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Original Research Article

Maxilomandibular changes in patients with Class I maloclusion – A cephalometric study

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ABSTRACT

Introduction: Maxillomandibular analysis relates the upper and lower jaw. The anteroposterior relationship of the maxilla and mandible through both angular and linear measurements is used to assess the sagittal jaw relationship.
Objective: To evaluate skeletal maxillomandibular changes in patients with class I malocclusion after extraction and non-extraction orthodontic treatment in the Solan population.
Materials and Methods: Cephalometric radiographs before and after treatment of 50 orthodontic patients were used in the study. The sample was divided into 2 groups, Group I (Class I, N=25, extraction cases) and Group II (Class I, N=25, non-extraction cases). Maxillomandibular parameters (ANB, Wits Appraisal, Harvold unit length difference, plane angle AB, convexity angle and MKG angle) were measured in both groups.
Result: When comparing the two groups, significant changes were observed in the ANB angle (p=0.05), AO-BO (p=0.00), MKG angle (p=0.03) and convexity angle (p=0, 00). Conversely, Harvold (p=0.70) and AB plane angle (p=0.75) were found to be insignificant.
Conclusion: The result of the above study indicated that bone maxillomandibular changes in ANB angle, AO-BO, MKG angle and convexity angle can be observed in patients after extraction and non-extraction orthodontic treatment.

1. Introduction

Orthodontics is a problem of relationships within the dentofacial complex. The profile pattern has attracted the most attention, probably because it affects the appearance of the individual so much and is a major concern in orthodontic therapy. The cephalometric radiographer provided a means of accurately evaluating the relationships of the parts of the face leading to the description of the mean or average facial form of normal occlusion. It also shows the range of variation that can occur. These capabilities allow an attempt to classify facial types.

A cephalometer is a measurement of the head from bone and soft tissue shadows on a radiograph. The cephalometer was first introduced in Germany by Hofrath. The cephalogram is an indispensable weapon for guiding clinical diagnosis and treatment planning using cephalometric analysis.[1]

Diagnosis and treatment planning are important steps in the practice of orthodontics and dentofacial orthopedics. They have a significant correlation with the size and form of the craniofacial structures. Cephalometry provides a broader way to access bone irregularities and determine an accurate treatment plan through cephalometric analysis.[2] It is one of the most important contributions to date to the study of

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growth and development and the science of orthodontics in general.

Researchers including Down's, Steiner, Tweed, Ricketts and Jacobson etc. have described a number of cephalometric landmarks and parameters. They have gained popularity and contributed much to setting standards for adjudicating irregularities. Among the three anatomical planes, i.e. vertical, sagittal and transverse, sagittal irregularities are most often encountered in everyday practice. Assessment of the sagittal or anteroposterior apical relationship of the base is of great importance. Cephalometric analyzes include angular and linear measurements.[1]

Maxilla-mandibular analysis relates the upper and lower jaw. The anteroposterior relationship of the maxilla and mandible through both angular and linear measurements is used to assess the sagittal jaw relationship. It is an important diagnostic criterion. Both angular and linear measurements have been proposed in the evaluation of the sagittal jaw relationship.

2. Aim

To evaluate maxillomandibular changes in patients with class I malocclusion after extraction and non-extraction orthodontic treatment.

3. Materials and Methods

Pre- and post-treatment cephalometric radiographs of 50 orthodontic patients were selected from the archives of the Department of Orthodontics, Bhojia Dental College, Baddi. Lateral cephalograms were selected according to the following inclusion criteria: patients older than 15 years, patients with a class I or class II skeletal pattern, patients with a class I molar relationship, patients treated with extraction of all four premolars, patients treated with fixed orthodontic therapies without orthopedic intervention, rest lips in a normal, natural posture and high-quality X-rays. The samples were divided into two groups as group 1 (N=25, extraction) and group 2 (N=25, non-extraction) (Table 1).

Table 1: Grouping of sample

Group 1	Group 2
N=25	N=25
Extraction cases	Non-extraction Cases

All acquired cephalograms were monitored by the same operator. Various landmarks were identified and marked (Table 2).

Various parameters were recorded to evaluate maxillomandibular changes (Table 4).

Table 2: Landmarks

Landmark	Definition
Nasion (N)	Located on the most anterior aspect of the frontonasal suture
Sella (S)	Geometric center of the pituitary fossa located by visual inspection
Anterior nasal spine (ANS)	Anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening
Point A (subspinale)	Represents a stable reference point in maxilla were it is located in the most posterior midline in the concavity between the anterior nasal spine and the prosthion (the most inferior point on the alveolar bone overlying the maxillary incisors)
Point B (supramentale)	Represents a stable reference point in mandible were it is located in the most posterior midline in the concavity of the mandible between the most superior point of the alveolar bone overlying the lower incisors (infra dentale) and pogonion.
Condylion (Co)	Most posterior and superior point on the mandibular condyle
Pogonion (Pog)	The most anterior point in the chin
Point M	Midpoint of the premaxilla
Point G	Center of the largest circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis
Point KR	Lowest point on the outline of the key ridge

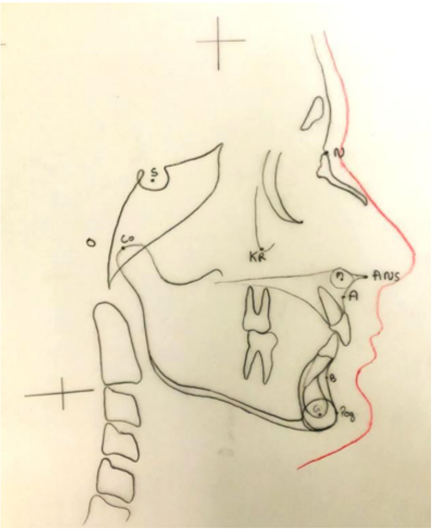

Fig. 1: Landmarks

Table 3: Planes

Planes	Definition
S-N Plane	It is a reference plane. Line joining from Sella to Nasion representing the anterior cranial base.
A-B Plane	Line from point A to point B.
Occlusal Plane	Line overlapping cusps of the first molars and incisal overbite.
Facial line	Line fron Nasion to Pogonion

Table 4: Parameters

Parameter	Definition
ANB angle	It is the difference between SNA and SNB. Provides the b information on the relative positions of jaws to each other.
AB Plane Angle	It is the measure of the relation of anterior limits of the apical bases to each other relative to the facial line.
Wits Appraisal	Perpendiculars from Point A and Point B are drawn onto the occlusal plane. The points of contact are labelled AO and BO, respectively. In Class I cases BO coincides with AO in females and BO is 1mm ahead of AO in males.
Harvold's Unit Length Difference	The difference between the unit length describes the disharmony between the jaws. This analysis also looks at the lower facial height which is from upper ANS to Menton.
MKG Angle	Parameter for assessing the sagittal apical base discrepancy. It uses the three skeletal reference points, that is: Point KR, Point M and Point G
Angle of Convexity	Measure the extent of protrusion or retrusion of the lower jaw, relationship of jaws to each other, convexity of maxilla and inclination of the lower jaw.

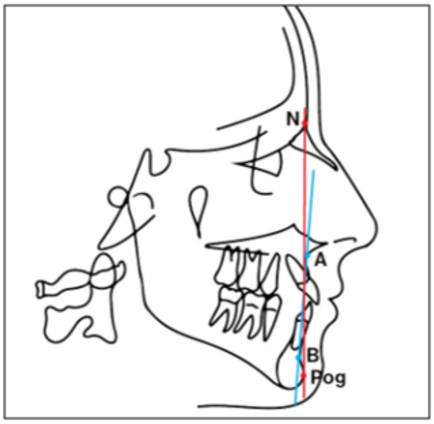

Fig. 3: AB plane angle

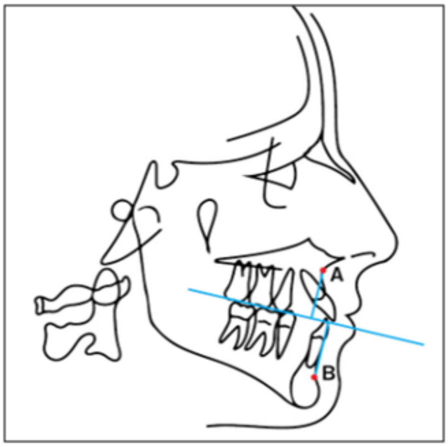

Fig. 4: Wits appraisal

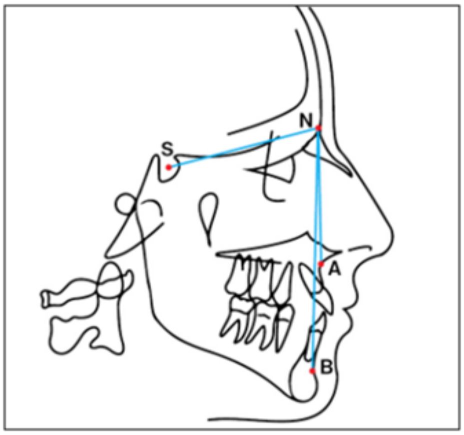

Fig. 2: ANB angle

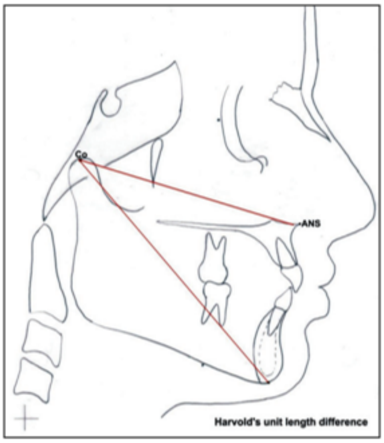

Fig. 5: Harvold's unit length difference

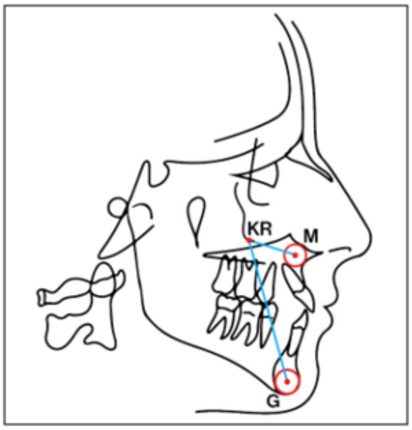

Fig. 6: MKG angle

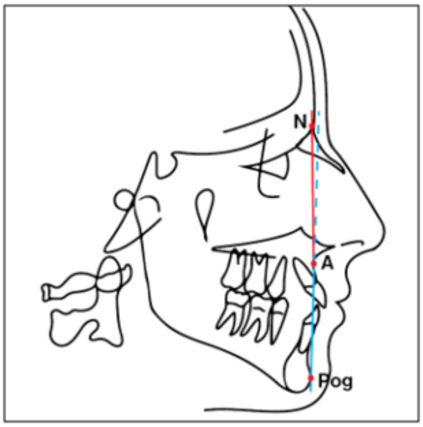

Fig. 7: Angle of convexity

3.1. Statistical analysis

The data obtained in this way were subjected to statistical analysis using SPSS software. Descriptive statistics, mean standard deviation was

4. Results

Lateral cephalograms before and after treatment of 50 patients with Angle class I malocclusion who underwent orthodontic treatment were included, divided into 2 groups, ie: group I (extraction, N=25) and group II (non-extraction, N=25). In both groups, 6 maxillomandibular parameters were recorded. When comparing changes before and after treatment in group I (class I, extraction), highly significant changes were observed in the ANB angle (p=0.00), AO-BO (p=0.00). The difference in Harvold unit lengths (p=0.03) and the convexity angle (p=0.39), while on the other hand the AB plane angle (p=0.06) and the MKG angle (p=0.00) were found to be insignificant as is shown in Table 5.

When pre- and post-treatment changes were compared in group II (angle class I, no extraction), statistically significant changes were observed in plane angle AB (p=0.00), AO-BO (p=0.00), difference length of Harvold units (p =0.00) and convexity angle (p=0.00). Conversely, ANB (p=0.04) and MKG angle (p=0.02) were found to be insignificant as shown in Table 6.

When comparing the maxillomandibular changes between group I and group II, significant changes were observed in the ANB angle (p=0.04), AB plane angle (p=0.00), AO-BO (p=0.02), MKG angle (p=0.00) and NAPog (p=0.00). On the contrary, Harvold (p=0.25) was found to be insignificant.

5. Discussion

The task of the orthodontist is to maintain the overall harmony and balance of the various facial features by predicting the individual's response to treatment. Orthodontic treatment leads to changes in the skeleton, teeth and soft tissues after treatment. Most dental and soft tissue orthodontic corrections are estimated clinically.[3] There is considerable interest in evaluating facial profile changes caused by orthodontic treatment in patients who have had their first premolars removed.[4] It is well known that premolar extraction is often chosen as an alternative for the treatment of patients with class I malocclusion and bimaxillary protrusion or crowding.[5] When deciding whether to proceed with extraction, it is important to consider not only the extent of crowding and crowding, but also the potential impact of orthodontic tooth displacement on the hard and soft tissue surfaces of the face. In the case of non-extraction therapy without extraoral traction, the anterior teeth and facial profile can be expected to protrude as a result of tooth alignment. Closing the remaining gaps could tilt back the front teeth and pull down the facial profile. Knowing the bony changes that occur in a patient after premolar extraction is essential to understanding how the patient's profile improves. The data obtained provide information on the advantages and disadvantages of extraction therapy for the patient profile. With this knowledge, we can better prepare to create an accurate treatment plan for the patient.[6]

Anteroposterior assessment of the jaw relationship after extraction alternatives is performed using different parameters. Among the various parameters that have been proposed, the most commonly used are the ANB angle, NA-Pog, AB-NPog, Wits assessment, Harvold's length difference per unit, and the MKG angle. The most commonly used measurement to assess skeletal discrepancy is the ANB angle. The ANB angle of the Steiner analysis is the angle that shows the anteroposterior relationship (sagittal) of the base of the maxillary skeleton to the base of the mandibular skeleton. Evan. A. Clement et al (2020) reported that there was a difference in the ANB angle between patients in the extraction and non-extraction groups. 2 Samir Bishara (1998)[7] showed that the

Table 5: Maxillomandibular changes in group I (Extraction)

Parameters	Pre	Post	T Value	P Value
ANB	4.03(±1.90)	3.16(±1.53)	5.066	**0.00****
AB Plane	7.93 (±2.33)	8.66 (±2.13)	-1.913	0.06
AO-BO	2.40 (±1.47)	1.90 (±1.51)	3.525	**0.00****
HARVOLD	19.86 (±1.97)	20.13 (±2.16)	-2.283	**0.03***
MKG	61.00(±6.92)	62.00(±5.86)	-863	0.39
NAPog	12.30(±4.80)	13.63(±4.18)	-2.016	**0.05***

Table 6: Maxillomandibular changes in group II (Non- extraction)

Parameters	Pre	Post	T Value	P Value
ANB	2.84 (±1.81)	2.52 (±1.38)	2.138	**0.04***
AB Plane	5.40(±2.50)	4.56 (±2.69)	5.629	**0.00***
AO-BO	2.52 (±1.15)	3.80 (±2.76)	-2.397	**0.02***
HARVOLD	20.68 (± 2.17)	20.84 (±1.99)	-1.163	0.25
MKG	56.40 (±1.04)	54.44 (±2.94)	3.259	**0.00***
NAPog	4.80 (± 2.46)	3.32 (± 1.81)	5.115	**0.00***

Table 7: Maxillomandibular changes between group I and group II

Parameter	Extraction group	Non-extraction group	Std Error Mean	T Value	P Value
ANB	0.86(±0.93)	0.38(±1.00)	0.182	2.009	0.05*
AB Plane	0.53(±0.28)	0.73(±0.73)	0.634	-.315	0.75
AO-BO	0.48(±0.71)	-1.28(±2.16)	0.539	3.263	0.00**
Harvold	-.24(±0.77)	-.16(±0.68)	0.207	-.385	0.70
MKG	-1.36(±6.21)	1.96(±3.00)	1.48	-2.232	0.03*
NAPog	-1.60(±2.59)	1.48(±1.44)	0.723	-4.259	0.00**

ANB angle changed significantly with age, while the Wits evaluation suggested that the relationship between points A and B do not change significantly with age. However, the main drawback of the Wits score is that it uses the occlusal plane, which is a dental parameter used to describe skeletal jaw discrepancies. The occlusal plane can be easily affected by tooth eruption or orthodontic tooth movement. Harvold's unit length discrepancy is determined by the position of the maxilla and mandible. In a study, Wu, Kaban, and Peacock (2019) demonstrated that Harvold's analysis and their linear measurements of maxillary and mandibular size better reflected the clinical impression of the sagittal position of the maxilla and mandible in these patients.[8] Lara-Carrillo et al. (2009) suggested using the Harvold analysis as an adjunct when there is doubt about the presence of maxillary changes in the patient's diagnosis.[9] The angle of the AB plane is a measure of the relationship of the anterior edge of the denture bases to each other and to the profile. On the other hand, the convexity angle is a measure of the protrusion of the maxillary part of the face in relation to the overall profile. Because facial type is known to vary racially, this parameter has different limits for different breeds. The MKG angle was developed to overcome some of the limitations of the parameters discussed above. The MKG angle is a new parameter for evaluating the sagittal-apical base discrepancy. It could be a potential marker for assessing mandibular discrepancy because it is based on stable landmarks. Skeletal landmarks G and M are used for this angle, representing the mandible and maxilla. They are marked in the center of the largest circle tangent to all surfaces of the maxilla and the inner anterior, inferior and posterior surfaces of the mandibular symphysis. Points M and G can also be used to assess the growth vector of the maxilla and mandible, respectively, which in itself defines the stability of these points even during active growth periods. Looking at the KR website, it can be seen that the anterior zygomatic and malar regions of the maxilla remodel along with the adjacent maxillary complex and their respective growth modes are similar. While the maxilla elongates horizontally by posterior remodeling, the malar region also remodels posteriorly by continued attachment of new bone to its posterior surface and resorption from its anterior surface. This remodeling process maintains the position of this area in proper relation to the elongating maxillary arch as a whole.[10]

Based on studies on different types of treatment to alleviate crowding, one of the routine procedures for Class I malocclusion and bimaxillary protrusion is extraction of first premolars. Stöckli (1994) suggested that extractions may have different effects depending on whether they are performed in the maxilla or mandible. He pointed out that the extraction of four premolars carried the risk of "intermaxillary discoordination with unsatisfactory results".[11] Bishara (1998) studied a group of patients who had extracted first premolars and reported that more pronounced changes were observed in terms of the relationship between the mandibles and maxilla than in the group of patients who underwent non-extraction treatment.[7] In a study conducted by Jagan Nath Sharma (2010), he evaluated skeletal and soft tissue A and B points with anterior tooth retraction among bimaxillary protrusion cases who all underwent first premolar extraction. The result of his study showed that SNA, SNB, and ANB showed a reduction in that order.[12] In another study conducted by Marisana Piano Seben (2013), she suggested that the extraction of two maxillary premolars in class 1 malocclusion II. class promotes dentoskeletal and tissue changes that contribute to improving the relationship between the skeletal bases and the soft tissue profile.[13] A systematic review by Guilherme Janson (2017), in which he evaluated the changes in the sagittal relationship of the apical base in the treatment of class II malocclusion with and without premolar extractions.[14] The result showed that in treated patients without extraction II. classes who were treated with both growth modification and fixed appliance therapy showed a mean reduction in the ANB angle. While in Class II malocclusions treated with two maxillary premolar extractions and four premolar extractions produced an estimated mean reduction in ANB. Various studies have attempted to show the skeletal changes that occur after extraction therapy. However, none of them used many detailed cephalometric parameters as in our study. Most studies used a class II division 1 malocclusion, but in our study we used a class I malocclusion.

The purpose of this study was to determine maxillomandibular facial changes after treatment in patients treated with premolar extraction and non-extraction. Pre- and post-treatment cephalometric radiographs of 50 orthodontic patients were selected from the archives of the Department of Orthodontics, Bhojia Dental College, Baddi. The sample was divided into 2 groups, i.e. Group I (Class I, N=25, extraction cases) and Group II (Class I, N=25, non-extraction cases). Various maxillomandibular parameters were evaluated and compared in both groups.

5.1. *Extraction group*

When the changes before and after treatment were compared, it was found that the ANB angle decreased after treatment and was found to be statistically significant because there is continuous bone remodeling, during the retraction of the anterior teeth after premolar extraction, there was a backward shift in point A and point B has the effect of reducing the angle ANB. Evan. A. Clement et al (2021) suggested that the ANB angle in patients treated with extraction showed a significant reduction, which was consistent with our study.[2] Scott Conleya (2006) also suggested that ANB decreased in class II patients who underwent first upper premolar extraction which was consistent with our study.[15] The change in intelligence score decreased after treatment and was also found to be highly significant. This could be due to the changed position of point A and point B, as the method requires drawing perpendiculars from points A and B on the upper and lower jaws to the occlusal plane and measuring the distance between the points. Keerthan Shashidhar (2021) suggested a decrease in Wits scores followed by an improvement in patient profile.[16] Bishara (1998) described "normalization of skeletal relationships" for both extraction and non-extraction groups compared to normal subjects with significant effects in the extraction group.[7] Luppanapornlarp and Johnston (1993) described a “significantly greater reduction in hard and soft tissue protrusion” after premolar extraction. Harvold’s difference in unit length increased after treatment and was found to be statistically significant.[17] A study by Dyer et al.(1991) demonstrated a statistically significant decrease in maxillary length in both adolescent and adult samples, which could explain the increase in Harvold unit length difference.[18] The change in convexity angle increased after treatment and was found to be significant. Most observations do not support the idea that tooth extraction significantly affects facial profiles (Dobrocky and Smith, 1989; Staggers, 1994; Bishara et al., 1997; Jäger et al., 1997; Boley et al., 1998; McLaughlin and Bennett, 1998). A minority of authors report a flattening of the profile leading to a more concave shape (Paquette et al., 1992; Zierhut et al., 2000).[19] This change in profile is caused by a change in point A. The withdrawal of point A leads to a less convex profile. The change in AB plane angle decreased after treatment and was found not to be significant. The change in the MKG angle increased after treatment and was found to be statistically insignificant, as points M and G are not affected by local remodeling secondary to tooth movements, unlike points A and B, as described by Achint Chachada (2020) in a study.[20]

5.2. *Non-extraction group*

When the changes before and after treatment were compared, the ANB angle was found to decrease after treatment and was found to be significant. A systematic review by Janson (2017) showed a significant reduction in the ANB angle in treated class II patients without extraction compared to untreated class II subjects, which is consistent with our study.[14] Evan. A. Clement et al (2021) suggested that the ANB angle in a patient treated with non-extraction showed a mean increase of 0.2°, which was not statistically significant and inconsistent with this study.[2] The change in the AB plane angle decreased after treatment and was found, that is significant. Change in intelligence ratings increased after treatment and was also found to be significant. This may have been due to a change in the position of point A and point B. Battagel and Orton (1991)[21] examined class III patients and found more significant effects on the mandibular skeleton in the non-extraction group than in the extraction group.[19] The change in the MKG angle decreased after treatment and was found to be statistically significant. Achint Chachada (2020) in his study suggested that the M and G points are not affected by local remodeling secondary to tooth movements, which is inconsistent with our study.[20] The change in convexity angle decreased after treatment and was found to be significant. Harvold's difference in unit length remained almost the same after treatment and was found to be statistically insignificant.

When the extraction and non-extraction group differences were compared, the ANB angle, Wits estimate, MKG angle, and convexity angle were found to be significant. Changes in ANB angle and convexity angle were more in the extraction group. In a study conducted by Nagmode et al (2017), it was found that after incisor retraction, there is a relationship between the retraction of bone point A and point B.[22] It was found that the changes at the bases were caused by the back movement of skeletal points A and B. This could explain the reason changes in the ANB angle and the convexity angle in the extraction group. Intelligence ratings and MKG angle changes were more significant in the non-extraction group. Orthodontic treatment improves the occlusal relationship and also affects the position of point A and point B, which results in changes in the judgment of reason. In a study by Dyer et al (1991) they suggested that changing the inclination of the occlusal plane would mimic an improved apical base relationship.[18]

6. Conclusion

1. The results of the above study indicate that the ANB angle, Wits score, Harvold unit length difference and convexity angle showed significant results in the extraction group.
2. ANB angle, AB plane angle, Wits estimate, MKG angle and convexity angle showed significant results in non-extraction group.
3. ANB angle, Wits estimate, MKG angle and convexity angle show significant difference when comparing extraction and non-extraction groups.
4. Changes in the ANB angle and the convexity angle were more pronounced in the extraction group, on the other hand, the changes in the Wits assessment and the MKG angle were more in the non-extraction group.

7. Conflict of Interest

None.

8. Source of Funding

None.

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