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Research Article

Evaluation of Changes on Maxillo-Facial Skeleton of Class II Patients with Deep Bite Treated with Anterior Bite Plane as a Functional Appliance

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I N F O

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A B S T R A C T

Background: Class II division 1 malocclusion can be produced by protrusion of upper anterior teeth with normal maxillary basis relationship, that can be as a result of mandibular deficiency with normal dental position or posterior rotation of the mandible due to the excessive vertical growth of the maxilla. Deep bite usually associated with class II malocclusion, in which the mandibular incisor crowns are excessively overlapped vertically by the maxillary incisors where the teeth are in centric occlusion, which can be seen in children as well as in adults. So that for the successful treatment of Class II/ 1 required controlling the deep bite before starting the virtual treatment of this malocclusion to get better retention.

Aim: The aim of this study was to investigate the morphological changes in maxillary and mandibular bones relationship after using the anterior bite plane appliance.

Material and Methods: Evaluative analysis of cephalograms by superimposing two lateral cephalograms before and after the treatment of 27 patients (12 girls and 15 boys) class II division 1 malocclusion with mean age 11.7 years old. They treated by utilization of anterior bite plane while the period of fixed orthodontic therapy. Cephalometric data were analyzed with the following methods: Delaire, Danguy and classical and the morphological changes were evaluated.

Results: The results of superposition of every patient before and after treatment showed a significant ($P<0.05$) reduction of deep bite and the facial convexity reduced in an average of 2.49°, anterior-posterior discrepancy reduced also very significantly ($P=0.001$), with a mean value of 1.81° and increasing in total mandibular length with a mean value of 2.95 mm. The decrease of the overbite can be due especially to the mandibular rotation and also supra-eruption of posterior teeth. Change in the mandibular length and the maxillary position improved facial profile but did not correct it completely as the mandible moved forward and also downward due to vertical and horizontal ramus growth and condylar remodeling.

Conclusion: It can be concluded that the use of an anterior bite plane in conjunction with a straight wire and edgewise orthodontic techniques improved the overbite. Further research is recommended to support the result.

Keywords: Anterior Bite Plane, Class II Malocclusion, Cephalograms, Deep Bite, Superposition, Skeletal changes

Introduction

An aesthetic facial profile is one of the goals in orthodontics treatment. However, this is not easily achieved, especially in patients with Class II Division 1 malocclusion who have the clinical characteristics of convex profile and significant skeletal discrepancy due to mandibular growth deficiency. Malocclusion with skeletal problems require proper treatment timing for growth stimulation, and it must be done in early age and in need of good cooperation from the patient. If this is not done and the patient has passed the growth period, the ideal treatment is orthognathic surgery which is more complicated and more painful. The growth stimulation of skeletal malocclusion requires a careful cephalometric evaluation ranging from diagnosis to determine the parts that require stimulation to post-treatment evaluation to see the success achieved through changes in the measurement of the skeletal parameters shown in the cephalometric analysis. Class II malocclusion is the result of multiple dental and skeletal defects that could be due to the mandible or maxilla or a combination of both.[1,2] Deep bite defined as malocclusion in which the mandibular incisor crowns are excessively overlapped vertically by the maxillary incisors when the teeth are in centric occlusion, it is one of the most common malocclusions seen in children as well as adults and the most difficult to treat successfully.[3] Unfavorable sequel of this malocclusion predisposes a patient to periodontal involvement, abnormal function, improper mastication, excessive stress, trauma from occlusion and temporomandibular joint disturbance make the dental treatment not effective unless the overbite can be controlled. The overbite (deep bite) can be classified as a dentoalveolar and skeletal, true and pseudo and incomplete and complete deep bite. This malocclusion could be caused by supra-eruption of upper and/or lower incisors or infra-eruption of posterior teeth, to evaluate the exact cause of the present problem.[4] Reported cases of temporomandibular joint disorder (TMD) due to misaligned jaws which cause chronic joint pain. The treatment of deep bite must be established for stability in function and retention when the relationship between the incisors and the jaws has been ideally corrected.[5] Class II dentoskeletal disharmony does not tend to self-correct with growth in association with worsening of the deficiency in total mandibular length and mandibular ramus height.[10]

According to Baccetti T *et al*. the mandibular growth does not exhibit significant growth from late puberty through young adulthood when they compared untreated cases of class II with untreated subjects with normal occlusion.[6] So the better treatment timing of class II division 1 is during the pubertal peak, that is able to produce significantly greater increases in total mandibular length and mandibular ramus height associated with a significant advancement of the bony chin when compared with treatment before puberty. Treatment at puberty also is characterized by a greater correction of overjet and sagittal molar relationship with respect to treatment before puberty.[15]

There are different methods for treatment of this dento-facial defect like; proclination of incisors, Intrusion of anterior teeth, extrusion of posterior teeth, and orthognathic surgery. In the present study the effect of the extrusion of posterior teeth by using fixed and removable anterior bite plane appliance associated with fixed orthodontic brackets on the teeth position and morphological changes of a maxillo-facial complex relationship. The purpose of this pilot study used to find out the effect of using the anterior bite plane in the patients with deep bite to help the orthodontists to determine the possibility of correcting skeletal defects related to dental malocclusions by functional orthodontic therapy and whether a patient can benefit from orthodontic therapy without considering surgical correction as a treatment option.

Materials and Methods

The sample included 27 patients (12 girls and 15 boys); have class II malocclusion associated with deep bite. The average age including in the study was of 11.7 years old. The selection criteria were: Dental class II in molars and canines; overbite >80%; light or severe dental crowding; hypo divergent facial. All cases selected in this study represented a severe deep bite and they do not receive any previous orthodontic treatment and also the treatment was during the pubertal peak based on the study of Chen et al.,[11] there is no racial preference in this study. All patients wore an anterior bite plane either fixed or removable appliances (Figure 1), for an average of 1.9 years long (Table 1). The study project was approved by the Ethical Committee at the University of Misurata and University of Benghazi, and informed consent was obtained from the subjects' parents. For each patient were traced two

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lateral cephalograms, at the beginning and at the end of the treatment. These radiographs have been taken by the same person. Morphological changes were evaluated by overlapping the lateral cephalograms on cranial basal plan with Sella point registered and comparing the values of analyzed issues at the beginning and at the end of treatment.

Cephalometric data were analyzed with the following methods: Delaire, Danguy and classical. There was a large variety of variables have been used belonging to different interpretation methods was to compensate the deficiency of some methods with more information given by others. As for any others dentofacial anomalies, in Class II, skeletal morphological changes might be hidden by dento-alveolar compensations, were analyzed more variables.

Statistics data analysis was done with Student's *t*-test, which compares two clinical situations. The significance of the values was determined by three levels of reliance: 0.05(*), 0.01(**) and 0.001(***).

Results

The results of this study are shown in (Table 2 and Figure 5). Facial convexity angle (N-A-Pog) decreased with 2.49degree (P<0.05) the same linear variable (mm) decreased from 4.72 mm to 1.77 mm, as well as statistically significant. The maxilla oriented to posterior related to cranial base, SNA angle decreased from 83.45 to 81.1 with mean value of 2.35 (P=0.001), SNB angle decreased from 75.1 to 77.4 with mean value of 2.3 (P<0.05), anterior-posterior discrepancy (ANB angle reduced from 6.44 to 4.63 with mean value of 1.81 mm (P=0.0001) and Ao-Bo distance reduced from 4.72 to 1.77 with mean value of 2.95 mm (P<0.01)). On the other hand, maxillary and mandibular retroversion incisive results showed very significant (P<0.005 and 0.01) respectively.

Our observation showed remarkable ameliorations in overall profile by reduction of the convexity and correction of intramaxillary and cranial base relationships as well as correction of teeth angulation and position. The deep bite had been corrected, we can see the pictures which showed the changes in patient's teeth at the end of treatment compared with that of the beginning of treatment that helps to overcome the protrusion of the upper lip (Figure 2 and 3).

The mandibular length was increased in both vertical and horizontal parts that by posterior growth the condylar and the ramus of the mandible that measured by the angle which termed as the condylar-ramus-occlusal (CRO) angle, this angle formed by the intersection between the line joined the most posterior points of the condayle and the ramus of the mandible with the occlusal plane. In our patients CRO angle decreased with mean value of 9 degrees from (114° to 105°). So this results showed closure of CRO angle which is in accordance with the normal growth. The deep bite and over jet had been corrected (Figure 4).

By comparing the two lateral cephalograms there was a displacement of the maxillary block incisive backwards that leading to correction of maxillofacial relationship and the point A in position posterior. The mandibular length was increased in both vertical and horizontal parts that by posterior growth level condylar and ramus of the mandible and anterior position of point B (Figure 5). The overall superimposition showed corrections of maxillary incisor teeth inclinations, which help to improve the correction of patient profile by reducing the convexity (Figure 6).

The mandibular superposition shows skeletal correction represented by anterior displacement of B point associated with relatively advanced position of mandibular incisors and the over jet was reduced, for the maxillary superposition shows retroclination of maxillary incisors and this significantly help to achieve satisfactory treatment outcome in our patients (Figure 6).

Table 1.Age and gender distribution and total treatment time

Treatment time	Boys (n=15)	Girls (n=12)	Total (n=27)
Initial (T1)	11.8±1.3	11.5±1.4	11.7±1.5
Final (T2)	13.4±1.0	13.6±1.3	13.5±1.3
Total treatment	2.8±0.7	2.0±0.5	1.9±0.7
Time			

Table 1. Shown the ages of all patients which were anterior bite plane the treatment of Class II associated with the deep bite.

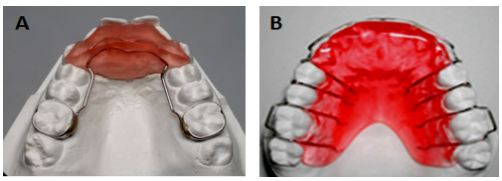

Figure 1.(A) Occlusal view of fixed anterior bite plane, (B) Occlusal view of removable anterior bite plane

The treatment Steps of one of patients were evaluated in presented study.

Table 2, NS: Non-significant; *: significant; **: very significant; ***: extremely significant; Mand: Mandibular; SD: Standard deviation; T1: Begin treatment and T2: Fin treatment; (N-A-Pog):Skeletal profile convexity; (NaSBa): Cranial flexion; (FMA): Frankfort Mandibular Plane Angle; (SNA): Relationship of the maxilla to the cranial base; (SNB): Relationship of the mandible to the cranial base; (ANB): Relationship of the mandible to the maxilla and to the cranial base; (Ao-Bo): Wits appraisal (mm); (I/F): Upper incisor/ Frankfort plane; (I/M): Lower incisor mandibular plane.

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Figure 2.Steps of orthodontic treatment for one of those patients which were treated with an anterior bite plane there were remarkable reduction of the deep bite and over jet retrusion of maxillary and mandibular incisors

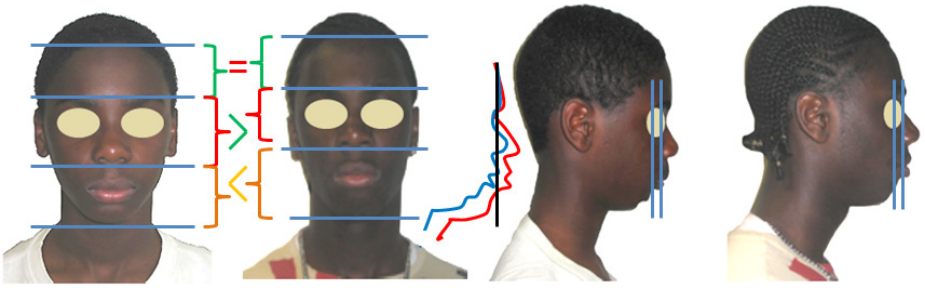
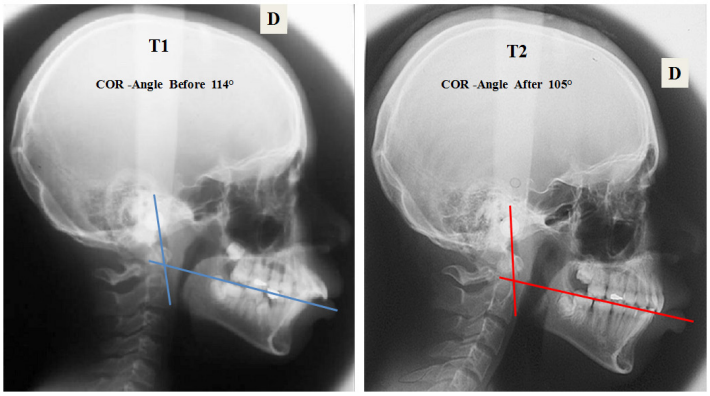


Figure 3.The pictures of the patient which have been treated with an anterior bite plane that shown obvious changes in the facial profile and remarkable correction of the vertical dimension and allover maxillofacial relationship and facial convexity



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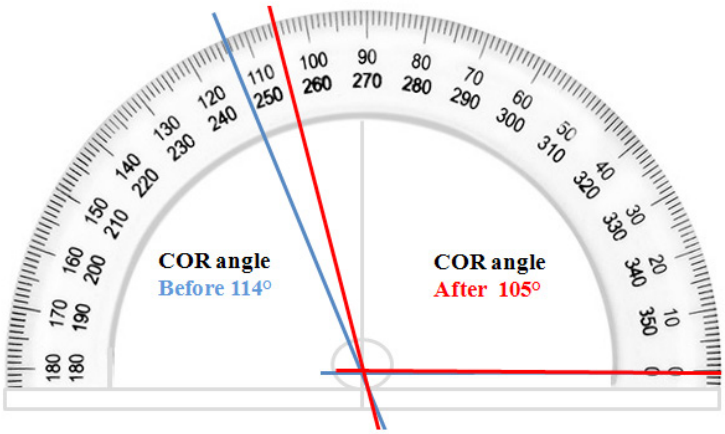

Figure 4.Lateral cephalogram at the beginning T1 and the end T2 of treatment showed decreasing of condylar-ramus-occlusal angle/ (CRO) angle with mean value of 9 degrees that from (114° to 105°)

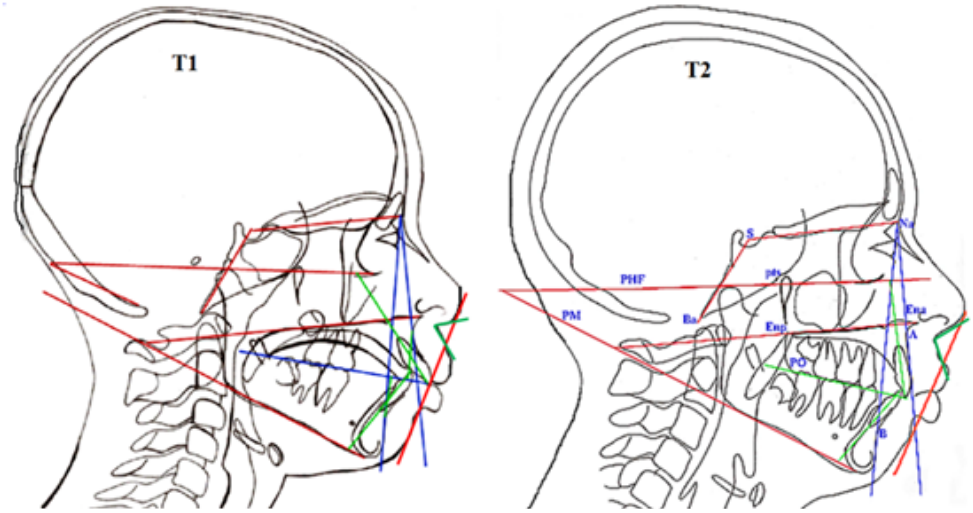

Figure 5.Cephalometric analysis of morphological changes between that one at the beginning of treatment T1 and that at the end of treatment T2, were showed remarkable effects of ABP at both skeletal and dental levels. (a) Retroclined position of maxillary incisors. (b) Correct intermaxillary relationships and the cranial base. (c) Nasolabial angle was corrected and (d) Mandibular position improved by both posterior condylar and vertical ramus growth respectively

Table 2.Comparison between variables before (T1) and after (T2) treatment

Parameters level	T1	SD1	T2	SD2	*t*-test	Significance	Significance level
Angular°							
N-A-Pog	7.5125	0.44	5.025	0.27	12.103	0.007	***
NaSBa	125.9	2.3	136	4.6	7.86	0.0001	***
FMA	24.86	3.18	26.5	3.22	1.355	0.1876	NS
Angle Mand	120.86	1.345	122.29	1.254	2.0576	0.06	NS
SNA	83.45	2.75	81.1	2.37	2.35	0.001	***
SNB	75.1	2.91	77.4	2.86	6.5	0.02	*
ANB	6.44	0.821	4.63	0.518	5.2821	0.0001	***
AoBo (mm)	4.72	1.95	1.77	1.59	0.06	0.07	NS
I/ F	117	7.06	108.5	5.45	3.1774	0.005	***
i/ m	98.25	5.345	93	16.909	2.697	0.01	**

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Discussion

The literature review showed that there were no studies carried out regarding the anterior bite plane application (ABPA) in the treatment of Class II/1 malocclusion that overcomes many disadvantages of the conventional functional appliances. In this study, the results of treatment with this type of appliance are evaluated by tracing and analyzing two cephalograms at the beginning and at the end of the treatment to compare the morphological changes due to the therapeutic effects of this appliance. The (ABPA)

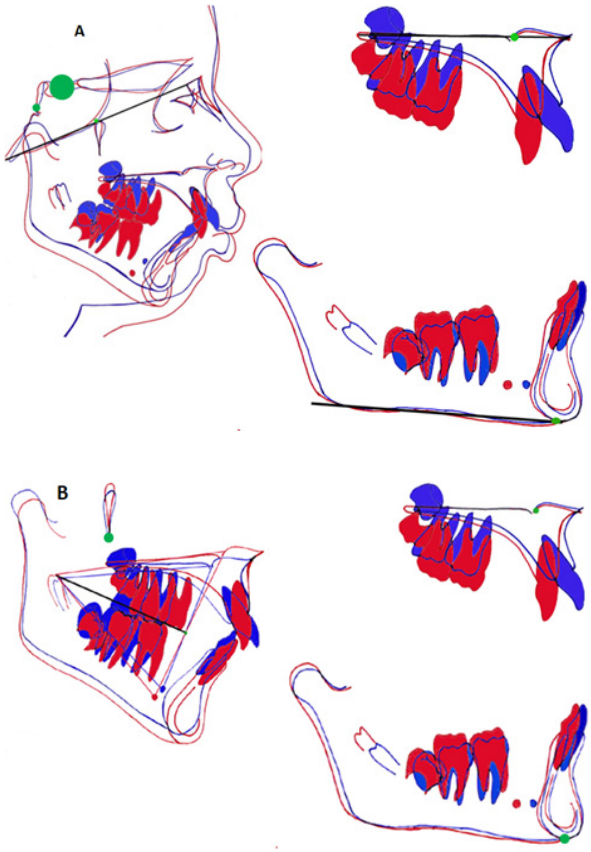

Figure 6.Traced tow lateral cephalograms at the beginning and the end of treatment overlapped for evaluate the skeletal changes after orthodontic treatment of the patients also that showed in maxillary level displacement of maxilla point A and correction of incisor teeth inclination and extrusion of posterior teeth (A) Superposition (overlapping) of two lateral cephalograms by the classical way on the Sella point. (B) Superposition of the same lateral cephalograms according to Danguy's method

is a removable or fixed intramaxillary appliance that forces the mandible to move in a forward position during the mandibular functional activity, particularly during the swallowing period.

Protractor muscle involvement results in the intermittent activation of the retractor muscles that leads to favorable bone remodeling. In comparison to the traditional functional appliances, this appliance does not restrict the three-dimensional mandibular movement nor it interferes with the regular physiological activity of the oral cavity, which has a great impact on the patient cooperation, and it requires less effort by the patient to follow oral hygiene instructions. This method is more effective in early stages of Class II/1 associated with severe deep bite malocclusion treatment, particularly to redirect the mandibular growth anteriorly and vertically by eliminating the lack of occlusion that acts as a physical barrier against the normal growth of the mandible.

This appliance prevents the further extrusion of the upper and lower anterior teeth because of the loss of anterior incisal contact. It provides a greater extrusion of the lower posterior teeth and this helps to correct the Class II/1 relationship and opens the bite simultaneously in the early mixed dentition period. The results showed that Class II correction was achieved mostly through dentoalveolar and skeletal changes of the mandible and revealed that the appliance had no effect on the naso-maxillary growth component. Anterior bite plane favorably improved the profile. As the upper incisors retruded, the upper lip moved back and the lower lip was no longer trapped behind the upper incisors. Lips competence has been achieved. In addition to that there were important changes in the facial skeletal morphology also correction of jaws relationship and facial esthetic amelioration.

The mandibular length was increased in both vertical and horizontal parts that, by posterior growth level condylar and ramus of the mandible that measured by the angle which termed as the condylar-ramus-occlusal (CRO) angle. The angle was progressively closed in our patient due to the effect of an anterior bite plane that in accordance with Mc Namara JA Jr *et al.*[9] Their observations showed a progressive closure of the CRO angle occurred in the control group. The opposite finding was observed in the experimental animals. However, instead of steadily decreasing in value, the CRO angle increased at the end of experimentation. Thus, our results were identical with the normal pattern of closure of the CRO angle. However, the anterior bite plane can be the treatment of choice for Class II/1.

Anterior Bite plane appliances associated with orthodontic fixed therapy induced an increase in mandible's length in both vertical and horizontal dimensional that by condylar and ramus growth respectively. These changes in the position and mandibular length explain the improvement in facial profile which not completely corrected because of the chin that moved forward and downward as a result of the vertical development of the ramus. Although there was a decrease in the anterior-posterior discrepancy between the upper and lower jaws which due to increasing

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the mandibular growth. So the necessity of orthodontic treatment in class-II division 1 malocclusion associated with severe deep bite is absolute because facial appearance is worsening with jaws growth and there is no tendency for spontaneously correction even in the presence of horizontal growth, that confirmed by Baccetti T *et al.* according to them the mandibular growth does not exhibit significant growth from late puberty through young adulthood, when they compared untreated cases of class II with untreated subjects with normal occlusion.[6]

According to Perillo *et al.* The significant growth deficiency in mandibular length that is associated with Class II malocclusion suggests that treatment strategies should be aimed at enhancing mandibular growth as a component of Class II correction during the pubertal phases.[21] So that appropriate treatment timing of orthodontic therapy associated with an anterior bite plane or any other orthopedic removable appliance according to patient status, guarantee orthopedic changes of the relationship between jaws, that capable to reduce the anterior-posterior and vertical discrepancy by modification of mandibular position and correction the relationship between the jaws and their relation with base cranial and not through dental camouflage.

The main skeletal change that results from our study is a mandibular advancement which in accordance with the study of Pangrazio-Kulbersh *et al.* which showed mandibular anterior repositioning appliance (MARA) produced measurable treatment effects on the skeletal and dental elements of the craniofacial complex. These effects included a considerable distalization of the maxillary molar, a measurable forward movement of the mandibular molar and incisor, a significant increase in mandibular length, and an increase in posterior face height.[7] Nevertheless, the mandibular advancement is not only due to changes in mandible's position but also to an increase in horizontal and vertical ramus length as well as to increase the total length of the mandible by activation of condylar remodeling. Previous studies have documented a significant increase in the mandibular length in comparison to the untreated controls.[23]

The restraining effect of the functional appliances on maxillary growth has been reported to be of minor importance in improving maxillo-mandibular relationships in Class II Division 1 patient with the deep overbite.[24-27] The effect of functional appliances on masticatory muscle activity has been extensively reported in the study. Tabe *et al.* found no increase in muscle activity during sleep, whereas an increased postural activity was detected in the masseter muscle during the day.[25] Miralles *et al.* found a significant increase in muscle activity during the swallowing of saliva with these appliances.[26]

Consequently, a review of the literature shows that functional appliances have favorable effects on dentoalveolar and skeletal structures.[28,29] Several types of functional appliances are currently used for the treatment of Class II malocclusion. They aim at improving the existing skeletal imbalances, arch forms, and orofacial functions. The functional appliance is capable of altering the neuromuscular activity of the oral cavity; this leads to the normal growth induction combined with unlocking the mandible from the abnormal occlusion. However, due to the bulk of the appliance, the cooperation of the patient is a major concern due to restriction in oral physiological and functional activities.[30-22]

In our study, a simple intramaxillary appliance was used in order to have free mandibular activity with the capability of altering the abnormal activity of the oral musculature system to achieve the same result as that of the functional appliance. The purpose of the present study is to evaluate the influences of an anterior bite plane on dentoskeletal changes. Comparing the results of our study with those from Baccetti and Güney, we can conclude the utilization of anterior bite plane in the treatment of deep bite during the pubertal peak induces a supplementary mandibular growth that was opposite to their study that showed there was no significant growth in the mandible from the lake puberty through young adulthood.[6-8]

Consequently, mandibular advancement could be the result of two processes the first one increasing in length and anterior displacement, the second is temporomandibular joint remodeling. The observation of our study is in accordance with those of McNamara which utilize serial protrusive appliance in a group of male juvenile monkeys. In which mandibular adaptation was monitored cephalometric evaluation. That induced mandibular functional protrusion.[9] Even our results showed agreement with Pangrazio-Kulbersch *et al.* when they used (MARA) which is a tooth-borne functional appliance for use in patients with Class II malocclusions; those showed a considerable correction in a dentoskeletal relationship as we have mentioned above. The effects of the MARA treatment were then compared with those of the Herbst and Fränkel appliances.

The treatment results of the MARA were very similar to those produced by the Herbst appliance but with less headgear effect on the maxilla and less mandibular incisor proclination than observed in the Herbst treatment group.[7] Our study was on the selected group of patients during the pubertal peak based on the study of Chen *et al*.[11] Some studies showed that there was no anterior repositioning mandibular and no remarkable condylar remodeling by using anterior bite plane help the mandible to express its genetic growth.[16,17] So, the skeletal changes depend on the individual response against that stimulus applied by the action therapeutic of the utilized appliance in function of the growth period. Consequently, the maxilla grows

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normally and decreased the value of the SNA angle at the end of treatment which is supported by the observations of Mills, Owen, Collet and, Marçan.[13,18-20]

There was also mandibular changes (Co-Gn) in the treated group were associated with improvements in the skeletal sagittal intermaxillary relationship, over jet, and molar relationship. So treatment during the pubertal peak was able to produce significantly greater increases in total mandibular length and mandibular ramus height associated with a significant advancement of the bony chin when compared with treatment before puberty as showed by Franchi *et al.*[12-14]

However, our study showed variation in SNB angle which increased in value at the end of treatment which confirms our observation of the anterior position of the mandible as a result of condylar remodeling and vertical growth of the ascending ramus. So, our results show a reduction of overbite also the correction of facial profile, convexity and chin advancement was confirmed by the decreased distance from B point to the same reference line associated with vertical growth and anterior positioning of the mandible.

Conclusion

To conclude our results showed there were important changes in the facial skeletal morphology also correction of jaws relationship and facial esthetic amelioration. Anterior Bite plane appliances associated with orthodontic fixed therapy induced an increase in mandible's length in both vertical and horizontal dimensional that by condylar and ramus growth respectively. There is a significant increase during the pubertal peak in total mandibular length and mandibular ramus height associated with a significant advancement of the bony chin, which moved forward and downward as a result of the vertical development of the ramus. Generally, there was a decrease in the anterior-posterior discrepancy between the upper and lower jaws which due to increasing the mandibular growth when compared with treatment before puberty. So the anterior bite plane can be considered as therapy of choice for treatment of class II division 1 malocclusion associated with severe deep bite during the pubertal peak period to correct the jaws and dental relationships when followed by orthodontic treatment without need any orthognathic surgery due to the stability of the treatment.

Conflict of Interest: None

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