	5.989	0.151
Pog-VRL	49.0833	15.204	50.1667	15.379	**0.025**

In maxillary skeletal parameters, there was decrease in the mean value of Co-A by -0.916±1.50 mm in Powerscope group whereas in Forsus group there was increase in the mean value by 0.250±1.23 mm, which was statistically significant (p value 0.048). Also, there was an increase in the mean value of A-HRL by 1.16±1.33 mm in group II (Forsus) in comparison to group I (Powerscope) and was statistically significant.

In mandibular parameters, on comparison both the groups have nearly similar skeletal effects except B-HRL, which have shown increase by 1.416±1.92 mm (p value 0.030) in Group II (Forsus) in comparison to group I (Powerscope) where this value was decreased by -0.33±1.77° and was statistically significant.

Both the groups have nearly same dentoalveolar effects except U6-HRL which have shown slight increase in group II (Forsus) and were statistically significant (p value 0.024). Similarly, in soft tissue parameters, Ls-VRL was the only statistically significant value that was decreased in Powerscope group by 0.333±1.302 mm in comparison to Forsus group in which the value was increased by 0.916±0.900 mm, whereas all other parameters were statistically non-significant

4. Discussion

Various fixed functional appliances have been widely used for the treatment of class II patients to eliminate the disadvantages of removable appliance. Removable appliances are bulky and loose in the mouth, so they are not easy for patients to use; thus, insufficient patient cooperation occurs. Of the various fixed functional appliances, Forsus FRD device is one of the newest popular appliance that do not require patients cooperation and is reported to be more comfortable for patients.

According to Lorenzo *et al*., the FRD protocol is effective in correcting Class II malocclusion with a combination of skeletal (mainly maxillary) and dentoalveolar (mainly mandibular) modifications[9].

Recently, new hybrid fixed functional appliance named Powerscope was introduced by American Orthodontics in 2012. It is the latest innovation in Class II correction, which is a direct derivative of the Herbst Type II appliance. Dr. Andy Hayes worked in conjunction with American Orthodontics to develop Powerscope indicated for treating Class II malocclusion during orthodontic treatment in both growing and non-growing patients[16].

Previously published studies have proved the efficacy of fixed functional appliances but since, Powerscope is one of the newest appliance, no reviews are present on the Powerscope or its dentoskeletal and soft tissue effects versus Forsus fatigue resistant device. So, the aim of the present study was to compare the skeletal, dental and soft tissue changes in correction of class II malocclusion with Forsus Fatigue Resistance Device (3MUnitek) and Powerscope (American Orthodontics).

In the present study, a total of 24 non extraction growing Class II malocclusion with mandible retrognathism subjects were selected from the patients seeking orthodontic treatment in Department of Orthodontics and Dentofacial Orthopeadics and those who fulfilled the inclusion criteria, mainly based on ANB, SNB, SN-MP angle and Overjet. Then, the subjects were randomly divided into two groups: Group I Powerscope and Group II Forsus FRD (12 subjects in each).

In our study, all the subjects were bonded with 0.022" MBT appliance which has -6° torque in the lower incisors brackets that prevent flaring of lower incisors which is the common side effect of fixed functional appliance therapy. Then after leveling and alignment both the appliances were delivered in group I and group II respectively, for a minimum duration of 6 months till Class I molar relation was achieved.

Since the findings can be affected by patient's characteristics as well as growth of maxilla and mandible, it is very important to compare the groups based on age and gender distribution, treatment duration and dentoskeletal pattern. So, in the present study, patients in both the groups i.e. group 1 (Powerscope) and group II (Forsus FRD) have similar gender distribution, chronological ages prior to treatment and duration of the fixed functional treatment as statistical comparison confirm the similarity.

In addition, the patients in both the groups have Class II malocclusion due to mandibular retrusion with normal growth pattern before treatment confirming the matching of both the groups. There was no statistically significant difference in the initial cephalometric measurements of both the groups. Therefore the factors that might have affected the findings were almost eliminated.

In our study, various skeletal, dental and soft tissue parameters were analyzed before and after the appliance that aid in correction of Class II malocclusion in both the groups.

4.1 Skeletal parameters

In both the group's results showed the restricted the forward growth of the maxilla (headgear effect) but the values were statistically non significant which is similar to the studies done by Celikgluet *at el*., on comparing both the groups, although there was reduction in SNA value but it was non-significant. In comparison with Co-Ain Forsus group[14]. In our study, there was increase in the linear measurement of Co to point A in group II (Forsus). The reason for this can be due to the adaptive growth of condyle.

In group I (Powerscope) the mean value of A-HRL remains constant which shows that there was no change in position of point A in the vertical plane, whereas in group II (Forsus) the mean value was significantly increased which shows the downward movement of the point A as a result of extrusion of upper incisors. Similar changes were observed in the study done by Celikoglu et *at el*., who reported increase in the mean value of A-HRL by 0.24±5.59 mm in the Forsus group[14].

The mean valueA-VRL for group I was reduced, whereas in group II Forsus the mean value was increased. This increase can be due to the forward position of point A resulting from tipping of upper incisor but in both the groups these values

were statistically non significant. Similar results were seen in the study done by Unal *et al.,*[15].

In the present study, both the groups had shown significant change in the position of mandible depicted by SNB and Co-Gn angle resulting in the correction of maxilla mandibular relationship, which is similar to the study done by Dada et al, Unal *et al.* and Zhang *et al*.,[12].

In the present study, the mean value of ANB in Group I (Powerscope) was decreased. Likewise for Group II (Forsus FRD) the mean ANB value was decreased which indicates correction of maxillomandibular relationship and results were statistically significant. On comparison between two groups the mean value of ANB angle was statistically non significant. This reduction in ANB was partly due to changes in the skeletal mandibular parameters and partly due to headgear effect in maxilla.

The angle of convexity was reduced in both the group indicating the correction of convex profile after the fixed functional therapy in both the groups. The reduction in facial convexity was statistically significant for Group I (Powerscope). On comparison between two groups the mean value of facial convexity angle were statistically non significant.

The mean value of MP-PP angle in Group I (Powerscope) was decreased, Whereas, for Group II (Forsus) the mean MP-PP value was increased but values for the group I (Powerscope) were statistically non significant, whereas values for group II were statistically significant, which indicates clockwise rotation of mandible with respect to palatal plane. This is similar to the study conducted by Unal *et al*. who evaluated the skeletal, dentoalveolar and soft tissues effects of Forsus with miniplates anchorage. Their result also showed significant improvement in the intermaxillary relationship sagittally.

In both the groups, U1-SN angle was significantly reduced which indicates more dentoalveolar correction of class II malocclusion in comparison to skeletal changes in the present study. Similar effects were seen in both the groups and on inter-group comparison no statistical significant changes occur.

The mean value of IMPA angle for both the groups has been increased which was statistically significant for both the groups, indicating proclination of mandibular incisors resulting in the reduction of overjet in both the groups. No statistical significant changes were observed during inter-group comparison.

In both the groups, overjet was decreased which can be due to retroclination of maxillary incisor and proclination of mandibular incisors and less of skeletal changes in both the groups. On comparison the mean value of overbite for group I (Powerscope) and for group II (Forsus FRD) was statistically non significant which indicates the correction of deep bite in both the groups.

On comparison between two groups, the mean value of U6-HRL for both the groups was statistically significant. In group II (Forsus) there was significant extrusion of upper molars resulting in clockwise rotation of mandible in comparison to group I (Powerscope). This extrusion of upper molars can also be considered as a normal eruption process during growth. Similar observation of extrusion of upper molars after use of the fixed functional appliance has been reported in previous studies[9-16].

A study was conducted by Chibberet *at el.,* to compare the dentoskeletal effects and treatment efficiency of the Twin force bite corrector appliance in Class II correction. They had reported extrusion of upper molars at the end of the treatment which is similar to the present study in which there was increase in U6-HRL in Group II (Forsus)[13].

4.2 Soft tissue parameters

On inter-group comparison of the nasolabial angle the results were statistically non significant. The increase in the nasolabial angle can be attributed due to the retroclination of maxillary incisors in both the groups. Similar results were observed in the study conducted by Celikogluet *at el.*[14].

In this study, the mean values of Ls-VRL for group I (Powerscope) was decreased which was statistically non significant. In contrast, for group II (Forsus) the mean value was increased which was statistically significant. This increase in the mean value can be attributed to growth changes with age in Forsus group. A study conducted showed decrease in the mean value of Ls-VRL similar to the change observed in the mean value of group I (Powerscope) of the present study. This indicates Powerscope appliance showed more soft tissue profile changes in comparison to Forsus appliance.

The mean values of Li-VRL for both the groups were statistically significant. This can be due to the forward positioning of lower lip leading to improvement of maxillomandibular relationship. On comparison between two groups, the mean value of Li-VRL was statistically non significant. A study conducted by Celikogluet *at el.,* also showed in their results increase in the mean value which was similar to our present study[14].

In the present study, the mean value of Pog-VRL was increased for both the groups which can be due to the forward positioning of the soft tissue chin, resulting in the improvement of maxillomandibular relationship.

Hence, in the present study, on comparison of the treatment results of two groups i.e. group I Powerscope and group II Forsus: In maxillary parameters Co-A and A-HRL were found to be statistically significant as the p value was 0.048 and 0.009 respectively, while other mean values SNA and A-VRL were found statistically non significant. Similarly, in mandibular parameters only B-HRL was found to be statistically significant as the p value was 0.030. All other mandibular parameters (SNB, Co-Gn, B-VRL, Pog-HRL and Pog-VRL) were found to be statistically non significant.

In maxillomandibular and dental parameters all the values i.e. ANB, NA-Pog, SN-MP, MP-PP, U1-SN, IMPA, U1-L1, Overjet and Overbite were found statistically non significant except U6-HRL, whereas on comparison of the soft tissue parameters Ls-VRL (p value 0.012) was found statistically

significant unlike other parameters (nasolabial angle, Ls-HRL, Li-HRL, Li-VRL, Pog-HRL and Pog-VRL) were found statistically non significant.

Therefore, it can be summarized from the overall findings of the study that both the appliances were equally effective in class II malocclusion correction. Most of the changes achieved were dentoalveolar (reduction in U1- SN and increase in IMPA) whereas less of the skeletal changes were observed.

5. Limitations of the study

One of the major limitations of the present study might be not using an untreated Class II group as a control group. However, it is un-ethical to postpone the treatment of those patients as it was shown that the amount of supplementary mandibular growth appeared to be significantly larger if functional treatment was performed at puberty peak.

The results obtained were applicable for short-term follow-up. Observation periods may differ if a long-term follow-up is carried out. A randomized clinical trial is always recommended, as it has the highest level of evidence when investigating the efficacy of orthodontic appliances.

6. Conclusion

Within the limitations of the study:

- Both the treatment protocols (Powerscope and Forsus) were effective in the correction of Class II malocclusion due to mandibular retrusion. Most of the correction is achieved through dentoalveolar changes with less influence on the skeletal tissues.

- In both the groups, the final correction of overjet and overbite was a result of an equal combination of upper incisor retroclination and lower incisor proclination. Also, both the appliances were effective in producing significant mandibular skeletal changes for correction of Class II malocclusion as compared to the maxilla.

- On comparison among the groups, there were favorable and similar changes in the sagittal relation but there were significant differences in vertical relation. In the Forsus appliance, along with retroclination, there was significant extrusion of upper incisor in comparison to Powerscope appliance. Also, there was extrusion of upper molars that resulted in increase of mandibular plane angle but on comparison among the groups it was non-significant.

- In our study, Powerscope appliance caused more restraining effect on maxilla which resulted in more improved soft-tissue profile as compared to the Forsus appliance.

Hence, it can be concluded that the skeletal, dental and soft tissue effects of both appliances are nearly same and therefore, Powerscope appliance can be considered as an acceptable substitute for the Forsus appliance.

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Source of support: Nil, Conflict of interest: None Declared