# OCCLUSAL PLANE CHANGE AS A PREDICTOR FOR CLASS II CORRECTION

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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To Melissa and Grace, for bringing me peace

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Introduction: The aim of this study is to correlate occlusal plane inclination change with molar and canine classification correction. Methods: The subjects for this retrospective study had participated in a prospective, longitudinal, randomized clinical trial designed to examine the effectiveness of early treatment with headgear/biteplane (H) or a bionator (B), compared to observation (O), among subjects with a Class II malocclusion. The occlusal plane changes were measured as angular changes in relation to cephalometric planes. Dental casts were used to score molar and canine classification from 0 to 10, with most in the range of 1 to 5 (1= full cusp class II and 5 = class I). Data were collected at the start of treatment (DC1) and at various time-points until the end of treatment (DCF). Results: These data indicate that changes in molar and canine classification over the course of treatment did not differ significantly for those with bionator or headgear early treatment or adolescent comprehensive treatment. A mean counterclockwise movement of the occlusal plane was observed in this sample of treated Class II subjects. Conclusion: Angular changes as measured to the occlusal plane were small and were not correlated with the changes in molar and canine classification

# CHAPTER 1
# INTRODUCTION

The treatment of malocclusion in orthodontics involves careful diagnosis, thorough treatment planning, and execution of technique that guides and corrects both the mature and growing dentofacial structures. Therefore, the orthodontist must understand the significant growth changes that occur in their patients and relate the changes to occlusion, skeletal relationships and facial profiles. Specifically, in the treatment of jaw discrepancies in the sagittal plane such as those seen in Class II or Class III malocclusions, it has been stated that control of the occlusal plane can facilitate molar classification correction.[1] In addition to the relationship of the jaws, the inclination of the occlusal plane also influences facial esthetics, dental function and occlusion. Therefore, management of occlusal plane inclination should be a fundamental component of orthodontic treatment. The occlusal plane is usually described on a cephalogram as moving in a steepening (clockwise) or flattening (counterclockwise) rotation. Occlusal plane inclination is determined by normal growth and by the mechanics used to treat malocclusions.

Björk and Skieller showed that maxillary growth was not only characterized by anterior-inferior displacement, but also a forward rotation accompanied by a descent of the upper molar region and a simultaneous forward mandibular rotation.[2] Therefore, rotational growth of the maxilla will cause a counterclockwise movement. With similar results, Riolo et al. found in a serial cephalometric study of untreated subjects that natural changes caused the Downs occlusal plane to rotate counterclockwise a mean of 6.15 degrees between the ages of 6 and 16 years [3]. Creekmore and Schudy showed that maxillary molars erupt more than the maxillary incisors, whereas mandibular incisors erupt more than the mandibular molars.[4] [5] These vertical changes explain the counterclockwise rotation of the occlusal plane during growth. Lux and Kim not only described the occlusal plane changes but related their influences on the sagittal dimension.[6]

[7] Both authors reported a counterclockwise rotation of the occlusal plane in untreated groups with good occlusion.

Orthodontic treatment mechanics can be used to manipulate the inclination of the occlusal plane. Proffit states that in a Class II situation, if upper posterior teeth are prohibited from erupting and moving forward, while the lower posterior teeth are erupting occlusally and forward, the resulting rotation of the occlusal plane and forward movement of the dentition will contribute to correction of the Class II molar relationship.[1] The upward and forward movement of the mandibular molar can be achieved with Class II elastics; this will establish the posterior occlusal plane at a higher level, a clockwise rotation of the occlusal plane. Braun and Legan developed a method to define the geometric and mathematical relationships between dental occlusion and rotations of the occlusal plane in the sagittal dimension.[8] Their main conclusion was that for each degree of rotation of the occlusal plane, a half millimeter change in the dental occlusal relationship was found and reasoned that a clockwise rotation would result in a Class II to Class I change.

On the contrary, Sato describes a counterclockwise rotation of the occlusal plane for a Class II correction using the Multiloop Edgewise Archwire (MEAW) appliance.[9] The MEAW technique is predicated on diagnosis of the pre-existing occlusal plane and the therapy aims to reconstruct the occlusal plane based on whether a Class II or Class III correction is needed. Numerous case reports by Sato show a counterclockwise of the occlusal plane for class II correction. In addition, Lamarque and Thompson also documented counterclockwise changes in the occlusal plane of their treated patients.[10] [11]

It has been shown that two major theories on the change of occlusal plane inclination exist. The review of the literature on occlusal plane change due to growth supports an age-related counterclockwise change. A dichotomy exists in regards to thinking of occlusal plane inclination change during orthodontic treatment. The purpose of this study was to analyze longitudinal cephalometric radiographs of a large sample to discern if a predictor exists between occlusal plane inclination change and molar and canine correction.

# CHAPTER 2
# METHODS

The subjects for this retrospective study participated in a prospective, longitudinal, randomized clinical trial designed to examine the effectiveness of early treatment with headgear/biteplane (H) or a bionator (B), compared to observation (O), among subjects with a Class II malocclusion. Details of the study have been previously published.[12] The subjects were stratified before random assignment into one of three groups. Strata included sex, severity of Class II, and severity of initial mandibular plane angle. Severity of Class II malocclusion was classified as mild if they had bilateral half-cusp Class II, moderate if at least one side was three-fourths cusp Class II and severe if at least one side was full cusp Class II. Severity of initial mandibular plane angle was classified into three groups; less than thirty degrees, between thirty and forty degrees, and greater than forty degrees.

Longitudinal cephalometric radiographs were collected at baseline (DC1), at the end of early Class II treatment (DC3) or observation (DC4), at the beginning of fixed appliances (DC7), and at the end of orthodontic treatment (DCF). The cephalograms were traced and digitized by a single calibrated examiner as reported in a previous article.[13] The landmarks used for the current study are shown in Figure 2-1. The sella nasion (SN) plane was constructed from 1) sella and 2) nasion. The Frankfort horizontal (FH) plane was constructed from 3) porion and 4) orbitale. The palatal plane (PP) was constructed from 5) posterior nasal spine and 6) anterior nasal spine. The occlusal plane (OP) was constructed from 7) posterior mean functional occlusal plane and 8) anterior mean functional occlusal plane. Finally, the mandibular plane (MP) was constructed from 9) gonion and 10) gnathion.

Dental casts were used to score molar and canine classification and overjet (upper right central incisor to lower right central incisor) by a single calibrated examiner. The examiner was trained by two faculty orthodontists and intra- and inter-rater reliability was assessed. For intra-rater comparison, over 98% of calls were within plus/minus one category, with exact agreement ranging from 70 to 85%. For inter-rater comparisons, over 93% of calls were within plus/minus one category, with exact agreement ranging from 54 to 85%.

The canine and molar classification scale was measured in quarter cusp increments from 0 to 10, with most scores in the range from 1 to 5 (1= full cusp Class II and 5 = Class I). The scores were then added together to get a total score (TS) (bilateral class I molar and canine TS = 20). Data were collected at the start of treatment (DC1), the end of phase I or 2 years (DC3 or DC4), during phase II treatment (DC7) and at the end of treatment (DCF).

The data was then analyzed comparing the angles formed by the planes identified in Figure 1 with the occlusal plane for each time point. The classification data was also compared to angular changes to determine if a correlation exists between molar and canine classification and change in occlusal plane inclination.

**Statistical Analysis:** Chi-square tests of association were used to test for sample characteristic differences between early treatment groups. Paired t-tests were used to test for differences in angular measurements over time. Analysis of variance was used to test for treatment group differences with regard to changes in the angular measures over time. Pearson correlation coefficient estimates were used to examine correlation between angle changes, and canine classification and overjet changes. A p-value less than 0.05 was considered statistically significant

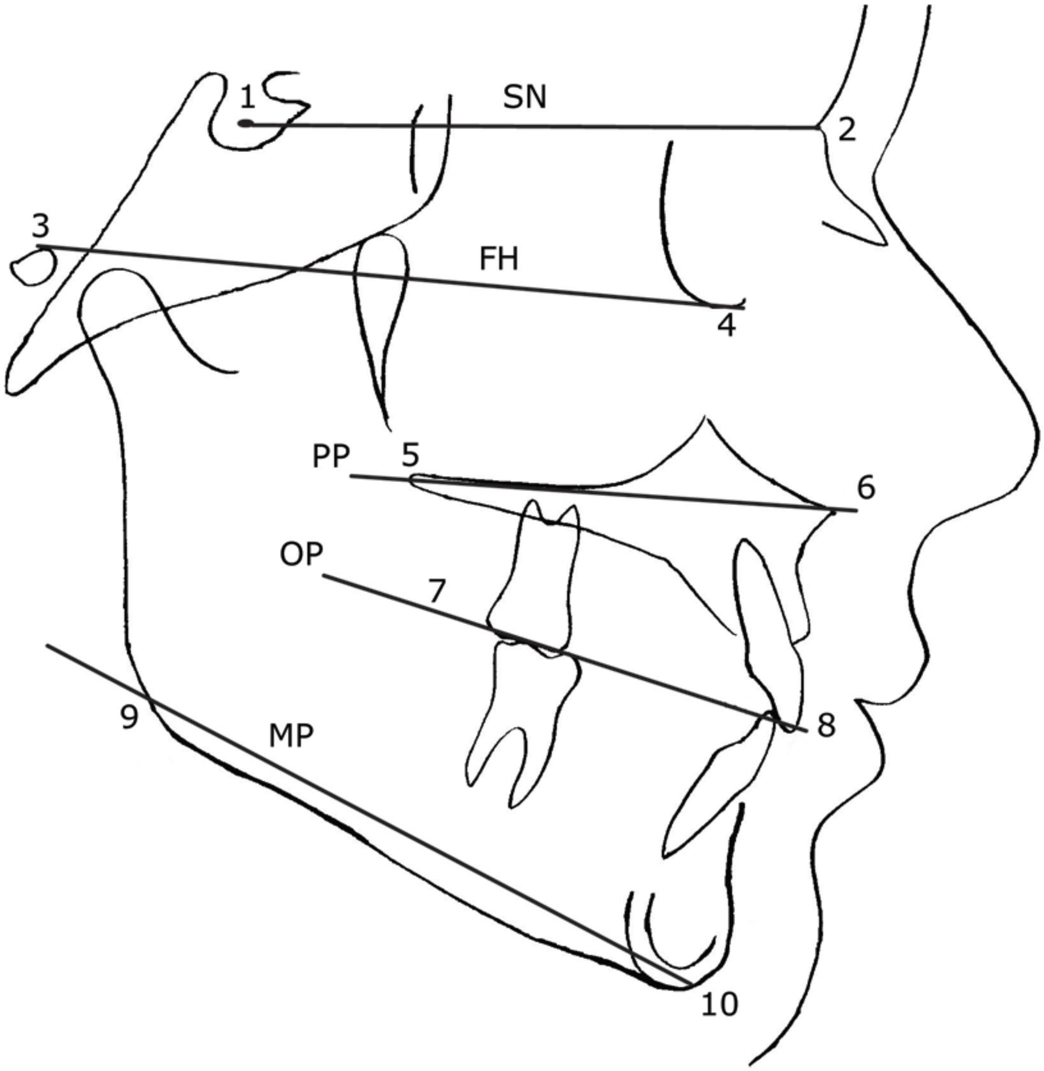


Figure 2-1. Cephalometric landmarks. 1) sella 2) nasion 3) porion 4) orbitale 5) posterior nasal spine 6) anterior nasal spine 7) posterior mean functional occlusal plane 8) anterior mean functional occlusal plane 9) gonion 10) gnathion. Planes: sella-nasion plane (SN), Frankfort horizontal plane (FH), palatal plane (PP), occlusal plane (OP), mandibular plane (MP)

# CHAPTER 3
# RESULTS

Overall, 325 subjects were randomized and baseline data were available for 277 subjects. The sample characteristics are shown in Table 3-1 and include subjects that had canine classification scores at DC3/4 or DCF. The original sample experienced attrition during the study period; therefore not all subjects had data at the initial and final time points. The total number of subjects studied was 259 and did not differ significantly by treatment group, sex, severity of Class II, or initial mandibular plane angle. The predominant racial origin of the sample was white. Two time periods of interest were created to analyze the data; time period 1 included DC1 to DC3/4 data (n = 259) and time period 2 included data DC1 to DCF (n = 211).

All planes were referenced to the occlusal plane for analysis and the angular changes for time period 1 are shown in Table 3-2. The changes were significant for SN-OP, FH-OP, PP-OP, and SN-MP; but they were less than one degree. Furthermore, when looking at angular changes by treatment group in time period 1, small but significant changes were observed. Table 3-3 illustrates that the headgear treatment group had significant changes for the SN-OP angle and FH-OP angle; an increase of $0.76^{o}$ and $0.87^{o}$ respectively. Also, the headgear group had significant changes in the SN-MP angle, an increase of $1.11^{o}$. The bionator treatment group had significant changes for the FH-OP angle, it increased $0.48^{o}$. Finally, the observation group had significant changes for the PP-OP angle, it decreased $0.24^{o}$.

Time period 2 measured both phase 1 and phase 2 treatment. The mean angular changes for each plane referenced to occlusal plane are shown in Figure 3-1. The SN-OP, FH-OP, PP-OP, and SN-MP all exhibited a decrease or counterclockwise movement in their angular measurements. In contrast, the MP-OP angle exhibited an increase or clockwise movement during the complete treatment period.

Treatment success, as measured by canine classification (Maximum score = 10) was observed to be high with 86% of subjects scoring 8 or higher (Figure 3-2). To account for upper premolar extraction patients, both canine and molar classification scores are reported. Overall, no significant differences were noted in occlusal plane angular changes when compared to the change in canine classification (Table 3-4). A significant correlation was found between canine classification and overjet. Table 3-5 illustrates the correlations of the angle changes from initial to final; all angular changes were significant with each other at a level of $p<0.01$.

Table 3-1. Sample characteristics

| | Bionator | Headgear | Observation | Total | P-Value |
|---|---|---|---|---|---|
| Total Patients | 86 | 93 | 80 | 259 | |
| Sex | | | | | 0.9464 |
| (Male) | 52 (60%) | 56 (60%) | 50 (63%) | 158 | |
| (Female) | 34 (40%) | 37 (40%) | 30 (38%) | 101 | |
| Severity | | | | | 0.9856 |
| Severe | 39 (45%) | 42 (45%) | 37 (46%) | 118 | |
| Moderate | 24 (28%) | 29 (31%) | 23 (29%) | 76 | |
| Mild | 23 (27%) | 22 (24%) | 20 (25%) | 65 | |
| MPA | | | | | 0.9441 |
| $<30^o$ | 21 (24%) | 24 (26%) | 18 (23%) | 63 | |
| $30^o$-$40^o$ | 57 (66%) | 63 (68%) | 56 (70%) | 176 | |
| $>40^o$ | 8 (9%) | 6 (6%) | 6 (8%) | 20 | |

Total number (percentage); chi-square test of association

Table 3-2. Angular changes referenced to occlusal plane, initial to end of phase I

| | Initial | End Phase I | Change | P-value |
|---|---|---|---|---|
| SN-OP angle | $19.8^o$ (4.0) | $20.1^o$ (4.0) | $-0.3^o$ (1.4) | 0.0009 |
| FH-OP angle | $7.5^o$ (3.8) | $8.0^o$ (3.9) | $-0.4^o$ (1.7) | <0.0001 |
| PP-OP angle | $12.0^o$ (3.7) | $11.9^o$ (3.8) | $0.1^o$ (0.6) | 0.0405 |
| MP-OP angle | $16.1^o$ (3.8) | $16.1^o$ (4.0) | $0.0^o$ (2.0) | 0.83 |
| SN-MP angle | $36.0^o$ (5.1) | $36.3^o$ (5.5) | $-0.3^o$ (1.9) | 0.0064 |

Mean (standard deviation) sample size (n=234); paired t-tests

Table 3-3. Angular change, initial to end of phase I by treatment group

| | Bionator (n=82) | Headgear (n=90) | Observation (n=62) | P-value^ |
|---|---|---|---|---|
| SN-OP angle | 0.20° | *0.76° | -0.20° | <0.0001 |
| FH-OP angle | *0.48° | *0.87° | -0.20° | 0.0007 |
| PP-OP angle | -0.01° | -0.05° | *-0.24° | 0.0900 |
| MP-OP angle | -0.40° | 0.35° | 0.12° | 0.0403 |
| SN-MP angle | -0.20° | *1.11° | -0.08° | <0.0001 |

Mean; *paired t-test (within groups, differences from zero), ^ANOVA (comparing groups)

Table 3-4. Correlation coefficients of change in classification and angular changes

DC1 to End of Early Treatment

| | Δ OJ | Δ SNOP | Δ FHOP | Δ PPOP | Δ MPOP | Δ SNMP |
|---|---|---|---|---|---|---|
| ΔMC | *0.57 | *-0.25 | *-0.23 | -0.05 | 0.02 | *-0.16 |
| Bionator | *0.57 | -0.08 | 0.00 | -0.01 | -0.01 | -0.07 |
| Headgear | *0.53 | *-0.22 | *-0.22 | 0.12 | 0.02 | -0.14 |
| Observation | 0.19 | -0.05 | -0.06 | 0.03 | 0.19 | 0.21 |

DC1 to F

| | Δ OJ | Δ SNOP | Δ FHOP | Δ PPOP | Δ MPOP | Δ SNMP |
|---|---|---|---|---|---|---|
| Δ CC | *0.56 | 0.00 | -0.04 | 0.03 | -0.14 | -0.15 |
| Bionator | *0.57 | -0.02 | -0.04 | -0.11 | -0.06 | -0.07 |
| Headgear | *0.51 | 0.01 | -0.10 | 0.00 | -0.15 | -0.18 |
| Observation | *0.58 | 0.02 | 0.01 | 0.16 | -0.21 | -0.21 |

Pearson correlation coefficient, *p-value <0.0001

Table 3-5. Correlation coefficients for angular changes, initial to final

| | ΔFHOP | ΔPPOP | ΔMPOP | ΔSNMP |
|---|---|---|---|---|
| ΔSNOP | *0.74 | *0.68 | *-0.55 | *0.46 |
| ΔFHOP | | *0.58 | *-0.55 | *0.19 |
| ΔPPOP | | | *-0.41 | *0.28 |
| ΔMPOP | | | | *0.49 |

Pearson correlation coefficient, sample size (n=200); significance p<0.01

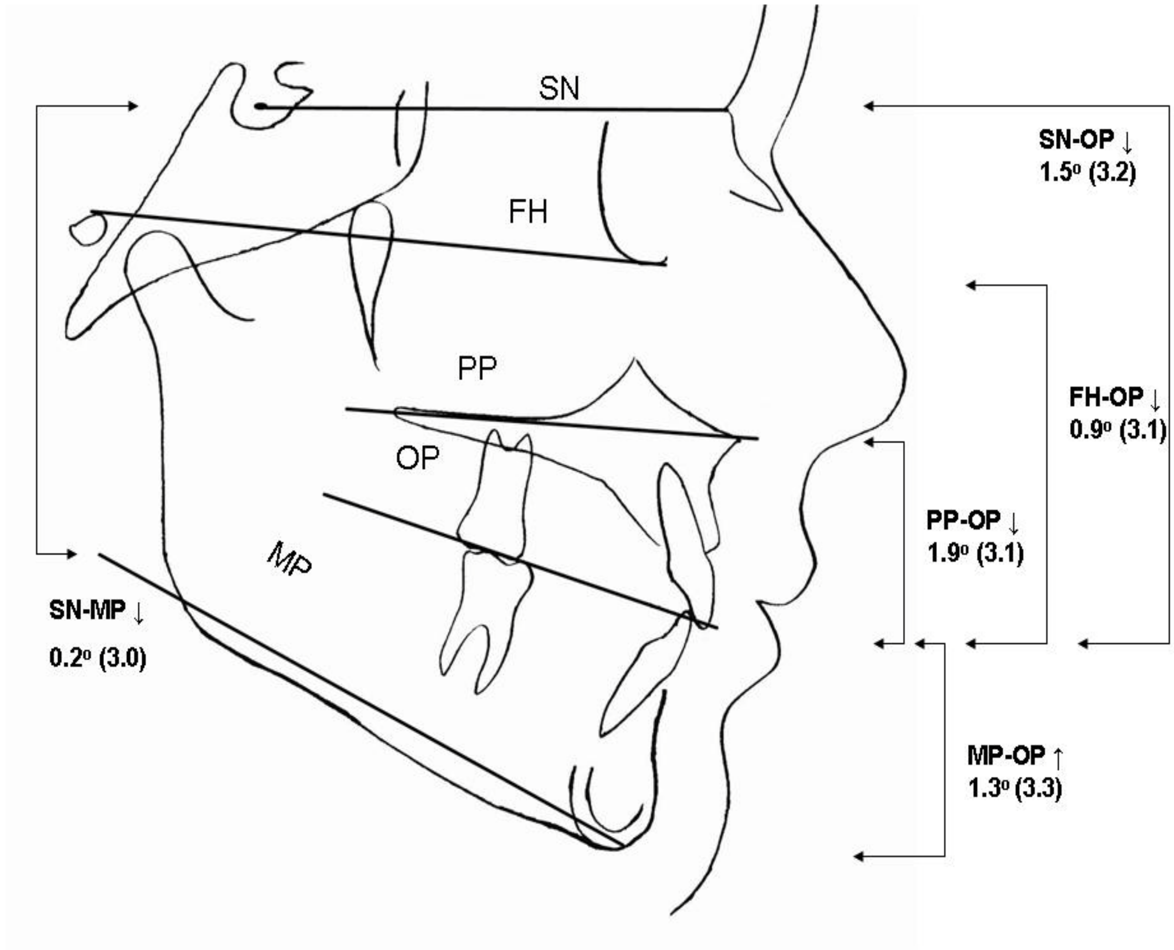


Figure 3-1. Angular changes in relation to occlusal plane from DC1 to DCF. Arrow down corresponds with a decrease in degrees and counterclockwise movement (SN-OP, FH-OP, PP-OP, SN-MP). B) Arrow up corresponds with an increase in degrees and clockwise movement (MP-OP).

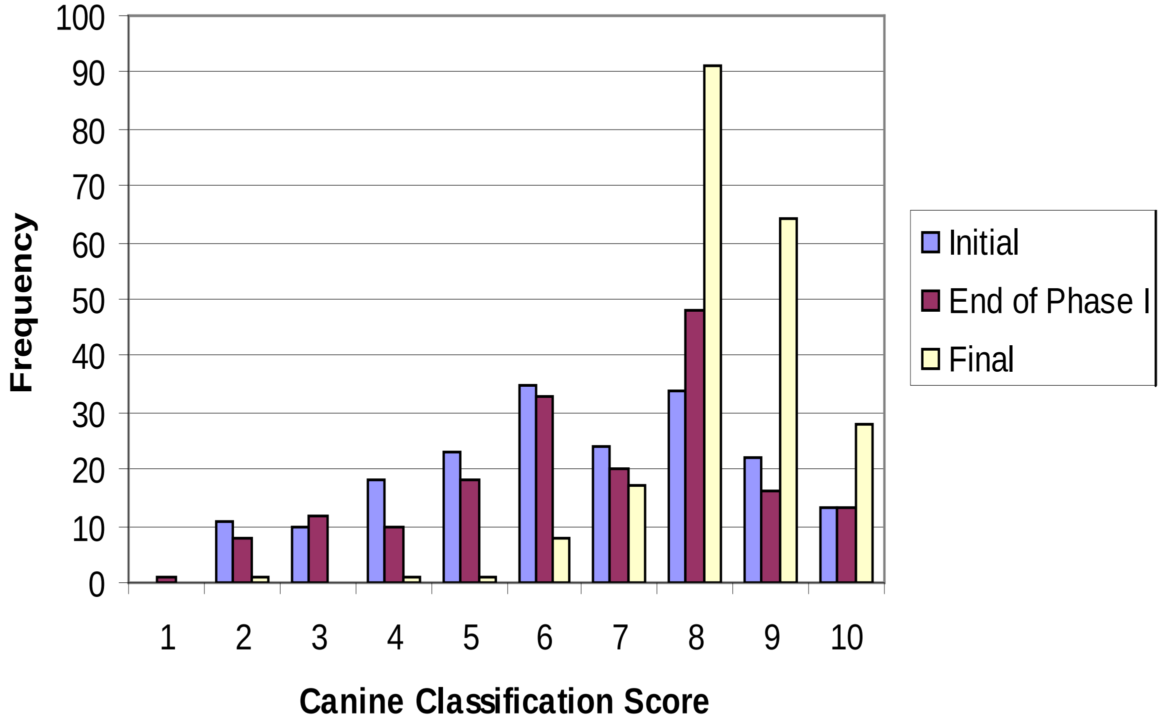


Figure 3-2. Treatment success measured by canine classification score. Right and left canine classification measured 1 to 5. Bilateral class I canine would be scored 10.

# CHAPTER 4
# DISCUSSION

The sample was evenly distributed and provided an excellent opportunity to retrospectively evaluate the effects of Class II treatment on the occlusal plane. Two time periods were created to correct for patient dropout; this also allowed the occlusal plane changes to be examined during phase 1 and phase 2 orthodontic treatment. Molar classification scores were collected and analyzed separately because some subjects received extraction of upper premolars to correct the Class II malocclusion.

Even though statistically significant changes were demonstrated in Table 3-2 and Table 3-3, it should be noted that these changes were less than one degree. The sample size was large overall, so there was a large amount of statistical power to detect small changes. Although the angular changes were small, close examination of Figure 3-1 shows that the overall mean movement of the occlusal plane is counterclockwise. The angles above the occlusal plane all decreased and the angle below the occlusal plane (MP-OP) increased. It was shown that the angular changes were not correlated with canine classification change, but the trend of counterclockwise movement would be in agreement with the results of Sato, Lamarque and Thompson.[9-11] Further the angular changes described in Table 3-5 were correlated with each other and also support a counterclockwise movement, with the positive correlations between SN-OP and FH-OP and the negative correlations with MP-OP.

It is well established that a surgical posterior maxillary impaction will result in autorotation of the mandible and a resultant forward position of the mandible in the sagittal dimension.[14] The oral and maxillofacial surgery community has recognized that the changes in the occlusal plane are a consequence of the surgical rotation of the jaws and not the inherent goal of orthognathic surgery; however they evaluate the rotation of the occlusal plane in their presurgical planning.[15] In this same manner, there has been a recent recommendation to include a more comprehensive evaluation of the occlusal plane in the diagnosis of malocclusion.[16]

The results of this study show that there is not a correlation between angular changes of the occlusal plane and canine classification correction. However, this sample population was treated with a functional Class II appliance (bionator), headgear, or the use of class II elastics. It is possible that evaluating treated samples of other clinicians such as those that routinely use the MEAW technique, a correlation could be found between occlusal plane inclination and class II correction.

It would be interesting to evaluate the different mechanics used to treat class II malocclusion to discern if different treatment modalities affect the occlusal plane in different ways. For example, use of class II elastics may result in more clockwise change by positioning the mandibular molars in a higher vertical position. In the same manner, the use of headgear restricts the downward descent of the maxillary molar and could impose more of a clockwise change. In contrast, the MEAW technique aims to intrude both maxillary and mandibular molars in the beginning of therapy and then aims to position the maxillary molar in a more down and forward position thus imposing a counterclockwise rotation of the occlusal plane and a resultant forward adaptation of the mandible in the correction of Class II malocclusions.[9]

As expected, the study population exhibited a significant change in overjet which was positively correlated with canine classification correction (Table 3-4). Further, as shown in Figure 3-2, an overall trend towards Class I was exhibited by 86% of the sample. Therefore, this population did in fact exhibit Class II correction; however it was not demonstrated to be significantly correlated with occlusal plane inclination. This study measured canine classification as the treatment outcome to be desired. Angle’s molar and canine classification should be considered as a measurement gathered from with the maxillomandibular complex. Another possible way to evaluate the success of Class II treatment would be the anteroposterior position of the mandible, a measurement gathered on the mandible itself. Further research should be conducted to evaluate the effect of occlusal plane inclination on the sagittal position of the mandible.

# CHAPTER 5
# CONCLUSION

This retrospective study of a large Class II patient population evaluated the impact of treatment effects of Class II correction on the occlusal plane. It was shown the angular changes measured to the occlusal plane were small and not significantly correlated with canine classification correction. However, an overall trend of counterclockwise movement of the occlusal plane was exhibited by these study participants during orthodontic treatment. Further research is needed to evaluate specific treatment mechanics to discern if those modalities affect the occlusal plane in ways different than what was observed in this study.

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## BIOGRAPHICAL SKETCH

John J. Metz received his Bachelor of Science in biology in 2002 from Indiana University in Bloomington. He continued his education at the University of Florida College of Dentistry in Gainesville and earned his Doctorate of Dental Medicine in 2006. This thesis is a partial requirement for the degree of Master of Science in Dental Sciences, Orthodontics. He received his M.S. from the University of Florida in the spring of 2009.