ASSESSMENT OF THE "RULE OF THIRDS" INTER-OCCLUSAL DISTANCE RATIO OF ANGLE CLASS I AND II OCCLUSIONS: AN IN VIVO STUDY

A Thesis

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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May 2016

Major Subject: Oral Biology

ABSTRACT

When treatment planning an increase in VDO a dental articulator is used to orient the maxillary and mandibular casts in centric occlusion. The incisal pin can be raised to increase the proposed VDO. This results in more inter-occlusal distance between the anterior teeth than the posterior because of the “arc of closure”. Several studies have mentioned this variation in inter-occlusal distance in the posterior teeth compared to the anterior teeth, specifically at the molar region and central incisors. Rebibo et al, proposed a “Rule of Thirds” explaining that for the same vertical variation, molar height, incisal edge and anterior pin are proportional. The “Rule of Thirds” states that for a 3mm increase at the incisal pin, we obtain a 2mm increase at the incisors and 1mm increase between molars.”

The purpose of this in vivo study was to:

1. Evaluate the validity of the “Rule of Thirds” for facebow-mounted casts on a dental articulator.
2. Assess differences between Angle Class I and II occlusions.

The null hypothesis was there would be no statistically significant difference in the findings of this study and previous studies regarding the “Rule of Thirds”, and there would be no statistically significant difference in the “Rule of Thirds” between Angle Class I and II occlusions.

Thirty participants were selected and impressions of the maxillary and mandibular arches were made with irreversible hydrocolloid. A facebow record was made and casts were mounted in centric relation on a SAM 3 dental articulator. The interocclusal

distance at the second molar was set at 1mm, and measurements at the central incisors, and incisal pin were recorded for data analysis.

Within the limitation of this in vivo study, the following conclusions can be drawn:

1. There was no significant difference between the findings of this study and previous studies regarding the “Rule of Thirds”.

2. There was no significant difference in the incisal vertical point, incisal horizontal point, and incisal pin point, between Angle Class I and II occlusions.

3. The inter-occlusal distance ratio of the second molar to the vertical overlap of the central incisor and incisal pin was approximately 1:1.8:2.9 on the SAM 3 articulator.

4. The inter-occlusal distance ratio of the second molar to the horizontal overlap of the central incisor was approximately 1:0.8.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Nagy, and my committee members, Dr. Kontogiorgos, Dr. Gonzales for their guidance and support throughout the course of this research and my residency.

To my director and mentor, Dr. William Nagy, I sincerely thank you for investing so much into the success of your students. Your genuine passion for teaching is evident and I am all the better for it. Thank you.

Thanks also go to my co-residents, past and present, and the department faculty and staff for making my time at Texas A&M University, Baylor College of Dentistry a great experience.

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1. INTRODUCTION AND LITERATURE REVIEW

The Glossary of Prosthodontic Terms defines vertical dimension of occlusion (VDO) as, “the distance measured between two points when the occluding members are in contact” [1]. For dentate individuals, it is determined by the remaining dentition, and for this reason tooth loss may affect the VDO. For example, loss of VDO in edentulous individuals may significantly effect their oral function, comfort, and appearance. Severe tooth wear may also cause a loss of vertical dimension. However, some authors believe that VDO is constant throughout the individual’s life and suggest that the original VDO is preserved by dentoalveolar compensatory eruption [2].

Altering vertical dimension of occlusion can be a challenging task in restorative dentistry, but there are instances in which it is necessary. The most common reason for increasing the VDO in rehabilitation is the need to create interocclusal space for restorative materials. However, such treatment commits the patient to restoration of at least one full arch in order to establish appropriate occlusal contacts. Clinical studies have discussed the potential negative effects of altering the VDO, such as induction of parafunctional habits, dental pain, fracture of restorations or teeth, temporomandibular pain, and muscle fatigue to name a few [3]. In contrast, a literature review by Rivera-Morales concluded that the masticatory system would be able to adapt to an increase in VDO if occlusal stability is maintained [4]. Abduo discussed the safety of altering the VDO permanently, and although these signs and symptoms may develop, they are usually transitory [5].

When treatment planning an increase in VDO a dental articulator is used to orient the maxillary and mandibular casts in centric occlusion. The incisal pin then can be increased to the proposed VDO. This results in a greater inter-occlusal distance more notably between the anterior teeth than the posterior. This is due to the arc of closure of the mandible, which can be described as "the circular or elliptic arc created by closure of the mandible viewed in the mid-sagittal plane"[1]. As a result, it may require more restorative material be added to the anterior teeth than the posterior teeth in order to maintain occlusal contact and stability. It can also result in more anterior horizontal overlap and lack of coupling.

Several studies have mentioned this variation in inter-occlusal distance in the posterior teeth compared to the anterior teeth, specifically at the molar region and central incisors. Rebibo et al, proposed a "Rule of Thirds" explaining that for the same vertical variation, molar height, incisal edge and incisal pin are proportional. The "Rule of Thirds" states that for a 3mm vertical increase at the incisal pin, we obtain a 2mm vertical increase at the central incisors and 1mm vertical increase second molars [6]. Spear reported that "for every 1mm increase in vertical dimension at the second molar, the vertical dimension at the incisors increases 3 mm" [7]. Okeson also mentioned this relationship in his text regarding occlusal guard fabrication. He stated that, "when the stop maintaining the anterior teeth is 3-5mm apart, this will result in the posterior teeth separation of only 1 to 3mm" [8]. Currently, there are no clinical validation studies for the "Rule of Thirds". Furthermore, no studies correlate the "Rule of Thirds" to the Angle Classification of occlusion. Patients are classified as Angle Class I occlusion when "the mesiobuccal cusp of the maxillary first molar aligned with the mesiobuccal groove of the mandibular first molar [9]. For Angle's Class II occlusal relationship "the first molar relationship is such that the mesiobuccal groove of the mandibular first molar is distal to the mesiobuccal cusp of the maxillary first molar [10].

The purpose of this in vivo study was to:

1. Evaluate the validity of the "Rule of Thirds" for facebow-mounted casts on a dental articulator.
2. Assess differences between Angle Class I and II occlusions.

The null hypothesis was there would be no difference in the findings of this study and previous studies regarding the "Rule of Thirds", and there would be no difference in the "Rule of Thirds" between Angle Class I and II occlusions.

2. MATERIALS AND METHODS

2.1 Pilot Study

All facets of this in vivo study were approved by the Texas A&M University, Baylor College of Dentistry Institutional Review Board. Because Rebibo's study only used one set of casts to make the measurements and no other studies had validated the "Rule of Thirds", a pilot study was done to determined the number of participants required for this study to be statistically significant. Five participantss for both Angle Class I occlusion and Angle Class II occlusion were used to determine the appropriate sample size, and were assigned to pilot groups 1 and 2 respectively. Measurements were made on the facebow mounted diagnostic casts using a digital caliper (Pittsburgh Automotive, CA, USA). The mean and standard deviation were calculated for both groups using SPSS Statistics software (Version 22.0, IBM, USA) and are shown in Table 1. A Pirori - t test was done in G-Power 3.1 software (Erdfelder, Faul, & Buchner, 2009) for both groups with power of 0.60 and 0.80, and are shown in Table 2. Because the "Rule of Thirds" only focuses on the vertical ratio at the anterior teeth and incisal pin, the number of participants needed for this study was selected based on the change at the anterior teeth and incisal pin. Each group required 15 participants for this study to have statistical significance.

2.2 Data Collection

Thirty participants were selected for this study (12 males and 18 females).

Inclusion criteria:

1. Angle Class I and II dentate participants.

2. Permanent dentition in both maxillary and mandibular arches.

Exclusion criteria:

1. History of Temporomandibular joint disorder.
2. Participants who were edentulous in the anterior segment of either arch.
3. Participants who were edentulous at the second molar of either arch.

Impressions of the maxillary and mandibular arches were made with irreversible hydrocolloid (Jeltrate regular set, Dentsply Caulk, Delaware, USA) using disposable plastic trays (President Tray, Coltene/Whaledent Inc, Ohio, USA). Impressions were poured with a type III dental stone (Microstone, WhipMix, Kentucky, USA). Participants were deprogramed with a leaf gauge [11] for 8-10 minutes, and the TMJs were load tested [12] to confirm that the condyles were in the centric relation position. Participants with tension or tenderness on load testing were deprogrammed for an additional 10 minutes with the leaf gauge. A load test was performed again to confirm the muscle skeletal stable position of both condyles. Participants, who still had tension or tenderness on load test in the second attempt, were excluded from this study.

Inter-occlusal registrations were obtained with dead soft bite registration wax tabs (Almore International, Oregon, USA) with the leaf gauge in place after heating in a water bath at 135^{o}F for one minute. Three records were made to verify the mounting of casts using Axiosplit rings (SAM 3® Prazisionstechnik GmbH, Fussbergstrasse 1 • 82131 Gauting bei Munchen). The first point of centric contact was recorded with occlusal interference detection wax (30 gauge O.I.D Wax, New York, USA) using chin point guidance and verified on the mounted casts. An ear facebow record was obtained with a SAM facebow (SAM 3® Prazisionstechnik GmbH, Fussbergstrasse 1 • 82131 Gauting bei Munchen) with orbitale as the anterior reference point, and SAM predetermined axis points [13]. The participant's transverse horizontal axis of rotation was transferred to a semi-adjustable articulator (SAM 3® Prazisionstechnik GmbH, Fussbergstrasse 1 • 82131 Gauting bei Munchen). Both maxillary and mandibular casts were mounted with type III dental stone (Mounting Stone WhipMix, Kentucky, USA), the mandibular cast using the interocclusal wax record.

The mid-buccal gingival margin on the second molar and the highest point of the gingival margin of the maxillary central incisor were identified and marked as reference points. Measurements were made using these points for the interocclusal distance at the first point of centric contact as a baseline by a digital caliper (Pittsburgh Automotive, CA, USA). The distance between the labial surface of mandibular central incisor and labial surface of maxillary central incisor was recorded as the anterior horizontal overlap baseline point. The interocclusal distance at the second molar was increased by 1mm, and measurements at the central incisor points and incisal pin points were repeated for comparison. Because the accuracy of the digital caliper is unknown, each measurement was determined three times and the mean value was used for data analysis. Data were imported to SPSS Statistics software (Version 22.0, IBM, USA) for statistical analysis. Paired t-test was used ($p < 0.05$) to determine if there is a statistical difference between the two groups.

2.3 Data Analysis

The data measurements collected from each cast, within each group were reported in 0.01 mm. Data was analyzed using statistical software (SPSS 19.0, SPSS Inc., Chicago, IL). The descriptive statistics and normality tests were performed for both groups and each group separately with each subcategory (incisal vertical point, incisal horizontal point and incisal pin point).

3. RESULTS

The inter-occlusal distance ratio was not different from the "Rule of Thirds" 1:2:3 ratio as measured at molars:incisors:incisal pin. The descriptive statistics for both Class I and Class II groups are shown in Table 3. With a 1 mm vertical increase at the second molar points, the incisal vertical points increased 1.8 (± 0.4) mm, the incisal horizontal points increased 0.8 (± 0.2) mm, and the vertical points at the incisal pin increased 2.9 (± 0.5) mm.

There was no statistically significant difference between participants with Class I and Class II occlusions as measured at the incisal vertical points ($p=0.489$), incisal horizontal points ($p=0.610$), and the incisal pin vertical points ($p=0.566$). The data for the measurements for Class I and Class II participants is summarized in Table 4 and Table 5 respectively. For Angle Class I occlusions, with a 1 mm inter-occlusal vertical increase at the second molar points, there was an vertical increase of 1.8 (± 0.5) mm at the incisal points, a 0.8 (± 0.2) mm horizontal increase at the incisal points, and a 2.8 (± 0.6) mm vertical increase at the incisal pin. For Angle Class II occlusions, with a 1 mm vertical increase at the second molar points, there was a vertical increase of 1.7 (± 0.4) mm at the incisal points, a horizontal increase of 0.8 (± 0.3) mm at the incisal points, and a vertical increase of 2.9 (± 0.5) mm at the incisal pin. Figure 6 showed the Pair-t tests results between Angle Class I and II occlusions with a significance level set at $p \leq 0.05$.

4. DISCUSSION

The aim of this study was to evaluate the change in inter-occlusal distance at the second molars, central incisors, and incisal pin in Angle Class I and II occlusions after increasing vertical dimension of occlusion. The results show that the Angle Classification does not affect the inter-occlusal distance ratio; therefore the null hypothesis cannot be rejected. The inter-occlusal distance ratio from second molar, to the central incisor, to the incisal pin was approximately 1:1.8:2.9, respectively. Spear stated there is a 1:3 ratio from the second molar to the central incisor [7]. Abduo stated there is a 1:3 ratio from the second molar to the incisal pin [5]. This study found a 1:2.9 ratio from the second molar to the incisal pin, and a 1:1.8 ratio from the second molar to the central incisors. However, there was no statistically significant difference between the results of this study and the previous study regarding the "Rule of Thirds" [6]. This was probably due to the use of a similar type of articulator and cast mounting in both Rebibo's study and the present study. Articulators may have different distances from the axis to the incisal pin. The incisal pin is a "convenience point" without standardized location for maintaining the vertical dimension of occlusion. As a result, the distance between the incisal pin to the second molar point may be different between articulators. Clinically, the inter-occlusal distance ratio should focus on the ratio between the second molar and central incisors.

There is no published evidence regarding a change in inter-occlusal distance at the second molars compared to the horizontal overlap at the central incisors. This study found a 1:0.8 ratio from the second molars to the horizontal overlap at the central incisors.

The maxillary casts were mounted using a SAM arbitrary facebow [13] and the mandibular casts were mounted using centric relation interocclusal records. Both the facebow mounting and inter-occlusal records can affect the arc of closure of the mandible on a dental articulator. A facebow transfer records the relationship of the maxilla to the cranial base and the transverse horizontal axis, however, different facebow systems use different posterior anatomical arbitrary landmarks to locate the axis. If the maxillary cast is mounted with an inaccurate facebow, it may be mounted inferior, superior, posterior, or anterior to its actual relationship to the axis. If the mandibular cast is mounted with a maximal intercuspation record, the relationship of the mandible to the axis will be inaccurate. Consequently, the arc of closure will be different and the "Rule of Thirds" will be also different as seen in Figure 6. Therefore, to acquire an accurate relationship of the maxilla and mandible to the axis, a facebow record and centric relation record are required. Because the vertical dimension of occlusion was increased in this study, centric relation records were used instead of the maximal intercuspation position. The centric relation records provide an accurate relationship of the mandible to the maxilla when the condyles are in centric relation.

The results of this study can have wide clinical implications. This ratio may be of particular importance when evaluating patients who require a change in their vertical dimension. As one increases vertical dimension in the posterior, the change in the anterior relationship could result in loss of coupling due to the 1:1.8 vertical relationship and 1.0.8 for the horizontal relationship. As a result, the anterior restorations would need to compensate for this posterior increase, resulting in an increased vertical height of the coronal portion. This increase in crown height may also produce negative results due to the unfavorable crown to root ratio. Moreover, it could introduce vertical cantilever complications in restorations that are implant supported. Understanding this ratio assists in planning cases that require an increase in vertical dimension, allowing the clinician to appropriately choose the restorative material and maintain coupling for anterior guidance. In another instance, if the occlusal contacts are adjusted and the vertical dimension of occlusion is decreased in order to obtain even and simultaneous contacts, knowing this inter-occlusal distance ratio will assist the clinician's decision when considering an occlusal equilibration or possibly fabricating new restorations. In this study, the occlusal clearance of the anterior is decreased approximately twice as much compared to the posterior when the vertical dimension of occlusion is decreased. An example of this can be seen in the worn dentition when the anterior teeth wear twice as much as the posterior teeth.

In summary, a 3mm increase in vertical opening at the incisal pin on a facebow mounted maxillary cast and centric relation related mandibular cast will have approximately a 1.8mm increase of vertical incisal opening and 0.8 mm of horizontal incisal opening.

Future studies should assess any correlation between skeletal relationships and the "Rule of Thirds". A difference in skeletal relationships may affect the arc of closure, which could potentially change the ratios or the dental relationship of the second molars to the central incisors or incisal pin.

5. CONCLUSIONS

Within the limitation of this in vivo study, the following conclusions can be drawn:

1. There was no significant difference between the findings of this study and previous studies regarding the "Rule of Thirds".
2. There was no significant difference in the incisal vertical point, incisal horizontal point, and incisal pin point, between Angle Class I and II occlusions.
3. The inter-occlusal distance ratio of the second molar to the vertical overlap of the central incisor and incisal pin was approximately 1:1.8:2.9 on the SAM 3 articulator.
4. The inter-occlusal distance ratio of the second molar to the horizontal overlap of the central incisor was approximately 1:0.8.

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APPENDIX A FIGURES

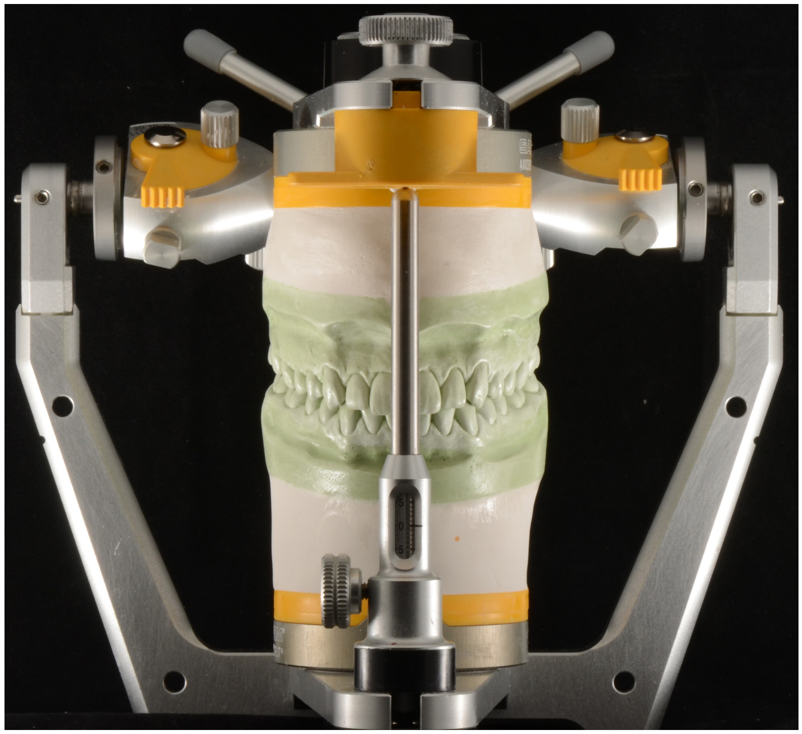

Figure 1. Mounted Casts On SAM 3 Semi-Adjustable Articulator

Figure 2. Vertical Measurement Point At The Molars

Figure 3. Vertical Measurement Point At The Central Incisors

Figure 4. Horizontal Measurement Point At The Central Incisors

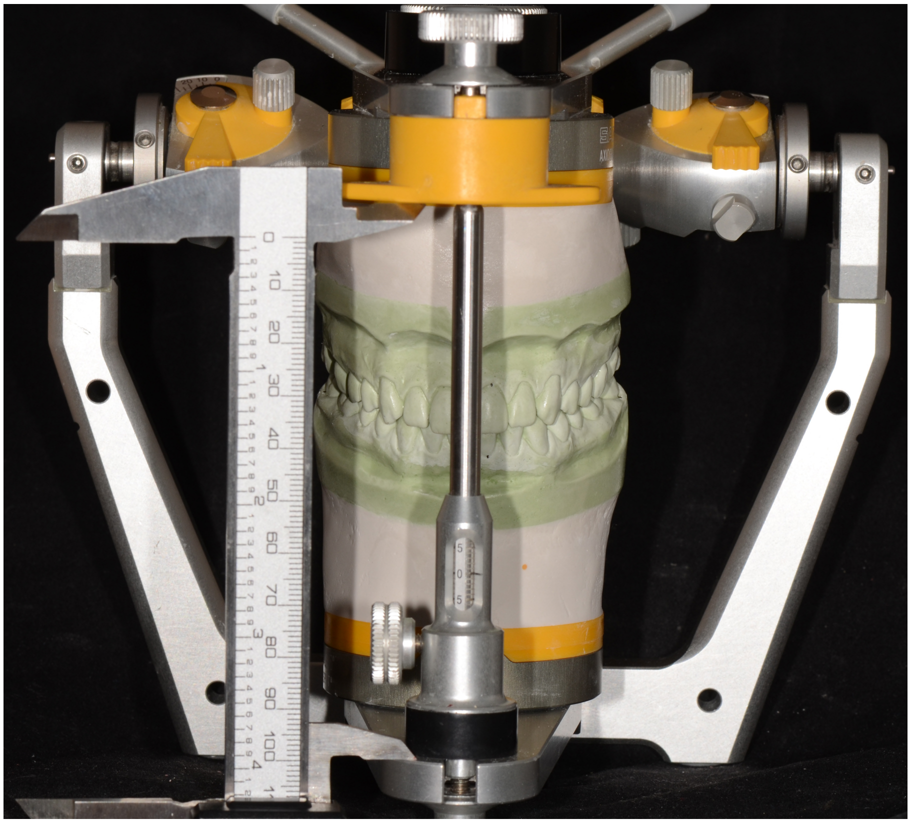

Figure 5. Vertical Measurement Point At The Insical Pin

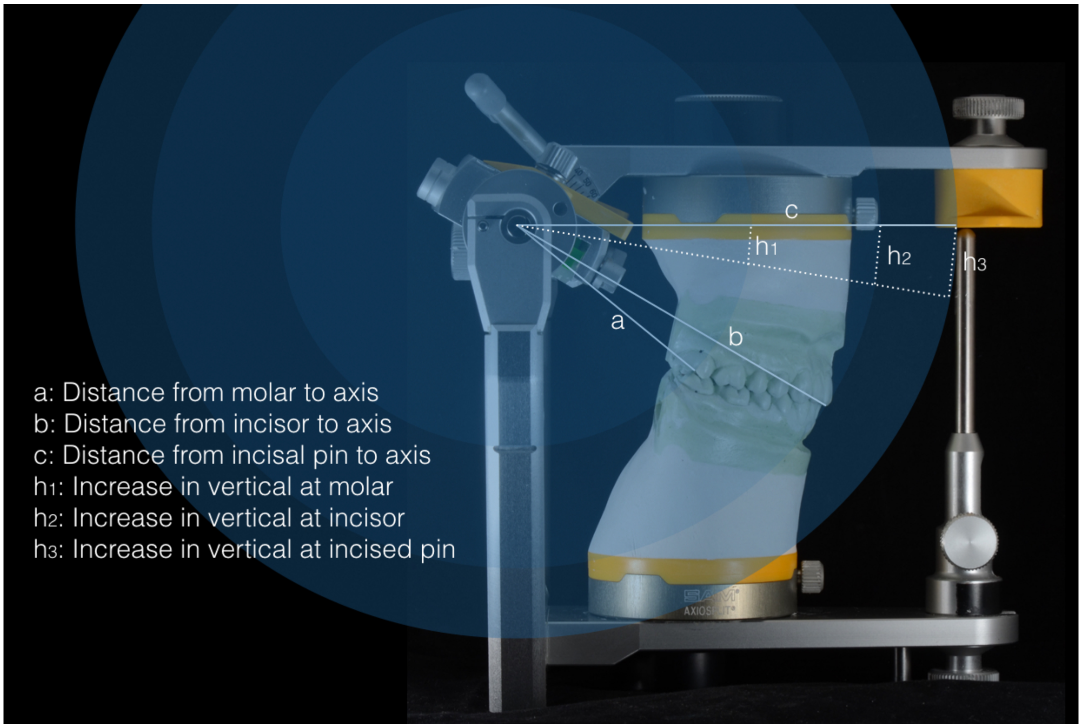

Figure 6. “Arc Of Closure”

APPENDIX B TABLES

Table 1. Descriptive Statistics For Pilot Study					
		Minimum	Maximum	Mean	Std. Deviation
Group 1: Class I	Vertical Point	1.6	2.2	1.8	0.3
	Horizontal Point	0.5	1.0	0.7	0.2
	Anterior Pin Point	2.5	3.2	2.7	0.3
Group 2: Class II	Vertical Point	1.2	1.8	1.6	0.3
	Horizontal Point	0.5	1.4	1.0	0.4
	Anterior Pin Point	2.1	3.9	3.1	0.8

*Measurement in millimeter

Table 2. Pair T-Test For Pilot Study		
	Power of 0.60	Power of 0.80
No. Participants for Vertical Point	7	11
No. Participants for Horizontal Point	24	38
No. Participants for Anterior Pin Point	10	15

Table 3. Descriptive Statistics For Both Groups			
	Overall		
	Incisal Vertical Point (mm)	Incisal Horizontal Point (mm)	Anterior Pin Point (mm)
Mean ± SD	1.8 ± 0.4	0.8 ± 0.2	2.9 ± 0.5
Median	1.7	0.8	2.8
Minimum	1.1	0.3	1.8
Maximum	2.7	1.3	4.3
Normality test*	P=.347	P=.543	P=.144

*Shapiro- Wilk test for normal distribution (α=.05)

Table 4. Descriptive Statistics For Group 1

	Class I		
	Incisal Vertical Point (mm)	Incisal Horizontal Point (mm)	Incisal Pin Point (mm)
Mean ± SD	1.8 ± 0.5	0.8 ± 0.2	2.8 ± 0.6
Median	1.8	0.8	2.7
Minimum	1.1	0.6	1.8
Maximum	2.7	1.2	4.3

Table 5. Descriptive Statistics For Group 2

	Class II		
	Incisal Vertical Point (mm)	Incisal Horizontal Point (mm)	Incisal Pin Point (mm)
Mean ± SD	1.7 ± 0.4	0.8 ± 0.3	2.9 ± 0.5
Median	1.7	0.8	2.9
Minimum	1.1	0.3	2.4
Maximum	2.6	1.3	3.8

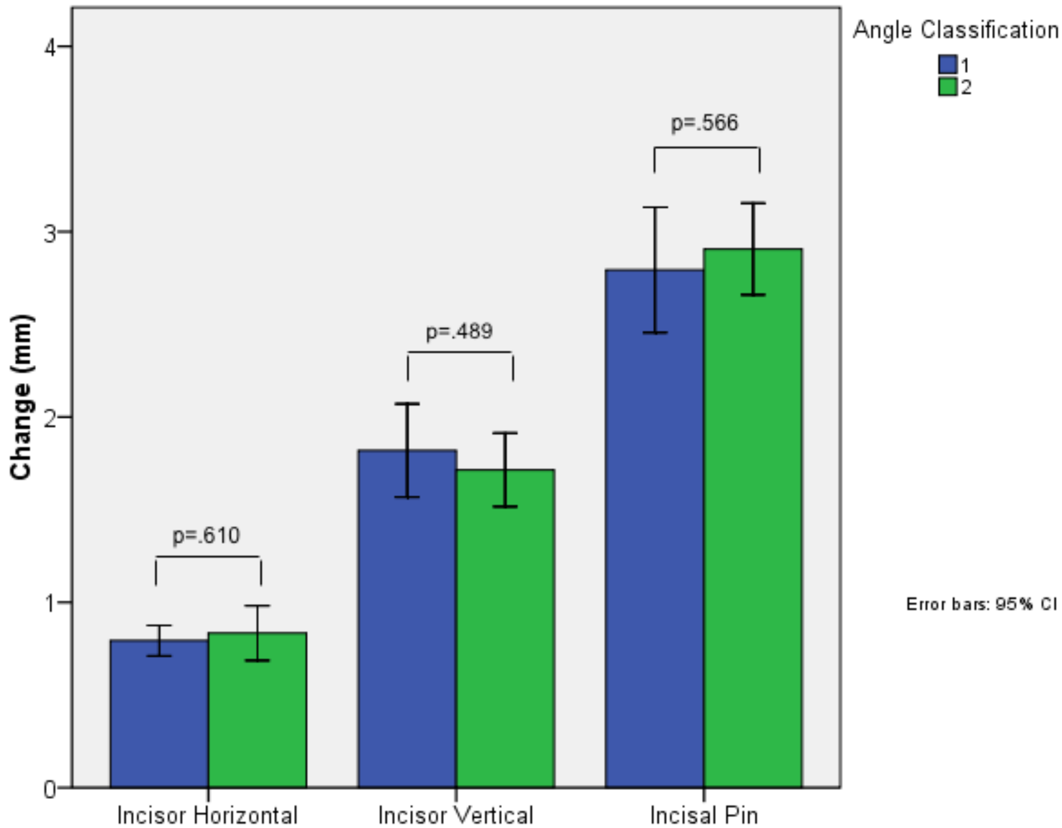

Table 6. Pair T-Test For Group 1 And 2