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Original Article

Is There Any Difference in the Outcome of Growth Modification Treatment Between Class II Division 1 and 2 Malocclusions?

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Abstract

Background: Class II malocclusion is one of the most common orthodontic problems that can be divided into class II division 1 and division 2. Considering the differences between the 2 malocclusions, the present study was designed to compare the dentoskeletal changes caused by growth modification treatment.

Methods: This retrospective study included 52 patients (2 groups) with class II division 1 and 2 malocclusions, who were within the age range of 11-13 years and were treated by growth modification. Initial and final cephalograms were analyzed by Dolphin software premium 11.8. In addition, 7 cephalometric variables including SNA, SNB, ANB, SN-GOGN, inter-incisal angle, mandibular body length, and overbite were measured in traced cephalograms. Finally, treatment changes in each group were analyzed by paired *t* test and between-group comparison was assessed by independent *t* test. The significant level was considered as 0.05.

Results: Based on the results of dentoskeletal changes in both groups, SNB, ANB, mandibular length, and overbite underwent significant changes during treatment in both groups. Further, the interincisal angle changed significantly in division 2 group ($P<0.0001$) and the final interincisal angle decreased significantly in class II division 1 patients ($P<0.025$). The results further revealed that changes in SNB and interincisal angles were statistically significantly greater in division 2 group compared to division 1 group ($P<0.021$ and $P<0.012$, respectively). Finally, there was no statistically significant difference between the groups regarding the other variables.

Conclusions: Overall, mandibular position changes more in class II division 2 patients and the treatment appears to be more successful in this group.

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Background

Class II malocclusion is considered as one of the most prevalent orthodontic problems affecting approximately 1/3 of the populations and most of the patients with this malocclusion seek orthodontic treatment (1,2,3). Both skeletal and dental factors can lead to Class II malocclusion. The etiologic factor should usually be found in order to choose the best treatment modality. Skeletal class II malocclusion can be due to maxillary protrusion or mandibular retrusion. However, later is the most common cause of the condition (4,5). Angle class II malocclusion can be classified into division 1 (i.e., having maxillary incisor protrusion) and division 2 (i.e., with retruded maxillary incisors) (6).

Class II division 1 may accompany various vertical and anteroposterior relationships between the jaws. However, there is no consensus on the morphologic variations causing the abnormal relationships between maxillary and mandibular teeth. There are at least 6 morphological variations in the dentofacial complex in class II division 1 patients. Maxilla and maxillary bone are placed anterior to the cranium. In addition, maxillary teeth are placed

Highlights

- In class II div 2 patients, by removing the limiting mandibular sagittal growth factor, which is the maxillary incisors retrusion and possibly the effect of unlocking the bite , the mandibular position changes more and treatment is more successful in this group

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anterior to the maxilla. Further, the mandible is deficient. The normal-sized mandible is placed posterior to the cranium as well. Furthermore, mandibular teeth are placed distally against the mandibular base, and finally, there is a combination of the above-mentioned conditions.

Contrarily, class II division 2 patients have characteristics that differ from those of class II division 1 patients. Their profiles are extremely similar to class I patients than class II division 1 patients. A mandibular plane angle is small and the gnathion point is not highly retruded. Baldrige et al indicated that the mandibular base is usually in the correct anteroposterior position relative to face and cranium in class II division 2 cases. Most of the orthodontists have experienced that class II division 2 patients mainly respond to treatment better than class II division 1 patients. Morphologically, the functional position and treatment results of class II division 2 malocclusions are similar to class I occlusion (7).

Moreover, the predictability of treatment is an important issue to discuss with patients and their parents in a treatment planning session. To the best of our knowledge, no study has so far revealed the successfulness of treatment in each group. Considering the differences between the 2 malocclusions, the present study aimed to compare the dentoskeletal changes caused by growth modification treatment in class II division 1 and 2 malocclusions.

Materials and Methods

A total of 52 patients (2 groups) with class II division 1 and 2 malocclusions were included in this retrospective study, who were in the age range of 11-13 years and were treated in the Orthodontic Department of Hamadan University of Medical Sciences.

The inclusion criteria for class II division 1 were skeletal class II with ANB angle ≥4 degrees, upper incisor protrusion (U_1-SN >102 degrees), and overjet more than 5 mm. Additionally, the inclusion criteria for class II division 2 included skeletal class II with ANB angle ≥ 4 degrees, the upper incisor retrusion, especially upper centrals (U_1-SN <102), and normal or more than normal overjet.

Similarly, the exclusion criteria included the missing of permanent teeth or the presence of large size discrepancies of teeth assessed by Bolton analysis, as well as the presence of craniofacial anomalies or syndromes and a history of unsuccessful previous orthodontic treatment.

Growing patients with the above-mentioned characteristics were chosen, who had complete medical and dental history, pre-treatment and post-treatment cast, along with panoramic and lateral cephalometric radiographs and were treated with functional appliances. All pre- and post-treatment cephalometries were prepared with Promax 2D (Planmeca, Finland) with defined magnification and lips in a rest position.

The initial cephalometries, casts, and photographs were assessed for the sample selection. In addition, the initial and final cephalograms were analyzed by a trained person using Dolphin software premium, version 11.8 (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). Seven cephalometric variables were measured in traced cephalograms (i.e., SNA, SNB, ANB, SN-GOGN, interincisal angle, mandibular body length, and overbite). Table 1 indicates the definition of cephalometric variables. The initial and final measurements were compared in each group, followed by comparing treatment changes between the 2 groups. The tracing was repeated 2 weeks later by applying Dolphin software as a new case and then the intra-class correlation coefficient was measured accordingly. The variables were reported as mean and standard deviation. Eventually, treatment changes in each group were analyzed by paired *t* test and comparison between groups was evaluated by independent *t* test. The obtained data were analyzed by SPSS software, version 23.

Sample Size Calculation

The sample size was calculated with PASS software (NCSS LLC, version 11) Based on the method of sample size calculation for 2 independent groups. According to Isik et al (8), the sample size was calculated as 26 in each group by considering a mean difference of 2, the standard deviation of 3, the power of 90%, and the significance level of 0.05.

Results

The initial and final records of 52 patients were assessed. Table 2 summarizes the age and gender distributions of the subjects. The results of dentoskeletal changes in both groups are shown in Table 3 as well. As shown, SNB, ANB, mandibular length, and overbite underwent significant changes during treatment in both groups. In addition, the interincisal angle changed significantly in division 2 group ($P < 0.0001$). The mean of final interincisal angle in class II division 1 and 2 was 121.91 ± 9.2 and 128.76 ± 11.9, respectively, and a significant decrease in final interincisal angle was observed in class II division 1 group ($P < 0.025$). The results revealed that changes in SNB and interincisal angles were statistically significantly greater in division 2 group compared with division 1 group ($P < 0.021$ and $P < 0.012$, respectively). Finally, no statistically significantly difference was found between the groups respecting the other variables.

Discussion

The aim of the present study was to compare dentoskeletal changes in class II division 1 and 2 malocclusions following growth modification treatment. The results represented that treatment changes in SNB, ANB, and mandibular length were statistically significant in both groups. These findings seem satisfactory in growth modification treatments, demonstrating successful mandibular growth during the treatment. This is in line with the results of Sidlauskas, Tulloch et al, and Ardeshna et al (9-11). In addition, incisor angulation changed significantly in class II division 2 patients. Therefore, overjet appears to be less

Table 1. Definition of Cephalometric Point

Cephalometric Points	Definitions
SNA	The position of maxilla relative to cranuim
SNB	The position of mandible relative to cranuim
ANB	Magnitude of discrepancy between the jaws
SN-GOGN	Mandibular plane angle
U_1-L_1	Angle formed by the long axis of upper and lower centrals
MP	Mandibular body length measure from Go to Me
Overbite	Vertical extension of the upper teeth over the lower teeth

Table 2. Age and Gender Distribution of the Investigated Samples

	Number	Mean (y)	SD	Age Range (y)
Class II division 1				
Female	15	11.8	1.7	11-12.6
Male	11	12.3	1.8	11.8-13
Total	26	12.05	1.8	11-13
Class II division 2				
Female	18	11.4	1.6	11-12.2
Male	8	12.5	1.7	11.5-12.9
Total	26	11.9	1.8	11-12.9

Table 3. Comparison of Dentoskeletal Changes Before and After Treatment Between the 2 Groups

	Class II Division 1			Class II Division 2			*P* Value
	N	Mean ± SD	*P* Value	N	Mean ± SD	*P* Value	
SNA° dif	26	-0.046 ± 1.26	0.854	26	0.396 ± 1.34	0.146	0.984
SNB° dif	26	0.19 ± 1.11	0	26	3.32 ± 2.20	0	0.021
ANB° dif	26	-1.91 ± 1.26	0	26	-2.65 ± 1.63	0	0.083
SN-GOGN° dif	26	0.23 ± 2.13	0.58	26	-0.11 ± 2.35	0.798	0.33
U_1-L_1° dif	26	1.46 ± 6.75	0.226	26	-15.9 ± 10.6	0	0.007
MP (mm) dif	26	3.65 ± 2.00	0	26	4.20 ± 3.28	0	0.067
Overbite (mm) dif	26	1.73 ± 54	0	26	2.89 ± 29	0	0

than the actual skeletal discrepancy since upper incisors are retroclined in these patients and treatment usually focuses on correcting the angulation in order to create enough clearance for mandibular forward growth.

The results of the between-group comparison indicated that changes in SNB, interincisal angle, and overbite were statistically significantly greater in class II division 2 patients. This can be attributed to the etiology of malocclusion. This malocclusion is characterized by occluding lower incisors on the cingulum of retroclined upper incisors, leading to increased overbite and decreased overjet in comparison with the skeletal discrepancy (12,13). The relationship between soft tissue labial area and the upper lateral incisor is a major etiologic factor in class II division 2 patients (14- 17), meaning that increased lip resting pressure on upper incisors caused the retroclination in these teeth. The hyperactivity of the musculature structure of the upper lip or the increased height of the lower lip line is the reason for increased lip resting pressure (18). McIntyre et al (13) found that class II division 2 patients have thicker lips compared with class I patients. In addition, larger areas of the labial surface of the upper central incisor were covered with the lower lip. These factors led to relative extrusion and longer clinical crown of permanent incisors, as well as a significantly larger interincisal angle and increased overbite. A high interincisal angle is considered an important factor in the development of deep overbite which is an inherent characteristic in the definition of class II division 2 malocclusion. Mill (17) further demonstrated a correlation between an overbite reduction and a change in the interincisal angle, giving a coefficient of 0.658 which was higher than that of the other cases. In other words, the overbite successfully reduced by the protrusion of the upper and lower incisors. The mean comparison of the final interincisal angle in class II division 1 and 2 showed a lower angle in class II division 1. As mentioned earlier, high interincisal angle and increased overbite are the main features for class II division 2 malocclusion and orthodontic treatment can improve these problems to an acceptable extent but not completely. Furthermore, the final interincisal angle is higher than class II division 1 patients at the end of the treatment. The retroclined upper incisors limit the sagittal growth of mandible as well. This can be proved by more restraint in dentoalveolar development (assessed by SNB angle) compared with basal bone development (assessed by SNPg angle) (19). Baldrige et al (7) concluded that mandibular basal bone is in a correct position in class II division 2 patients. In addition, Erickson and Hunter (20) proposed the "unlocking the bite" concept. It implies that the mean growth of mandible increases by 1.5 mm/

year by unlocking the bite compared with untreated patients so that bite opening accompanies the correction of upper incisor angulation and thus mandibular growth stimulation can be the explanation of more treatment effects in this group. Functional appliances are designed to change the mandibular position in sagittal and vertical dimensions. Moreover, these changes can stimulate condylar cartilage growth, leading to an increase in mandibular length (21). The available evidence suggests that the optimal response of growth is not always achievable in functional treatments. Some researchers reported an increase in mandibular length and condylar growth (22-25) while the others failed to find such an increase (26-28). In the present study, mandibular length increased in both groups with no difference. Accordingly, in addition to mandibular lengthening, lower jaw moved to a forward position (assessed by increased SNB angle) in class II division 2 patients, causing more treatment effects.

Although the afore-mentioned explanation seems sensible, greater SNB changes in division 2 patients are probably because B point is not completely a skeletal point. Al-Abdwani et al reported that the incisor position affects the anteroposterior position of A and B points (29). Considering the initial retroclined position of lower incisors and the real effect of functional treatment in increasing the incisor angulation, greater changes in the SNB angle are possibly attributed to more incisal changes. However, insignificant and small changes in the SNA angle in both groups make this hypothesis less possible.

There is no consensus regarding the real effect of functional appliances on the maxilla. Some researchers indicated the restricting effect of these appliances on maxilla (28,30) while the others reported that the appliances have no obvious effect on the maxilla (31,32). Tulloch et al (10) found that, on average, the headgear has more effect on maxilla while functional appliances mostly affect mandibular growth. This finding is similar to that of the present study, showing insignificant changes in maxillary position during the treatment.

The assessment of vertical changes showed insignificant changes in the mandibular plane angle in and between the 2 groups. This finding is in line with the results of Mills et al (33) Based on their report, treatment by Twin block led to increased anteroposterior facial height during the treatment while the mandibular plane angle represented no change. It seems that the presence of acrylic ramps in the Twin block appliance creates a bite plane effect on posterior teeth, which thus increases the clinical control on a vertical dimension. All patients in the present study were treated with the Twin block appliance.

It should be noted that, nowadays, the validity and reliability of lateral cephalograms are questionable (34). These radiographs may be unsuitable for finding the real effects of the treatment. To the best of our knowledge, the present study was one of the first studies assessing the treatment effects in class II division 1 and 2 malocclusions. Since all patients had lateral cephalograms as the routine records of orthodontic treatment, taking new radiographs such as 3-dimensional images seemed unethical. However, prospective studies using new 3-dimensional images are suggested to draw a clear conclusion.

Conclusions

In general, growing class II division 2 patients seem to respond better to growth modification treatment in comparison with class II division 1 patients. This may be due to the jumping effect of the mandible after unlocking the bite. Therefore, future studies are recommended to design a randomized clinical trial using 3-dimensional imaging.

Authors' Contribution

Ziba Banisafar: observational procedure,data collecting, manuscript preparation, editing and review, article preparation
Sepideh Soheilifar: study concept, study design, observational procedure,manuscript preparation, article preparation,editing and review
Vahid Molabashi:data collecting, observational procedure
Behnaz Alafchi:statiscal analysis

Conflict of Interest Disclosures

There is no conflict of interests.

Ethical Statement

The Research and Medical Ethics Committee of Hamadan University of Medical Sciences approved the study protocol.

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