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Research Report

The difference between Begg and Straightwire appliances on molar position, occlusal plane angle, and anterior and posterior facial height changes

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ABSTRACT

Background: *Bimaxillary and bidental protrusion Class I Angle malocclusions have a characteristic convex facial profile and protrusion lips due to the labial inclination of the anterior teeth. Extraction of the first four premolars is the most common choice for orthodontic treatment of these cases when all the permanent teeth are complete and in good condition. Orthodontic treatment can be performed using the Begg or Straightwire techniques.* ***Purpose:*** *This study aims to investigate the difference in the effect of orthodontic treatment with Begg and Straightwire appliances on molar position, occlusal plane, and anterior and posterior facial height.* ***Methods:*** *Sixty pairs of lateral cephalograms before and after the treatment of patients with bimaxillary and bidental protrusive Angle malocclusion Class I, aged 18–35 years old, who underwent orthodontic treatment using the Begg and Straightwire techniques with the extraction of all first premolars that met the inclusion criteria. Data analysis was performed using two-way repeated analysis of variance ($p<0.05$) and Pearson correlation ($p<0.05$).* ***Results:*** *Molar position, occlusal plane angle, and anterior and posterior facial heights increased significantly after the Begg technique treatment and decreased significantly after the Straightwire technique treatment ($p<0.05$), but there were no significant differences between the four variables in the two techniques ($p>0.05$). Medium correlation was found between variables in both the Begg and Straightwire techniques.* ***Conclusion:*** *Molars were extruded and mesialized and the occlusal plane angle and height of the anterior and posterior faces increased after the Begg appliances treatment. The molars moved mesially and occlusally and there was a decrease in the occlusal plane angle, as well as the height of the anterior and posterior faces, after treatment with the Straightwire appliances. However, there was no difference between the two techniques.*

Keywords: *Bimaxillary and bidental protrusion; fixed orthodontic treatment; molar position; occlusal plane; facial vertical height*

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INTRODUCTION

Malocclusion is a condition deviating from the normal occlusion that occurs due to a discrepancy between the dental arch and the jaw arch.[1] This situation can occur in the upper and lower jaw and results in disturbances in chewing, phonation and aesthetics.[1–3] The prevalence of Class I Angle malocclusion in the Indonesian Deutero-Malay population is 48.8%.[4,5] Class I bimaxillary protrusion malocclusion has a convex profile.[2] The orthodontic treatment objective is the correction of the malrelation and malposition of teeth to achieve stable occlusion function and pleasant facial aesthetics.[2,6]

The vertical dimension of the face of the patient undergoing orthodontic treatment is an important aspect to consider because it determines facial aesthetics.[7] The height of the vertical dimension of the face is influenced by the angle of the occlusal plane, the height of the anterior face, the height of the posterior face and the movement of the molar in the horizontal and vertical directions.[8–10]

The Begg technique is a fixed orthodontic treatment technique that has long been used.[11] Round section

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archwires provide the free tipping motion of crowns.[11,12] The function of the anchorage bend is to open the anterior bite and control anchorage, thereby preventing the tipping of the mesial anchoring molars.[11,12] Correction of a malocclusion Angle Class I bimaxillary protrusion uses Z elastic (intramaxillary elastic combined with intermaxillary elastic Class II) from the first stage of treatment.[11–13] The anchorage bend creates a force vector that acts on the anterior mandibular teeth down and front, whereas on the mandibular molars it is down and back.[10,11,14] Intermaxillary elasticity causes forward and upward force vectors on the mandibular molars as well as down and backward on the anterior mandibular teeth.[10,11,14] An extrusion of the molars will result in a rotation of the mandible backwards and downwards so that the occlusal plane angle increases and the facial height increases.[10,11,14–16]

The Straightwire technique is one of the orthodontic treatment techniques.[2] Orthodontic tooth movement uses sliding mechanics.[1,2] Stainless steel bow wire measuring 0.016 x 0.022 inches is used at the anterior retraction stage so that there is bodily tooth movement, and maximum anchorage is required.[1–3] Maximum anchorage is obtained by bonding the buccal tube to the first and second molars.[2,3] A gable bend is used during retraction functions to increase anchorage control in the molars.[2,3,17] The vector of forces acting on the mandibular molars is forward and downward, whereas in the anterior mandibular teeth it is backward and upward due to archwire deflection.[17] A gable bend on the mesial buccal tube will create a forward and upward force vector of the mandibular molar, whereas in the anterior teeth the force vector is forward and down.[17] Anchorage loss causes the molars to move mesially and there is a forward and upward rotation of the mandible resulting in smaller mandibular plane angles and a shortening of facial height.[17–19]

Alkumru et al. disclosed that the vertical dimension of the face is not affected by the movement of the molar to the mesial.[20] The research results of Tarvade et al. are contrary to the popular opinion that the Begg technique causes greater vertical dimensional height increases than the preadjusted appliances technique (Edgewise and MBT).[15] Based on the data that has been described, it is necessary to conduct a study to investigate the differences between the orthodontic treatments using the Begg and Straightwire techniques on molar position, angle of the occlusal plane, and anterior and posterior facial height.

MATERIALS AND METHODS

An ethics permit was obtained from the Research Ethics Commission of the Faculty of Dentistry, Universitas Gadjah Mada with the number 00435 / KKEP / FKG-UGM / EC / 2020. The research object was secondary data, in the form of an initial 120 lateral cephalograms followed by fixed orthodontic treatments using the Begg or Straightwire techniques, which are appropriate standard requirements by the Faculty of Dental Surgery, The Royal College of Surgeons of England, which provide a clear contrast and sharpness of the image.[21] Lateral cephalograms were calibrated using Corel Draw X5 (Corel Corp., Ottawa, Canada). Inclusion criteria: a. 18–35 years old; b. Angle Class I malocclusion is bimaxillary and bidental protrusion; c. ANB angle 0°–4°; d. upper and lower lips in front of the S line; e. index of orthodontic treatment need/IOTN (Dental health component/DHC) scores 1–3; f. complete number of teeth except third molars; g. network periodontal healthy; h. do not have systemic diseases; i. treatment plan the first four premolars were removed. Exclusion criteria: a. anodontia; b. there are edentulous; c. badly crowded teeth; d. impacted other than the third molars.

Determination of the position of the left mandibular first molar in the horizontal direction was calculated using the Pancherz parameter, namely the linear distance from the mesiobuccal molar cusp to the vertical mandible (Figure 1a). The position of the left mandibular first molar in the vertical direction was calculated using the Pancherz parameter, namely the linear distance of the mesiobuccal molar cusp to the horizontal mandible (Figure 1b). The position of the left maxillary first molar in the horizontal direction was calculated using the Pancherz parameter, which is the linear distance between the mesiobuccal molar cusp to the maxillary vertical (Figure 2a). The position of the first molar of the left maxilla in the vertical direction was calculated using the Pancherz parameter, namely the linear distance of the mesiobuccal molar cusp to the horizontal maxillary (Figure 2b). The occlusal plane angle was calculated using the Steiner parameter (Figure 3a), which is the angle formed from the occlusal plane (overlapping lines of the first molar and premolar) and sella-nasion. The anterior face height was calculated using the Gebeck parameter (Figure 3b), which is the distance between the palatal plane (ANS-PNS) perpendicular to the menton. The posterior facial height was calculated using the Gebeck parameter (Figure 3c), which is the distance between the articular and the mandibular plane (gonion-menton).

The data obtained in this study were tabulated and tested for normality and homogeneity, then analysed using

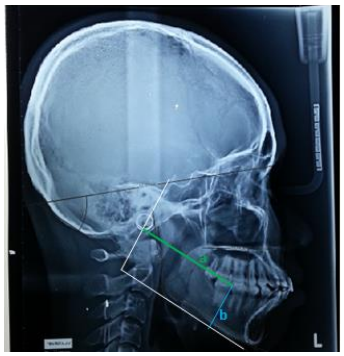

Figure 1. Measurement of the horizontal mandibular molar position (a) and vertical mandibular molar position (b) using Corel Draw X5.

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Figure 2. Measurement of the horizontal maxillary molar position (a) and vertical maxillary molar position (b) using Corel Draw X5.

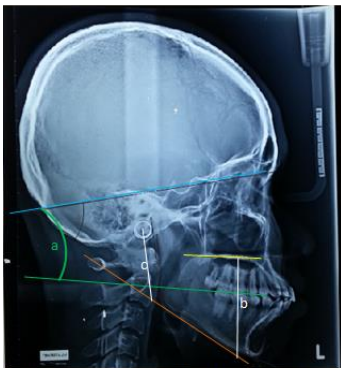

Figure 3. Measurement of the angle of the occlusal plane (a), and height of the anterior face (b) and posterior face (c) using Corel Draw X5.

the parametric test. The change in molar position, angle of the occlusal plane, anterior facial height and posterior facial height before and after orthodontic treatment were analysed by means of a two-way repeated analysis of variance (ANOVA). The relationship between changes in molar position, angle of the occlusal plane, and height of the anterior face as well posterior facial height after orthodontic treatment were analysed using Pearson's parametric correlation and regression. The level of trust that was used in the study was 95% ($\alpha = 0.05$). Analysis was carried out using the Statistical Package for Social Science (SPSS) (IBM, Illinois, US) version 23.

RESULTS

The results showed an increase in vertical maxillary molars, vertical mandibular molars, occlusal plane angle, and anterior and posterior facial height after the Begg technique orthodontic treatment. Decreased horizontal maxillary molars, horizontal mandibular molars, occlusal plane angle, and anterior and posterior facial height were found after fixed orthodontic treatment with the Straightwire technique (Table 1).

There were significant differences between molar positions, occlusal plane angles, and anterior and posterior facial heights after treatments using the Begg and Straightwire techniques ($p = 0.000$) (Table 2). There was no significant difference ($p > 0.05$) in molar position, occlusal plane angle, and anterior and posterior facial height after the Begg and Straightwire orthodontic treatments (Table 3).

Table 1. Mean (x) and standard deviation (SD) values of molar positions, angle of the occlusal plane, and height of the anterior and posterior faces of subjects with orthodontic treatment using the Begg and Staightwire techniques

Variable	Mean ± Standard deviation (SD)			
	Begg		Straightwire	
	Before	After	Before	After
Horizontal maxillary molar (mm)	66.02±6.60	64.94±5.72	67.30±9.34	66.43±7.07
Vertical maxillary molar (mm)	22.25±2.10	22.92±2.41	22.52±2.93	22.88±2.79
Horizontal mandibular molar (mm)	68.35±6.78	67.37±5.54	70.13±9.58	69.66±8.60
Vertical mandibular molar (mm)	27.80±3.48	28.24±3.89	27.54±4.49	28.65±3.76
Occlusal plane angle (°)	22.27± 6.62	23.75±5.29	23.74±5.63	22.61±4.44
Anterior facial height (mm)	64.78±5.26	66.43±5.44	68.16±8.06	66.55±6.46
Posterior facial height (mm)	41.94±5.50	43.17±7.29	41.62±4.96	40.81±4.94

Table 2. Two-way repeated ANOVA test results, molar position, occlusal plane angle, and anterior and posterior facial height of subjects with orthodontic treatment using the Begg and Straightwire techniques

Group	F	Sig.
Treatment stage	73.829	0.000*
Treatment stage * type of treatment	3.296	0.075
Treatment effect	1327.033	0.000*
Effect of treatment * type of treatment	1.417	0.207
Treatment stage * treatment effect	1275.541	0.000*

* significant difference $p < 0.05$

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Table 3. The results of the two-way repeated ANOVA test for molar position, occlusal plane angle, and anterior and posterior facial height between the Begg and Straightwire techniques

Variable	df	F	Sig.
Type of treatment	1	0.742	0.392

* significant difference p <0.05

Table 4. Pearson correlation of fixed orthodontic treatment using the Begg and Straightwire techniques

	Begg		Straightwire	
	Correlation coefficient	Sig.	Correlation coefficient	Sig.
MMxH-MMxV	0.442	0.020	0.442	0.020
MMxH-MMdH	0.442	0.020	0.412	0.020
MMxH-MMdV	0.442	0.020	0.442	0.020
MMxH-SBO	0.415	0.018	0.401	0.020
MMxH-TWA	0.456	0.010	0.455	0.010
MMxH-TWP	0.373	0.023	0.363	0.023
MMxV-MMdH	0.443	0.020	0.423	0.020
MMxV-MMdV	0.443	0.020	0.443	0.020
MMxV-SBO	0.411	0.024	0.411	0.024
MMxV-TWA	0.491	0.006	0.481	0.006
MMxV-TWP	0.414	0.021	0.373	0.023
MMdH-MMdV	0.420	0.020	0.420	0.020
MMdH-SBO	0.391	0.022	0.391	0.022
MMdH-TWA	0.605	0.000	0.565	0.000
MMdH-TWP	0.365	0.022	0.363	0.023
MMdV-SBO	0.420	0.017	0.389	0.022
MMdV-TWA	0.620	0.000	0.590	0.000
MMdV-TWP	0.425	0.014	0.373	0.023
SBO-TWA	0.420	0.017	0.412	0.019
SBO-TWP	0.397	0.021	0.389	0.024
TWA-TWP	0.404	0.019	0.414	0.019

Information:

MMxH: Horizontal maxillary molars MMxV: Vertical maxillary molar SBO: occlusal plane angle
MMdV: Vertical mandibular molar MMdH: Horizontal mandibular molar SWA: Straightwire
TWA: anterior face height TWP: posterior face height

Table 5. Regression of fixed orthodontic treatment using the Begg and Straightwire techniques

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Begg	0.784	0.581	0.359	1.23654
Straightwire	0.759	0.529	0.098	1.67787

Table 6. The results of regression analysis of molar position, angle of the occlusal plane, and height of the anterior and posterior faces on the Begg and Straightwire appliances

	Begg			Straightwire		
	B	t	Sig.	B	t	Sig.
MMxH-MMxV	0.223	0.232	0.019	0.196	0.557	0.023
MMxH-MMdH	0.199	0.764	0.020	0.344	1.170	0.000
MMxH-MMdV	0.158	0.272	0.028	0.383	1.677	0.017
MMxH-SBO	0.106	0.350	0.010	0.211	0.800	0.032
MMxH-TWA	0.194	0.805	0.019	0.239	1.031	0.013
MMxH-TWP	0.356	0.556	0.013	0.281	0.233	0.011
MMxV-MMdH	0.258	0.138	0.008	0.383	0.557	0.023
MMxV-MMdV	0.116	0.189	0.010	0.212	1.170	0.000
MMxV-SBO	0.159	0.033	0.015	0.196	0.715	0.022
MMxV-TWA	0.181	0.318	0.025	0.265	0.752	0.020
MMxV-TWP	0.123	0.055	0.019	0.274	0.112	0.011
MMdH-MMdV	0.139	0.182	0.048	0.383	1.677	0.007
MMdH-SBO	0.139	0.329	0.045	0.101	0.800	0.032
MMdH-TWA	0.450	0.044	0.043	0.281	1.031	0.013
MMdH-TWP	0.379	0.605	0.021	0.239	0.455	0.033
MMdV-SBO	0.233	0.049	0.023	0.129	1.871	0.044
MMdV-TWA	0.638	0.422	0.006	0.426.	1.871	0.044
MMdV-TWP	0.379	0.264	0.011	0.426	0.126	0.039
SBO-TWA	0.214	0.025	0.013	0.204	0.273	0.048
SBO-TWP	0.146	0.030	0.019	0.124.	0.032	0.025
TWA-TWP	0.233	0.542	0.033	0.462	0.780	0.011

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The fixed orthodontic treatment using the Begg and Straightwire techniques showed a correlation in direction and moderate closeness. The effect of vertical mandibular molars on the angle of the occlusal plane has the greatest value when compared to other molars in the Begg technique. Horizontal maxillary molars have the greatest value when compared to other molars in the Straightwire technique (Table 4).

The contribution of molar position, anterior face height and posterior face height is 58.1% on the angle of the occlusal plane in the Begg technique and 52.9% in the Straightwire technique (Table 5). There was significant influence between the four variables in both the Begg and Straightwire techniques ($p > 0.05$). Each 1 mm increase in horizontal maxillary molars, vertical maxillary molars, horizontal mandibular molars and vertical mandibular molars caused the occlusal plane angles to increase by 0.106°, 0.159°, 0.139° and 0.233°. An increase in the angle of the occlusal plane by 1° cause the anterior and posterior facial heights to increase by 0.214 mm and 0.146 mm. The results of the regression analysis on the Straightwire technique showed that every 1 mm increase in the horizontal maxillary molar caused the occlusal plane angle to increase by 0.211° (Table 6).

DISCUSSION

This study found that there were changes in molar position, occlusal plane angle, and anterior and posterior facial height after orthodontic treatments with the Begg and Straightwire techniques. The after-treatment effect of the Begg technique causes the maxillary molars to extrude and move mesially, and the angle of the occlusal plane and the anterior and posterior facial height to increase, while the treatment effect of the Straightwire technique causes the maxillary and mandibular molars to move mesially and extrude, and the angle of the occlusal plane and the anterior and posterior facial height to decrease, which shows a statistically significant difference.

Molar extrusion and mesialization in the Begg technique are probably due to the use of intramaxillary elastic. Maxillary molars receive orthodontic force from the use of intramaxillary elastic for retraction and the use of an anchorage bend is intended to prevent anchorage loss as well as to avoid a deep bite due to anterior retraction.[10,11] Use of an anchorage bend to the mesial buccal tube causes the molar to tip distally. This force can be neutralised by using intramaxillary elastic as the molars will receive an anterior force from the intramaxillary elastic. The anchorage bend angle used in the treatment of the subject was 30–45° and dynamic because it was adjusted to the subject's overbite each time the control is carried out. Intramaxillary strength was ¼ light to ¼ medium or 2.5–4.5 oz. The maxillary molars remain in the initial position, but if the anchorage bend angle is too small or the use of the intramaxillary elastic is too strong, the maxillary molars can extrude and move mesially as in the results of this study.

The retraction in the Straightwire technique consists of two stages, namely canine retraction followed by anterior/incisor retraction, which can cause the molars to move mesially. Efforts to prevent molar mesialization include using a gable bend that serves as anchorage preparation. The decrease in the occlusal plane angle and facial height are due to molar mesialization. Maxillary and mandibular molars receive orthodontic force through the use of a powerchain and gable bend that are fixed during orthodontic treatment. The molars tip distally due to the use of a gable bend.[17] It is intended that the molars remain in their position when the retraction stage starts using the powerchain because the molars act as anchorage.[2,11] Not all orthodontists use a gable bend as this can make it easier for molars to move mesially. The use of force for retraction is 100–250 grams, however, the use of this force is less certain because a tension gauge is not used. A force that is too large is also one of the causes for a molar to move mesially.[11] The shorter height of the anterior face despite molar extrusion could be due to the vertical movement of the molar being smaller than the horizontal movement, or the molar extrusion being smaller than the mesial to the molar shift. The movement of molar to mesial can also be caused by the principle of bodily motion in the Straightwire technique so that the molar as anchorage moves mesial.[2,11] During the finishing stage of this technique, both box elastic and intermaxillary Class II elastic were used.[11,18] The use of elastics can cause the extrusion of molars. Other factors that lead to molar extrusion include placing the buccal tube deeply into the gingival.[2,11]

The changes that occurred after orthodontic treatment using both the Begg and the Straightwire techniques were not statistically significant. This could be due to the difference in the values of the two techniques that are not very dissimilar. The results of this study are the same as those of Tarvade et al., who stated that there was no significant difference in facial height increase between the Begg and preadjusted (MBT) technique treatment groups.[15] The results of the correlation test for fixed orthodontic treatment using the Begg and Straightwire techniques show that there was a moderate correlation between the angle of the occlusal plane, molar position, and anterior and posterior facial height. In the Begg technique, vertical mandibular molars have the greatest correlation with the angle of the occlusal plane compared to other molar positions, indicating that the tooth has the greatest influence on the angle of the occlusal plane. For each increase in vertical mandibular molars by 1 mm, there is an increase in the angle of the occlusal plane by 0.233°. This could be due to the use of intramaxillary elastic, Class II intermaxillary elastic and the use of an anchorage bend to open the anterior bite. Bratu et al. stated that when intermaxillary elastic is used throughout the day, the effect of the vertical component is much greater than that of the horizontal component.[22]

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In the Straightwire technique, horizontal maxillary molars have the greatest value compared to other molar positions. For each increase in horizontal maxillary molar by 1 mm, there will be an increase in the angle of the occlusal plane by 0.196°. A study by Chandra et al. reported that mandibular molars moved mesially by 2.26 mm.[23] This could be due to the application of excessive force and the eruption of the third molars.[23,24] Some of the study subjects had impacted third molars and some of the third molars had erupted. According to Nanda, a maximum anchorage with two molars as anchors will still have a 25% chance of moving the posterior teeth mesially.[17] This study used different cephalogram instruments. Efforts to overcome this, namely by calibration of the lateral cephalogram and a validity test of the head length (glabella-occipital), were carried out between the patient and lateral cephalogram. Suggestions for further research need to be carried out in prospective studies with the same cephalogram instrument.

Based on the research results, it can be concluded that the molars extruded and mesialized, and the occlusal plane angle and height of the anterior and posterior faces increased after the Begg technique treatment. The molars moved mesially and occlusally and there was a decrease in the occlusal plane angle and the heights of the anterior and posterior faces after treatment with the Straightwire technique. However, there was no difference between the two techniques.

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