Dental Journal
Majalah Kedokteran Gigi

Dental Journal
(Majalah Kedokteran Gigi)
2020 September; 53(3): 133–139

Research Report

The changing of occlusal plane inclination in Class II malocclusion

Nelvi Yohana, Siti Bahirrah and Nazruddin
Department of Orthodontics,
Faculty of Dentistry, Universitas Sumatera Utara,
Medan – Indonesia

ABSTRACT

Background: *Camouflage treatment of skeletal Class II malocclusion can be performed using extraction or non-extraction techniques. These treatments can cause changes in occlusal plane. Steep occlusal plane during corrective treatment generally relapses after active orthodontic treatment, resulting in unstable interdigitation.* ***Purpose:*** *This study aims to determine and evaluate changes in occlusal plane inclination in skeletal Class II malocclusion cases using extraction or non-extraction techniques of the permanent maxillary first premolar.* ***Methods:*** *The samples consisted of initial and final cephalometry of 40 adult patients with skeletal Class II malocclusion divided into two groups, namely extraction of the permanent maxillary first premolar and non-extraction group. The inclination of occlusal planes in both groups was measured using the ImageJ software, then the factors associated with these changes were observed. Furthermore, the occlusal plane inclination was compared between the extraction and non-extraction groups by using t-test.* ***Results:*** *The occlusal plane inclination in the non-extraction group increased slightly, while the inclination in the extraction group increased significantly ($p = 0.017$, p-value < 0.05). However, there was no correlation found in the occlusal plane inclination between the extraction and non-extraction groups ($p = 0.07$, p-value < 0.05).* ***Conclusion:*** *Class II malocclusion correction with either extraction or non-extraction of the maxillary first premolar increased the inclination of the occlusal plane. This study indicated that control of the occlusal plane inclination is highly essential.*

Keywords: *cephalometry; Class II malocclusion; extraction; inclination; occlusal plane*

Correspondence: Nelvi Yohana, Department of Orthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Jl. Alumni No. 2, Medan 20155, Indonesia. Email: nelviyohana@yahoo.com

INTRODUCTION

Skeletal Class II malocclusion is the most common problem in orthodontics, and about one-third of these patients are treated by orthodontists.[1] This type of malocclusion is not a single diagnosis, but is produced from various dentoalveolar skeletal components. Skeletal Class II patterns can be caused by protrusive maxilla with normal mandible, normal maxilla with retrusive mandible, or a combination of protrusive maxilla and retrusive mandible.[2,3] Sridharan et al.[4] state that about 10% of the Tumkur population have Class II malocclusion. Ardani et al.[5] in their study of 65 lateral cephalometric radiographs from the adult Javanese (Deutero Malay) population, have found that the highest frequency of Class II malocclusion variations was in the combination of normal maxilla with mandibular retrusion. The disturbance can be in the form of size, position or relation between the jaws.[3,6,7] Clinical manifestations of patients with skeletal Class II malocclusion include maxillary and anterior teeth protrusion, deep bites, clockwise rotation of the mandibular growth, incompetent lips and an aesthetic face.[8,9] This appearance could affect the patient's confidence, mental health and daily communication. Successful orthodontic treatment not only forms a balanced and stable occlusion relation, but also achieves an aesthetic facial appearance.[10,11]

Comprehensive orthodontic treatment using fixed orthodontic appliances usually consists of two treatment modalities, namely extraction and non-extraction. [10,11] Orthodontic treatment with tooth extraction is performed

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v53.i3.p133–139

to treat moderately to severely crowded teeth, and/or to reduce dental or dentoalveolar protrusions. In contrast, non-extraction orthodontic treatment is conducted in cases with minor skeletal discrepancies and moderate dental discrepancies.[11] The orthodontic treatment affects various parameters, such as vertical dimensions, treatment stability, arch width, perioral soft tissue, facial convexity and occlusal plane.[11,12]

Occlusal plane (OP) is a line following the bite of the teeth and is considered an important reference plane to achieve functional balance.[8] The shape and inclination of the occlusal plane depend on each person's characteristics and are related not only to the stomatognathic system, but also dentofacial aesthetics.[13] The occlusal plane inclination is an important factor in dentofacial morphology and is one of the standards for reconstructing occlusion.[14]

The inclination of the occlusal plane is obtained through angular measurements between the occlusal plane (OP) relative to the reference plane, such as sella-nasion (SN) plane, basion-nasion plane (BaN) or horizontal Frankfort plane (FH).[8,15] There are various ways to determine the occlusal plane, including bisected occlusal plane (BOP), functional occlusal plane (FOP) and lower incisor occlusal plane (LIOP).[15–17] Downs has defined BOP (a line that connects two points dividing the overlapping distobuccal first molar and overlapping overbite incisors) as the most commonly used method. FOP is a plane that divides the first premolar intercuspation and the first molar cuspid intercuspation. [15,16] Changes in the occlusal inclination can be caused by molar movement to the mesial (loss of anchoring) or due to extrusion and intrusion (molars and incisors).[17] Factors affecting the morphology and function of the occlusal plane include growth, head and neck muscles, mandibular rotation during growth, tooth eruption and bad habits.[13]

Class II malocclusion has a relatively steep occlusal plane.[15] Bawman and Johnston state that increased occlusal plane inclination during treatment indicates reduced vertical control and tends to become unstable, because the occlusal plane angle is determined by the muscle balance, especially masticatory muscles.[12] Orthodontic treatment changes the position and angulation of the teeth and moves them to the ideal aesthetic and functional position. A slight angular change in orthodontic treatment will cause a significant occlusion change, so it can lead to functional disharmony and relapse.[16]

A study conducted by Li et al.[16] has shown that the occlusal plane inclination (BOP-SN and FOP-SN) in skeletal Class II samples was steeper than the skeletal Class I and III samples. There was a significant increase in the average BOP-SN angle of 1.51° after orthodontic treatment without premolar extraction in growing and developing patients.[16] Contrary to this, a study by Zenab et al.[18] examining changes in the occlusal plane inclination before and after the extraction of four premolars in bimaxillary protrusion cases has shown that the occlusal plane inclination after treatment became smaller than before treatment. According to Zimmer and Nischwitz,[19] there was no significant change in BOP inclination to the anterior cranial base before and after treatment in skeletal Class II patients treated with elastic. Furthermore, there are still limited studies investigating the changes in occlusal plane inclination in skeletal Class II malocclusion treated with extraction of the first maxillary premolars and non-extraction in adult patients. Therefore, the present study aims to evaluate changes in the occlusal plane inclination in skeletal Class II malocclusions treated with maxillary premolar extraction and non-extraction at the Department of Orthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Indonesia.

MATERIALS AND METHODS

Ethical clearance was obtained from the health research ethics committee of the Faculty of Medicine, Universitas Sumatera Utara, number: 900/TGL/KEPK FK-RSUP HAM/2019. This study was retrospective analytical and sample selection method was applied by purposive sampling method adhering to fulfilled inclusion and exclusion criteria. The number of samples was determined using the formula of sample size for two-means-dependent samples. The research samples were taken from lateral cephalometric radiographs of Mongoloid race before and after orthodontic treatment using fixed orthodontic devices from 40 Class II Skeletal patients with ANB > 4° at the Department of Orthodontics, Faculty of Dentistry, University of Sumatra Utara between August 2019 and January 2020. The patients were willing to become research participants and gave written informed consent. The samples were divided into two groups, namely the group treated with non-extraction and the group treated with permanent maxillary first premolar extraction. The average age of the samples was 22.5 years. The samples were selected based on the following inclusion criteria: (1) cephalometric radiographs before and after treatment showed a good condition; (2) male and female patients aged 18-35 years; (3) a complete number of permanent teeth in patients before treatment regardless of the presence or absence of third molars; (4) no congenitally missing teeth/agenesis; (5) no supernumerary or anomalous form teeth; and (6) no history of oral cavity trauma and bad habits. The exclusion criteria in this study were a history of cleft lip and/or palate and patients who underwent functional or orthognathic surgery before and after treatment.

Photographs were taken from lateral cephalogram radiographs that were placed on the tracing box using a Nikon D90 camera (12.3 megapixel digital single-lens reflex camera made in Thailand) with a Nikon DX AF-S NIKKOR 18-105 mm lens mounted on a tripod in zero tilting position (seen waterpass on a tripod) and 50 cm away from the lateral cephalogram radiograph. The images were then traced and measured using ImageJ software version 1.53c (Figure 1 and 2).[20] ImageJ is a Java-based image

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v53.i3.p133–139

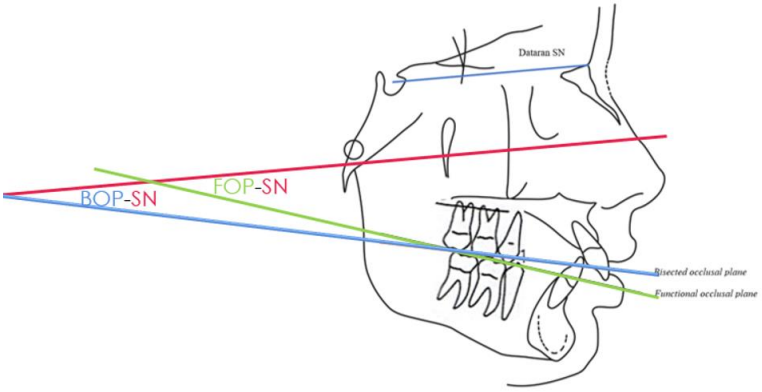

Figure 1. Occlusal plane inclination BOP-SN (°) and FOP-SN (°).

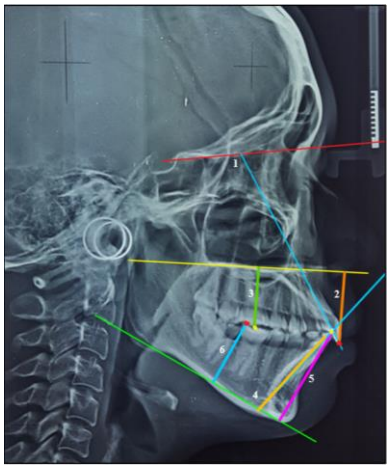

Figure 2. Determination angulation and position of central incisors and first molar. (1) Angulation of the maxillary central incisor (U1-SN (°)), (2) maxillary central incisor position (U1-PP (mm)), (3) maxillary permanent first molar position (U6-PP (mm)), (4) angulation of the mandibular central incisor (L1-MP (°)), (5) mandibular central incisor position (L1-MP (mm)), (6) mandibular permanent first molar position (L6-MP (mm)).

Table 1. The cephalometric variables used in this study

Variable	Definition
Used Plane	
BOP	The bisected occlusal plane is a region formed by connecting points that bisect the overlapping distobuccal cuspid of the maxillary and mandibular first molars with points that bisect the overlapping overbite incisors (Downs).
FOP	The functional occlusal plane is a plane that divides the intercuspation of the first premolar with the first molar cuspid intercuspation (Jacobson).
SN	The line that runs through the mid sella turcica and nasion.
PP	The palatal plane is a line connecting the anterior nasal spine and posterior nasal spine.
MP	The mandible plane is a line connecting gonion and menton.
Measurements	
BOP-SN (°)	Inclination of occlusal plane formed between the sella turcica-nasion plane and BOP.
FOP-SN (°)	Inclination of occlusal plane formed between the sella turcica-nasion plane and FOP.
U1-SN (°)	Angulation of the maxillary central incisor, which is a posterior-inferior angle that is formed from the long axis of the maxillary central incisor (U1) and SN plane.
U1-PP (mm)	The position of the maxillary central incisor, which is the perpendicular distance from the maxillary central incisor (U1) to the palatal plane (PP).
U6-PP (mm)	The position of the maxillary first molar, which is the perpendicular distance from the distobuccal cusps of the maxillary first molar (U6) to the palatal plane (PP).
L1-MP (°)	Angulation of the mandibular central incisors, i.e. angles formed from the long axis of the mandibular central incisors (L1) and MP plane.
L1-MP (mm)	The position of the mandibular central incisors, which is the perpendicular distance from the mandibular central incisors (L1) and the mandibular plane (MP).
L6-MP (mm)	The position of the mandibular first molar, which is the perpendicular distance from the mandibular first molar distobuccal cusps (L6) to the mandibular plane (MP) before and after treatment.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
 Available at http://e-journal.unair.ac.id/index.php/MKG
DOI: 10.20473/j.djmkg.v53.i3.p133–139

processing programme developed at the National Institutes of Health and the Laboratory for Optical and Computational Instrumentation (University of Wisconsin, United States). Determination of landmark points, lines, and reference angles in the extraction and non-extraction groups can be seen in Table 1. The tracing and measurement process was carried out by one operator and repeated twice. The study statistics use Statistical Package for Social Science (SPSS) software version 22 (New York, United States). P-value of this study was <0.05 using bivariate test, Pearson test and t-test.

RESULTS

Analysis of the mean values of variables in patients treated with non-extraction using the Bivariate test showed a significant change in L1-MP (°) and L6-MP (mm) ($p < 0.05$) before and after treatment, where the inclination of the mandibular incisors was more anterior, and extrusion occurred from the permanent mandibular first molars. There was also an increase in FOP-SN (°) and BOP-SN (°) with an insignificant value. The FOP-SN (°) value was greater than that of BOP-SN (°) in this group. Analysis

Table 2. Average changes on FOP-SN (°), BOP-SN (°), U1-SN (°), U1-PP (mm), U6-PP (mm), L1-MP (°), L1-MP (mm) and L6-MP (mm) before and after treatment in patients with maxillary premolar extraction and non-extraction

Variable	Non-extraction			Extraction		
	Before X±SD	After X±SD	*p-value*	Before X±SD	After X±SD	p-value
FOP-SN (°)	16.67±5.29	16.88±4.19	0.818	-	-	-
BOP-SN (°)	15.86±4.58	16.37±5.05	0.549	16.78±6.21	18.72±4.11	0.017*
U1-SN (°)	108.08±8.19	105.21±9.54	0.295	108.02±6.71	97.39±6.12	0.0001*
U1-PP (mm)	31.28±2.85	32.09±3.36	0.078	32.99±3.47	33.94±3.28	0.036*
U6-PP (mm)	23.15±2.54	23.73±2.79	0.066	25.27±3.48	25.92±3.38	0.083
L1-MP (°)	101.39±7.47	109.05±6.91	0.0001*	101.40±6.36	101.58±6.82	0.892
L1-MP (mm)	44.27±3.31	44.61±3.46	0.437	46.48±3.91	45.35±4.05	0.019*
L6-MP (mm)	32.74±2.73	33.53±3.11	0.039*	33.09±2.75	33.97±3.31	0.019*

*p<0.05= significant

Table 3. The relationship between the inclination of the FOP-SN (°) and BOP-SN (°) occlusal plane in patients given non-extraction treatment

Variable	X±SD	r	*p-value*
BOP-SN (before) FOP-SN (before)	15.86±4.58 16.67±5.29	0.780	0.0001*
BOP-SN (after) FOP-SN (after)	16.37±5.05 16.88±4.19	0.892	0.0001*

*p<0.05= significant

Table 4. The relationship between the average changes in U1-SN (°), U1-PP (mm), U6-PP (mm), L1-MP (°), L1-MP (mm) and L6-MP (mm) to BOP-SN (°) in the non-extraction and extraction treatment groups

Variable	X±SD	r	*p-value*	X±SD	r	p-value
U1-SN (°) BOP-SN (°)	2.88±11.95 0.50±3.70	-0.598	0.005*	10.07±13.85 2.97±4.52	-0.230	0.329
U1-PP (mm) BOP-SN (°)	0.81±1.94 0.50±3.70	0.435	0.056	0.51±3.09 2.97±4.52	0.376	0.102
U6-PP (mm) BOP-SN (°)	0.57±1.31 0.50±3.70	-0.267	0.254	0.86±2.84 2.97±4.52	-0.341	0.141
L1-MP (°) BOP-SN (°)	7.66±6.46 0.50±3.70	0.173	0.464	0.23±9.78 2.97±4.52	0.143	0.548
L1-MP (mm) BOP-SN (°)	0.34±1.91 0.50±3.70	-0.226	0.338	0.92±3.23 2.97±4.52	-0.215	0.363
L6-MP (mm) BOP-SN (°)	0.79±1.59 0.50±3.70	0.743	0.0001*	0.92±2.38 2.97±4.52	0.287	0.220

*p<0.05= significant

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
 Available at http://e-journal.unair.ac.id/index.php/MKG
DOI: 10.20473/j.djmkg.v53.i3.p133–139

of the mean values of variables in patients treated with maxillary premolar extraction using the Bivariate test showed that the changes in BOP-SN (°), U1-SN (°), U1-PP (mm), L1-MP (mm), and L6-MP (mm) were significant ($p < 0.05$) before and after treatment with maxillary premolar extraction (Table 2).

The Pearson test was used to investigate the relationship between FOP-SN (°) and BOPSN (°) in patients treated with non-extraction orthodontic treatment (Table 3). The statistical results showed a strong correlation between BOP-SN (°) and FOP-SN (°) before and after treatment ($p = 0.0001$).

The Pearson test used to analyse the relationship between U1-SN (°), U1-PP (mm), U6- PP (mm), L1-MP (°), L1-MP (mm) and L6-MP (mm) to BOP-SN (°) in the non-extraction treatment group showed a significant relationship between the maxillary central incisor angulation ($p = 0.005$) and mandibular first molar position ($p = 0.0001$) to the occlusal plane

inclination. Correlation analysis of changes between U1-SN (°), U1-PP (mm), U6-PP (mm), L1-MP (°), L1-MP (mm) and L6-MP (mm) to BOP-SN (°) in orthodontic treatment patients with maxillary first premolar extraction showed that there was no significant relationship between the variables with $p > 0.05$ (Table 4).

The correlation between the maxillary premolar extraction and non-extraction groups was analysed using the t-test. The comparison analysis of the non-extraction and extraction groups showed that there was a significant correlation in the maxillary central inclination U1-SN (°), mandibular incisors inclination L1-MP (°) and position of the central mandibular incisors L1-MP (mm) between the two groups. However, there was no significant difference between the occlusal plane inclination in the extraction and non-extraction of the maxillary first premolar groups, but there was a greater change in the occlusal plane inclination in the extraction group than the non-extraction group (Table 5).

DISCUSSION

This study has found that the mean occlusal plane was steeper after orthodontic treatment, both FOP-SN (°) and BOP-SN (°) with insignificant values. This correlates with research conducted by Li et al.[16] who had found an increase in BOP-SN (°) and FOP-SN (°) after non-extraction orthodontic treatment. These changes can occur due to the extrusion of molars and incisors from orthodontic treatment mechanics. Class II elastic is often used in treating patients with skeletal Class II malocclusion, which can cause rotation of the occlusal plane downward and backward.[16,18,21]

There was a significant increase in the mandibular incisor inclination (L1-MP/°) and vertical position of mandibular first molars (L6-MP (mm)) before and after non-extraction treatment in this study. These results correlate with the findings of Janson et al.[22] which have shown that there was a change in the mandibular incisor inclinations to the anterior and extrusion of the mandibular first molar. This change can be caused by the use of elastic Class II.[22] According to Braun and Legan,[23] the use of elastic can also lead to extrusion of posterior teeth, in this case extruding mandibular posterior teeth in skeletal Class II cases. Increased mandibular incisor inclination can also be associated with skeletal Class II camouflage treatment, by protruding mandibular anterior teeth so that overjet is reduced.[24] Singh et al.[25] state that the lower second molar should be used to extend the elastic if used for more than two months of treatment. This treatment regimen minimises the side effects from the use of elastics (extrusion of the lower posterior teeth and labial tipping of the lower anterior teeth, lowering of the anterior occlusal plane and the creation of gummy smile).[22,25]

This study has found a significant increase in the mean of occlusal plane inclination after orthodontic treatment with the extraction of two maxillary first premolars. Demir et al.[26] have found similar results in a study conducted on 53

Table 5. Differences in the changes of BOP-SN (°), U1-SN (°), U1-PP (mm), U6-PP (mm), L1-MP (°), L1-MP (mm) and L6-MP (mm) between the extraction and non-extraction groups

Variable	Group	X±SD	*p-value*
BOP-SN (°)	Non-extraction	0.50±3.70	0.07
	Extraction	1.93±5.16	
U1-SN (°)	Non-extraction	2.88±11.96	0.022*
	Extraction	10.62±8.10	
U1-PP (mm)	Non-extraction	0.81±1.94	0.808
	Extraction	0.95±1.88	
U6-PP (mm)	Non-extraction	0.57±1.31	0.877
	Extraction	0.64±1.57	
L1-MP (°)	Non-extraction	7.66±6.46	0.001*
	Extraction	0.18±5.96	
L1 MP (mm)	Non-extraction	0.34±1.91	0.022*
	Extraction	1.13±1.97	
L6-MP (mm)	Non-extraction	0.79±1.59	0.870
	Extraction	0.87±1.53	

*p<0.05=significant

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v53.i3.p133–139

Class II malocclusion patients with mandibular retrognathia with insignificant values. Elih et al.[27] report that posterior anchorage must be considered so that the position does not change during retraction. Changes in occlusal plane inclination can also be caused by extrusion and intrusion. Changes in the position of the posterior teeth can change the vertical dimensions, leading to increased occlusal plane inclination. It can be concluded that maximum anchorage can prevent posterior tooth changes.[26] If the anterior teeth are retracted to prevent the posterior teeth from moving forward, posterior anchorage can be added by involving the second molar.[18]

In this study, we have found that there was a significant reduction of maxillary central incisor inclination, maxillary central incisor and mandibular first molar extrusions, and mandibular central incisor intrusions. This finding correlates with Demir et al.[26] who have found a significant reduction in the maxillary incisor inclination and an increased mandibular incisor inclination. Adverse effects from the use of intermaxillary elastics may contribute to an increased height of the anterior upper face and also to tip the incisors.[23,26] Class II elastic adverse effects include retroclination of the maxillary incisors and proclination of the mandibular incisors. The vertical vector of elastic Class II causes the anterior part of the maxilla to rotate downwards.[26]

According to a study by Li et al.[16] there was a very strong correlation between BOP-SN (°) and FOP-SN (°) in patients treated with non-extraction. The study also reports that the BOP and FOP occlusal plane inclinations were statistically steeper in Class II malocclusion groups compared to Class I and Class III before and after treatment.[16] Similarly, the present study has found a strong relationship between BOP-SN (°) and FOP-SN (°) before and after orthodontic treatment without maxillary premolar extraction. The inclination of FOP-SN (°) was greater than that of BOP-SN (°). Moreover, BOP was found to be a more reproducible reference plane compared to FOP during the cephalometric imaging process. Determination of the point that bisects the maxillary and mandibular first premolar intercuspation is difficult to determine, especially in malpositioned teeth.

The present study has shown a significant correlation between the angulation of the maxillary central incisor, and the vertical position of the mandibular first molar, to occlusal plane inclination. Maxillary central incisor angulation was negatively correlated, whereas the vertical position of the mandibular first molar was positively correlated to the changes in occlusal plane inclination. This change may be due to the use of intermaxillary elastics.[22] According to Lamarque,[28] changing and maintaining the occlusal plane during orthodontic treatment depends on molar movement to the mesial, vertical control of the maxillary and mandibular molars, and extrusion and intrusion of the incisors. A molar movement to the mesial is usually less in non-extraction treatment cases, so these are only affected by two factors.[29]

The present study has not shown a relationship between the changes in maxillary central incisor angulation, and mandibular central incisor angulation with changes in the occlusal plane inclination (BOP-SN (°)), in patients treated with maxillary first premolar extraction. Changes in the position of maxillary central incisors, mandibular central incisors, and permanent mandibular first molars also did not have a significant relationship to changes in the occlusal plane inclination.

The group comparison analysis with and without maxillary first premolar extraction showed a significant relationship between maxillary central incisor inclination U1-SN (°), mandibular incisor inclination L1-MP (°) and central mandibular position L1-MP (mm). The extraction group showed changes in maxillary central incisor inclination U1-SN (°), which was greater than that of the non-extraction group. This may be due to the fact that when the anterior teeth were retracted in the extraction group, there was a greater change in the inclination of the maxillary incisors to the lingual, than to bodily movements due to lack of third-order bend control. These results are in line with a study conducted by Saelens which concludes that the extraction group produced more retroclined teeth, which were generally caused by the use of intramaxillary elastic.[26]

There was a greater change in mandibular incisor inclination (L1-MP (°)) in the non-extraction group, where the mandibular incisor inclination became more anterior. Similarly, Saelens reported that teeth inclination was more proclined in the non-extraction group, especially on mandibular incisors. This result may be due to the use of elastic Class II.[26] The position of the central mandibular incisor L1-MP (mm) in the two groups was also significantly different, possibly due to the relatively protracted use of Class II elastic in the non-extraction cases.

From this present study, it can be concluded that there was not a significant increase in changes to occlusal plane inclination treated with non-extraction in skeletal Class II malocclusion. Changes in maxillary central incisor inclinations and vertical position of the mandibular first molar have a significant correlation to changes to occlusal plane inclination before and after non-extraction treatment. Occlusal plane inclination increased significantly in the group treated with extraction of the maxillary first premolar in skeletal Class II malocclusion. Changes in position and angulation of the molar and incisor are not correlated with changes in occlusal plane inclination after orthodontic treatment with maxillary first premolar extraction. The increase in occlusal plane inclination was greater in the extraction group compared to the non-extraction group. There were no significant differences in the changes to occlusal plane inclination between the two groups. Further studies are expected to be conducted with larger sample sizes.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
 Available at http://e-journal.unair.ac.id/index.php/MKG
DOI: 10.20473/j.djmkg.v53.i3.p133–139

REFERENCES

1. Aslam A, Naeem A, Jan H, Bukhari GA, Abbas Q, Amjad M. Prevalence of class II malocclusions in Pakistani sample - A study. Pakistan Oral Dent J. 2010; 30: 96–100.
2. Kapoor D, Garg D. Cephalometric characteristics of Class II division 1 malocclusion in a population living in the Chitwan distric of Nepal. Int J Contemp Med Res. 2017; 4(4): 947–9.
3. Sivaraj A. Essentials of Orthodontics. New Delhi: Jaypee Brother Medical Publishers; 2013. p. 83–100.
4. Sridharan K, Udupa V, Srinivas H, Kumar S, Sandbhor S. Prevalence of Class II malocclusion in Tumkur population. J Dent Scinces Res. 2011; 2(2): 14–7.
5. Ardani IGAW, Anandamaya D, Alida. The relationship between skeletal and dental characteristics in patients with Class II malocclusion. J Int Dent Med Res. 2019; 12(4): 1421–5.
6. Premkumar S. Textbook of orthodontics. New Delhi: Elsevier; 2015. p. 265–98.
7. Bishara SE. Class II malocclusions: Diagnostic and clinical considerations with and without treatment. Semin Orthod. 2006; 12: 11–24.
8. Hassan R, Rahimah AK. Occlusion, malocclusion and method of measurements-an overview. Arch Orofac Sci. 2007; 2: 3–9.
9. Xuan J, Bing L, Li S-F, Ma Y-N, Kwon T-G, Wu X-P. Morphological characteristics of soft tissue profile of Angle's Class II division I malocclusion before and after orthodontic treatment. Int J Morphol. 2018; 36: 26–30.
10. Hosseinzadeh-Nik T, Eftekhari A, Shahroudi AS, Kharrazifard MJ. Changes of the mandible after orthodontic treatment with and without extraction of four premolars. J Dent (Tehran). 2016; 13(3): 199–206.
11. Konstantonis D, Vasileiou D, Papageorgiou SN, Eliades T. Soft tissue changes following extraction vs. nonextraction orthodontic fixed appliance treatment: a systematic review and meta-analysis. Eur J Oral Sci. 2018; 126(3): 167–79.
12. Bowman SJ, Johnston LE. The esthetic impact of extraction and nonextraction treatments on Caucasian patients. Angle Orthod. 2000; 70: 3–10.
13. Vukušić N, Lapter M, Muretić Ž. Change in the inclination of the occlusal plane during craniofacial growth and development. Coll Antropol. 2000; 24: 145–50.
14. Ogawa T, Koyano K, Suetsugu T. Characteristics of masticatory movement in relation to inclination of occlusal plane. J Oral Rehabil. 1997; 24(9): 652–7.
15. Jacobson A, Jacobson RL. Radiographic cephalometry: From basics to 3-D imaging. Canada: Quintessence Publishing; 2006. p. 63–151.
16. Li J, Kau CH, Wang M. Changes of occlusal plane inclination after orthodontic treatment in different dentoskeletal frames. Prog Orthod. 2014; 15: 41.
17. Thayer TA. Effects of functional versus bisected occlusal planes on the Wits appraisal. Am J Orthod Dentofac Orthop. 1990; 97(5): 422–6.
18. Zenab NY, Hambali TS, Salim J, Mardiati E. Changes of occlusal plane inclination after orthodontic treatment with four premolars extraction in dento-alveolar bimaxillary protrusion cases. Padjadjaran J Dent. 2009; 21(2): 100–3.
19. Zimmer B, Nischwitz D. Therapeutic changes in the occlusal plane inclination using intermaxillary elastics. J Orofac Orthop. 2012; 73(5): 377–86.
20. Lemos AD, Katz CRT, Heimer MV, Rosenblatt A. Mandibular asymmetry: A proposal of radiographic analysis with public domain software. Dental Press J Orthod. 2014; 19(3): 52–8.
21. Kawamura J, Park JH, Kojima Y, Kook YA, Kyung HM, Chae JM. Biomechanical analysis for total mesialization of the mandibular dentition: A finite element study. Orthod Craniofacial Res. 2019; 22(4): 329–36.
22. Janson G, Sathler R, Fernandes TMF, Branco NCC, De Freitas MR. Correction of Class II malocclusion with Class II elastics: A systematic review. Am J Orthod Dentofac Orthop. 2013; 143(3): 383–92.
23. Braun S, Legan HL. Changes in occlusion related to the cant of the occlusal plane. Am J Orthod Dentofacial Orthop. 1997; 111(2): 184–8.
24. Suresh R, Priya K. Orthodontic camouflage treatment of skeletal class II malocclusion with severe maxillary dentoalveolar protrusion. J Pierre Fauchard Acad (India Sect. 2013; 27(4): 118–23.
25. Singh V, Pokharel P, Pariekh K, Roy D, Singla A, Biswas K. Elastics in orthodontics: a review. Heal Renaiss. 1970; 10(1): 49–56.
26. Demir A, Uysal T, Sari Z, Basciftci FA. Effects of camouflage treatment on dentofacial structures in Class II division 1 mandibular retrognathic patients. Eur J Orthod. 2005; 27(5): 524–31.
27. Elih, Thahar B, Soemantri ESS, Rasyid HN. Evaluation of dento facial vertical dimension in Class II division 1 malocclusion after premolar extraction. Int J Sci Res. 2016; 5(6): 1396–9.
28. Lamarque S. The importance of occlusal plane control during orthodontic mechanotherapy. Am J Orthod Dentofac Orthop. 1995; 107(5): 548–58.
29. Fushima K, Kitamura Y, Mita H, Sato S, Suzuki Y, Kim YH. Significance of the cant of the posterior occlusal plane in Class II division 1 malocclusions. Eur J Orthod. 1996; 18(1): 27–40.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v53.i3.p133–139