CHANGE IN THE POSTERIOR OCCLUSAL PLANE VERSUS CLINICAL OUTCOMES

By

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To my family and friends for all their support

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LIST OF ABBREVIATIONS

AFH	Anterior Face Height
AP	Anterior-Posterior
APDI	Antero-Posterior Dysplasia Indicator
FH	Frankfort-Horizontal
MPA	Mandibular Plane Angle
ODI	Overbite Depth Indicator
OJ	Overjet
OP	Occlusal Plane
PFH	Posterior Face Height
POP	Posterior Occlusal Plane

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The etiology of malocclusion is multifaceted, with contributions from skeletal growth, dental eruption, genetics, environment, and many other areas. Most studies tend to focus on the anterior-posterior dimension of the dentition in an attempt to achieve ideal molar and canine relationship. This is a retrospective cephalometric study to look at the vertical component of the development of the occlusion. One hundred fifty two Class II and 25 Class III pre- and post-treatment lateral cephalograms were analyzed for the following measurements: posterior occlusal plane angle, overjet (OJ), antero-posterior dysplasia indicator (APDI), saddle angle, ANB , MPA, posterior face height, anterior face height, gonial angle, vertical height of maxillary first molar(U6) and vertical height of mandibular first molar(L6). There was no significant correlation in subjects with a Class III malocclusion between OJ and ANB with any of the other variables except between ANB and APDI, most likely due to the small sample size. In Class II subjects however, there was significant correlation between ANB and OJ with posterior face height, anterior face height, vertical height of U6 and vertical height of L6. These results show that for Class II patients, the change in vertical position of the upper and lower molars influenced their final anterior-posterior position towards correction to a

Class I occlusion. This suggests that treatment modalities might need to be modified to take into consideration the vertical dimension of occlusion.

CHAPTER 1
INTRODUCTION

The etiology of malocclusion is multifaceted, with contributions from skeletal growth, dental eruption, genetics, environment, and many other areas. In orthodontics it is important to be able to diagnose malocclusions and identify potential contributing factors. Most studies tend to focus on the anterior-posterior dimension of the dentition in an attempt to achieve ideal molar and canine relationship. However, the vertical component of occlusion may be just as important in diagnosis and treatment. Previous research has shown that there is a strong correlation between inclination of the posterior occlusal plane (measured from the buccal cusp of the maxillary second premolar to the cusp of the maxillary first molar with the Frankfort-Horizontal reference plane) and development of Class II or Class III Malocclusion[1]. (Figure 1-1)

In addition, a steep posterior occlusal plane was found to be correlated with smaller mandibular lengths and ramus heights.[2] This suggests that the occlusal plane angle might be related to deficient mandibular growth and/or the backward rotation of the mandible that is often seen in patients with a Class II malocclusion. It is also believed that the steep angulation of the posterior occlusal plane prevents the mandible from rotating forward to try to correct the malocclusion.[4]

While Class II malocclusions show a steeper posterior occlusal plane, Class III malocclusions tend to show flatter posterior occlusal planes.[4] The more acute the angle between the posterior occlusal plane and the Frankfort-Horizontal plane, the more forward the mandible tended to be.[4] No studies to date have looked at the treatment effects related to changes in the posterior occlusal plane and Class III treatment. Although numerous other factors are involved in the etiology of malocclusion, it is reasonable to suggest that changes to the occlusal plane inclination have the potential to influence mandibular position and thus help to correct anterior-posterior malocclusions. The aim of this project was to examine the changes in the posterior occlusal plane with the correction of Class II and Class III patients with they hypothesis that Class II and Class III malocclusions can be treated to a stable result by altering the posterior occlusal plane.

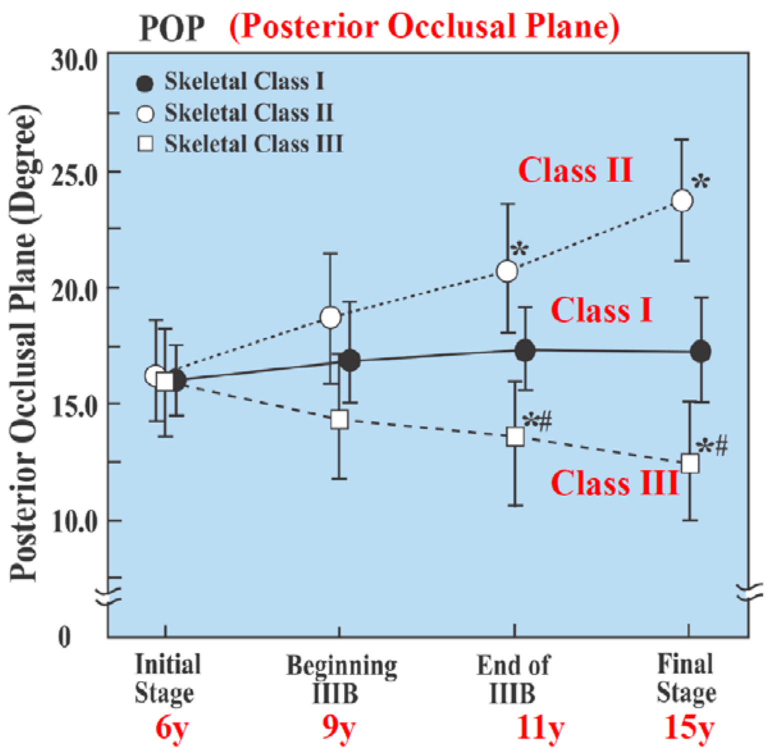

Figure 1-1. Changes in Inclination of Posterior Occlusal Plane with Age

CHAPTER 2
METHODS

This is a retrospective study with the sample consisting of 25 Class III patients previously treated at the Department of Orthodontics at the University of Florida College of Dentistry as well as those treated in private practice by Jorge Coro, DMD and 152 Cl II patients from the archives at the University of Florida.[5] Cl III patients were selected based on negative overjet pre-treatment and the availability of pre- and post-treatment lateral cephalograms. Cl II patients were selected based on pre-treatment Cl II molar classification and availability of pre- and post-treatment lateral cephalograms. Lateral cephalometric x-rays taken before and after treatment were analyzed for the following measurements:

Posterior Occlusal Plane (POP) Angle (FH-OP)	Angle between the line extending from the cusp tip of the maxillary second premolar to the midpoint of the maxillary second molar at the occlusal surface and the Frankfort-Horizontal plane extending from porion to orbitale. (Figure 2-1)
Overjet	Distance measured from the labial incisal edge of the most protruded maxillary incisors to the labial incisal edge of the most protruded mandibular incisor.
Antero-posterior Dysplasia Indicator	Sum of the angle between the Frankfort-Horizontal Plane and the Facial Plane (the line extending from Nasion to Pogonion), the angle between the A-B plane and the Facial Plane, and the angle between the Palatal plane and the Frankfort-Horizontal Plane. (Fig. 3)
Saddle Angle	Inferior angle formed by lines connecting Nasion, Sella, and Basion.
ANB Angle	Inferior angle formed by lines connecting A point, Nasion, and B point.
MPA	Angle between Porion-Orbitale and Menton-Gonion
Posterior Face Height (PFH)	Vertical distance from Gonion to Horizontal Reference Line

ANTERIOR FACE HEIGHT (AFH)	Vertical distance from Menton to Horizontal Reference Line
GONIAL ANGLE	Interior angle formed by Articulare, Gonion, and Menton
VERTICAL HEIGHT OF U6	Vertical distance from U6 to Horizontal Reference Line
VERTICAL HEIGHT OF L6	Vertical distance from L6 to Menton-Gonion

Descriptive statistics and graphical techniques were used to characterize the data. Correlation between baseline variables and changes over time was evaluated using parametric Pearson correlation coefficients and nonparametric Spearman rank correlation coefficients.

Linear mixed models were used to examine changes in overjet as a function of posterior occlusal plane angle, initial overjet, antero-posterior dysplasia indicator, age, sex, and treatment time. In this framework, the correlation between multiple measures within a subject over time is taken into account, and the pattern of change and/or stability and factors affecting this can be examined. Interactions between variables and model diagnostics were examined. A p-value of less than 0.05 was considered statistically significant.

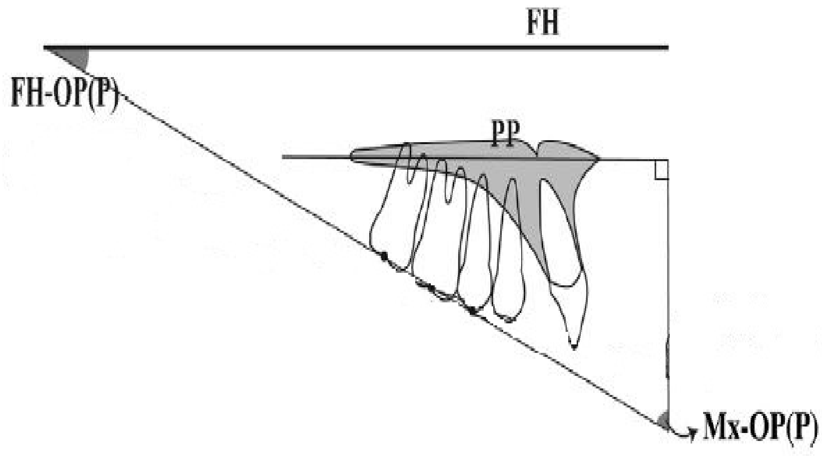

Figure 2-1. Posterior Occlusal Plane Angle

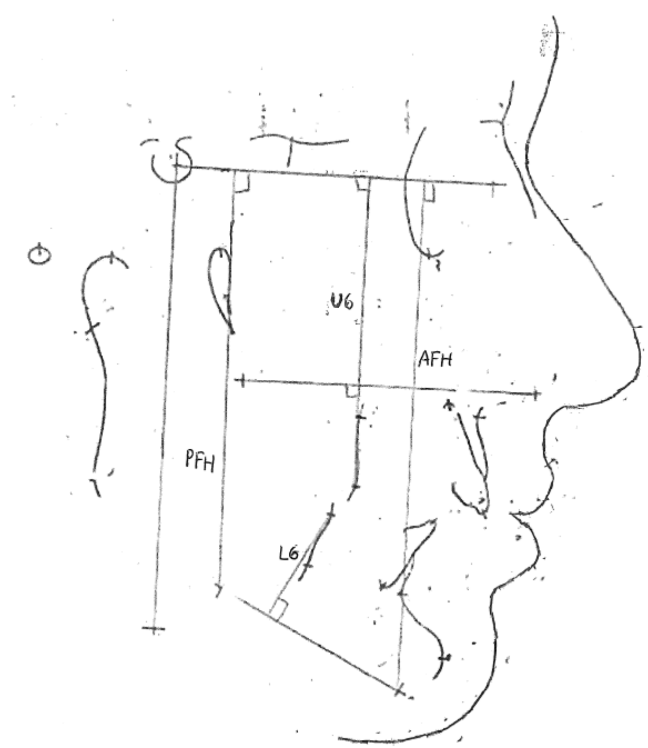

Figure 2-2. Addtitional Measurements:Vertical Height of U6, Vertical Height of L6, Posterior Face Height, Anterior Face Height

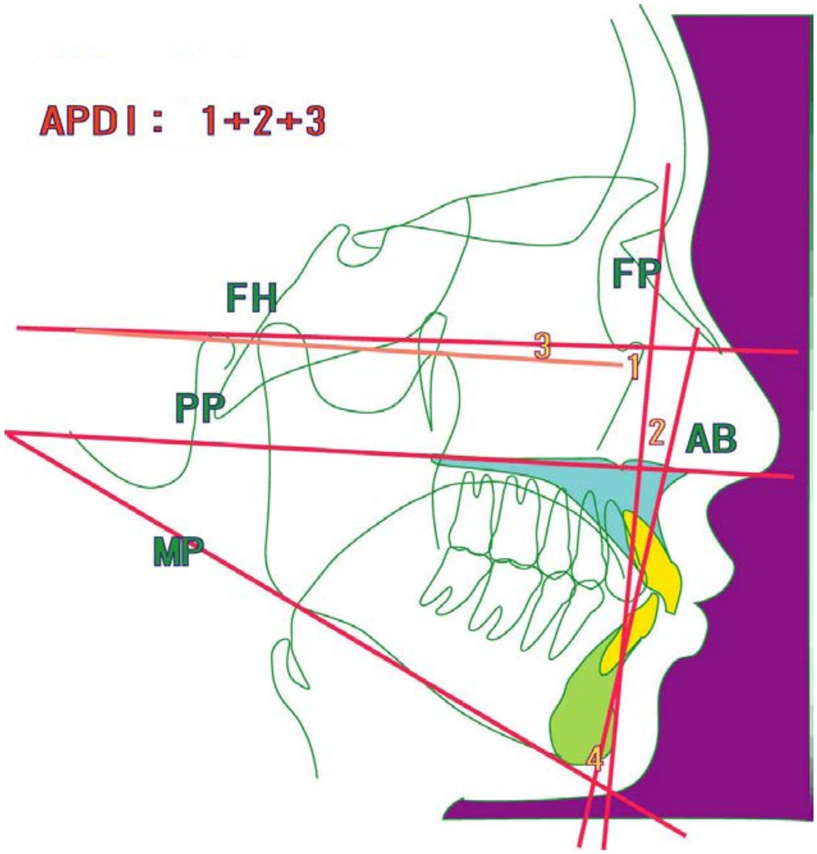

Figure 2-3. Antero-posterior Dysplasia Indicator

CHAPTER 3
RESULTS

There was no significant correlation in Class III patients between OJ correction or ANB with any of the other variables besides ANB with APDI, which had a correlation coefficient of -0.79 and a p-value less than 0.0001 (Figure 3- 1). The lack of other significant correlations was most likely due to the small sample size. In Class II patients however, OJ correction was significantly correlated with U6, L6, AFH, and PFH while ANB was significantly correlated with PFH only (Figure 3-2). Mixed model analysis showed correlation coefficients as high as 0.66 (Table 3-1). However, further analysis of the Class II data show that there are no significant differences between subjects treated with either one-phase or two-phase treatment in the vertical dimension outcomes examined (Figure 3-3).

	POP	MPA	Saddle Angle	APDI
ANB	-0.09 (0.69)	0.11 (0.59)	-0.014 (0.94)	**-0.79 (<0.0001)**
OJ	-0.20 (0.38)	0.08 (0.70)	-0.12 (0.57)	-0.24 (0.25)

Figure 3-1. Class III Correlation coefficients. (P-values)

	U6	L6	AFH	PFH
ANB	-0.08 (0.26)	-0.01 (0.85)	-0.10 (0.13)	**-0.30 (<0.0001)**
OJ	**-0.15 (0.03)**	**-0.14 (0.04)**	**-0.18 (0.006)**	**-0.24 (0.0003)**

Figure 3-2. Class II Correlation Coefficients (P-values).

Table 3-1. Class II Mixed model correlation coefficients.

Variables	R^2
ANB	0.52
ANB + MPA	0.60
ANB + L6 + PFH	0.66

	PFH	AFH	U6	L6
Headgear	1.40 (0.47)	1.49 (0.47)	1.04 (0.33)	0.46 (0.20)
Bionator	1.53 (0.60)	1.47 (0.42)	1.06 (0.32)	0.44 (0.18)
Control	1.47 (0.51)	1.47 (0.45)	1.06 (0.31)	0.44 (0.18)

Figure 3-3. Change in mm from baseline to end of treatment in vertical variables with respect to treatment modality. No changes were statistically significant. (Standard deviation)

CHAPTER 4
DISCUSSION

Traditionally, molar classification has been viewed as an anterior-posterior (AP) problem and treatment has been focused on this dimension of occlusion. For example, in previous studies at the University of Florida, the Johnston analysis was used to determine the AP changes during Class II treatment [5]. Vertical changes were examined using a centrographic analysis[7], but no vertical measures were made. The centrographic analysis used 5 triangles based on craniofacial landmarks from which 5 centroids were determined and used as reference points. It is reasonable to assume that because Class III and II problems are assessed in the sagittal plane that treatment should be focused on this plane, however, as shown by this study, the vertical dimension may also be important and should be considered. Previously Zhou[6] has shown that molar classification did not match the anterior-posterior assessment of skeletal jaw-base relationship in up to 30% of subjects, therefore there might be something else contributing to sagittal classification. To date, no research on Cl III patients has been done to compare overjet with the occlusal variables used in this study. The data provided here show no correlation except between ANB and APDI, which is reasonable considering they are both indicators of sagittal discrepancy. Changes that occur to the posterior occlusal plane would necessitate a change in the vertical at either the anterior or posterior occlusion. Tanaka and Sato[4] concluded a possible relationship between posterior occlusal plane inclination and the position of the mandible, namely, the flatter the posterior occlusal plane angle, the more forward the mandible tended to be. Changes in the inclination of the posterior occlusal plane could alter the position of the mandible relative to the maxillary teeth as well as induce a condylar adaptive response to the new position[3]. This is supported by this study which showed that changes in the vertical positioning of the upper and lower molars as well as changes in facial height can help predict final molar classification in the Class II subjects.

Current treatment (Herbst, Forsus, Bionator, Facemask, etc.) focuses on sagittal correction but actual correction might be dependent on other dimensions such as vertical changes. Treatment which incorporates vertical changes (i.e. Headgear, Utility arch, Multiloop Edgewise Archwires (MEAW), etc) might lead to more predictable treatment outcomes. To date, studies have only looked at Cl 2 correctors and their impact on facial height and changes in the MPA although none have looked at actual vertical changes in molar positions or inclinations of the posterior occlusal plane. Siara-Olds[8] looked at the Bionator, Herbst, Twin-Block and Mandibular Anterior Repositioning Appliance (MARA) and found that the Twin Block was best at controlling the MPA while Oztoprak[9] compared the Sabbagh Universal Spring with the Forsus and found that neither produced any statistically significant changes in the vertical dimension with regards to facial height although there was clockwise rotation of the occlusal plane due to intrusion of the upper molars from the headgear effect.

Limitations of this study included small sample size for Cl III patients which could contribute to the lack of statistically significant findings. Another limitation was the analysis of only growing adolescents for the Cl II portion; this may confound the results and should be supported by additional research on non-growing subjects.

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CHAPTER 5
CONCLUSION

Although more research is needed, this data shows that for Cl III patients there was significant correlation between ANB and APDI but not with any other variables. For Class II patients, the vertical position of the upper and lower molars influenced their final anterior-posterior position. This suggests that treatment modalities might need to be modified to take into consideration the vertical dimension of occlusion.

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BIOGRAPHICAL SKETCH

Lauren Kovaleski was born and raised in Panama City, FL where she graduated from Bay High School in 1999. She subsequently went to the University of Florida where she received a Bachelor of Science degree in mathematics. She took a year away from academics to pursue volunteerism with AmeriCorps NCCC from 2005-2006. She then went to the University of Pennsylvania and earned her Doctorate of Dental Medicine degree in 2010. She received a Master of Science in dental sciences as well as a certificate in orthodontics from the University of Florida in 2013.