Comparison of the Skeletal and Dentoalveolar Effects between the Herbst Appliance and the Forsus Fatigue Resistant Device in Class II Correction

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ABSTRACT

This study compared the skeletal and dentoalveolar effects accompanying the correction of Angle Class II malocclusions in patients treated with the Herbst appliance and the Forsus Fatigue Resistant Device (Forsus) in two private practices. The treated samples were also compared to a matched untreated control sample of Class II subjects selected from the American Association of Orthodontists Foundation (AAOF) Craniofacial Growth Legacy Collection. The Herbst group consisted of 38 patients treated with the Herbst appliance in conjunction with fixed appliances. The Forsus group included 38 patients treated with fixed appliances in combination with the Forsus appliance. Lateral cephalograms were made before treatment (T1) and immediately after comprehensive treatment (T2). Subjects in all three groups were matched according to skeletal development. A total of 40 sagittal, vertical, and angular cephalometric measurements were evaluated. Analysis of Variance (ANOVA) and Tukey post-hoc tests were used for comparisons of measurements at T1, their changes from T1 to T2, and at T2. Results showed that the two groups were similar at T1 with regard to maxillary and mandibular skeletal and dentoalveolar relationships. Exceptions were the Forsus group which had a greater Wits appraisal and larger interdental values, both associated with greater maxillary incisor proclination and protrusion at T1. From T1 to T2, the Herbst group exhibited a significantly greater correction in the ANB angle of about 1°, while the Forsus group demonstrated greater dentoalveolar effects. Skeletal results at T2 showed that both appliance groups had a restrictive effect on the sagittal advancement of the maxilla, with the Herbst appliance showing a stronger effect with a significantly greater decrease in the ANB angle by 1.2° and Wits appraisal by 2.4 mm, as well as a significant

increase in the maxillary-mandibular differential. Dentoalveolar comparisons showed forward movement of mandibular incisors in both treatment groups, with the Forsus demonstrating significantly more proclination of the mandibular incisors. Overall, both treatment protocols were effective in the normalization of Class II malocclusions by the end of comprehensive treatment, with the Herbst approach showing a mildly enhanced skeletal effect.

INTRODUCTION

Affecting more than one third of the general population, Angle Class II malocclusions are the most frequent type of malocclusions dealt with in the field of orthodontics.[1] McNamara has demonstrated that the most common characteristic of this form of malocclusion is mandibular skeletal retrusion as opposed to maxillary protrusion.[2] For over a century orthodontists have made use of appliances aimed at functional jaw orthopedics to correct Class II skeletal and dental disharmonies.

The Herbst appliance was first described by Emil Herbst in 1909 as a fixed functional appliance to be used for Class II treatment (Figure 1).[3] After a period of obscurity, Hans Pancherz popularized the appliance during the late 1970's, proposing that mandibular growth modification would occur by continually maintaining the mandible in an anterior, forced position through use of the rigid bilateral telescoping mechanism.[3] Recent studies suggest that the Herbst appliance is effective in correcting Class II skeletal and dental abnormalities by restraining maxillary sagittal growth, promoting mandibular growth, distalizing the maxillary molars, and advancing the mandibular molars and incisors.[4-6] Despite these findings, controversy remains regarding the overall effectiveness of the Herbst appliance, particularly with regard to stimulating mandibular growth.

The Forsus Fatigue Resistant Device (Forsus; 3M Unitek, Monrovia, CA) is a relatively new and widely used fixed functional appliance developed by Bill Vogt in 2001 (Figure 2).[7] Comprised of a semirigid telescoping system that is aimed at protruding the mandible, this appliance has been shown to effectively improve Class II discrepancies

by restraining maxillary sagittal growth, increasing total mandibular length, distalizing the maxillary molars, and advancing the mandibular dentition.[7-9]

Although both appliances have been compared to several other fixed and removable functional appliances,[1, 8, 10-14] no previous study has assessed the effectiveness of the Herbst appliance when compared to the Forsus. The purpose of this study therefore was to determine the skeletal and dentoalveolar effects produced during Class II correction with the Herbst appliance compared to those produced by the Forsus. Main features of this study include the comparison of both treated groups with matched untreated Class II controls and the appraisal of the sagittal, vertical, and angular dental and skeletal changes induced by the appliances.

MATERIALS AND METHODS

Institutional review board approval was obtained from Oregon Health & Science University prior to initiating the study. Approval was also obtained from the orthodontists' offices for the use of the patient records.

The Herbst and Forsus treatment groups each included 38 patients consecutively treated from two private practice settings. The treatment sequences described below are based on protocols used in the practices.

With the Herbst approach, orthodontic treatment started with use of the Herbst appliance in combination with fixed appliance therapy. The Herbst framework included stainless steel crowns attached to the maxillary and mandibular permanent first molars with double buccal tubes on the molar crowns to permit the use of auxiliary archwires. Brackets were bonded to the maxillary and mandibular incisors during the initial phase of treatment to control incisor inclination and mandibular molar movement as necessary. The archwire sequence began with a 0.014-in copper-nickel-titanium wire. This was followed by 0.016 x 0.025-in copper-nickel-titanium wires, with the maxillary wire tied back to the maxillary first molars and the mandibular wire cinched back distal to the mandibular molars. Next a mandibular 0.019 x 0.025-in reverse curve nickel-titanium archwire was placed when more leveling was necessary, and a maxillary 0.019 x 0.025-in beta-titanium alloy wire was placed if more leveling and torque was desired. When possible, the occlusion was advanced to an edge-to-edge incisor relationship. Otherwise, the appliance was activated in a step-by-step fashion, 4 mm every 12 weeks until the occlusion was overcorrected. The overcorrected position was held for 12 weeks, after

which the Herbst appliance was removed. Patients were then received for comprehensive orthodontic treatment to finalize the occlusion.[15]

With the Forsus group, the patients started treatment with fixed appliance therapy and the Forsus appliance was added at the end of the aligning and leveling phase, with a 0.019 x 0.025-in stainless-steel archwire inserted into both arches. The mandibular archwire was cinched back distal to the molars in an attempt to limit increasing the labial inclination of the lower incisors. The rods of the Forsus appliance were placed on the mandibular archwire distal to the first bicuspids. Once the malocclusion was overcorrected to an edge-to-edge incisor relationship, the appliance was removed and fixed appliances were maintained to finalize the occlusion. [9]

The treated subjects in both groups had the following features: (1) pretreatment Class II malocclusion defined by at least an end-to-end molar relationship, (2) standardized treatment protocol for either the Herbst appliance or Forsus therapy, (3) no permanent teeth extracted before or during treatment, and (4) radiographs of sufficient quality such that adequate landmark visualization was possible on images made before treatment (T1) and immediately after comprehensive treatment (T2).[11] Subjects in both groups were matched according to the skeletal maturational levels at T1, assessed with the cervical vertebral maturation method.[16]

Cephalometric radiographs of 38 untreated individuals with Class II malocclusion were obtained from the American Association of Orthodontists Foundation (AAOF) Craniofacial Growth Legacy Collection as the control group.[30] Control subjects were matched with the experimental groups according the skeletal maturation levels at T1.[16]

Cephalometric Analysis

Two calibrated investigators digitally traced all the lateral cephalograms. Using cephalometric software (Dolphin Imaging Version 9.0, Chatsworth, CA), a customized analysis was designed based on measurements used in a previous study (for purposes of comparison) and incorporated measurements from the analyses of Steiner, Jacobson, Ricketts, and McNamara.[9] Six additional measurements were included based on the methods of Jones and colleagues to further analyze vertical dental and skeletal changes (Figure 3).[13] Linear measurements from the lateral cephalograms of treated and control samples were adjusted by 8% to account for an average enlargement factor.[9, 11]

To investigate error in landmark identification and associated measurements, 15 lateral cephalograms were randomly chosen, retraced and digitized. Dahlberg's formula was used to calculate the method error. The error for linear measurements ranged from 0.4 mm (overbite) to 1.6 mm (N to ANS), while the error for angular measurements varied from 0.3° (ANB) to 1.7° (interincisal angle; see Table I).

Statistical Analysis

The power of the study was calculated on the basis of the sample size of the treatment groups and of an effect size equaling 1.[9, 17] The power was found to exceed 0.90 at an alpha level of 0.05.

One-way analysis of variance (ANOVA) assessed if there was significant differences among the treated and control groups at T1, their changes from T1 to T2, and at T2. When ANOVA results were significant, Tukey post-hoc tests were used to determine group differences. The level of significance was set to $p \leq 0.05$.

RESULTS

Categorization of subjects based on the stages of cervical vertebral maturation in the treatment and control groups revealed a relatively similar distribution of subjects within each phase of skeletal maturation. The number of subjects in each phase (CVM 1-5) ranged from 5 to 8 (Table 2).

Statistical comparison of the cephalometric measurements at T1 revealed that the Herbst and Forsus groups were similar for the most part at the start of treatment with regard to maxillary and mandibular skeletal and dentoalveolar relationships. Exceptions were the Forsus group which had a greater Wits appraisal and larger interdental values, associated with greater maxillary incisor proclination and protrusion at T1 (Table 3). Skeletal and dentoalveolar comparisons between treatment and control groups showed many similarities at the start of treatment, but there were a number of measurements that differed. Both groups had 4 measurements showing statistically significant differences between the groups, and the Forsus group had a smaller SNB angle, a greater upper anterior facial height, and mandibular incisors that were more proclined (Table 3).

Descriptive statistics for comparisons of the changes T1 to T2 for the treatment and control groups are shown in Table 4. For skeletal measurements, a greater decrease in the ANB angle of about 1° was found in the Herbst group when compared to the Forsus group (change of -2.1° vs. -1.2°, respectively; $p=0.038$). No other statistically significant differences were demonstrated comparing the treatment groups with regard to maxillary and mandibular sagittal or vertical skeletal changes.

For dentoalveolar comparisons T1 to T2, both treatment groups exhibited a significant reduction in overjet, overbite and the Class II molar relationship. When

comparing the two treatment groups, no statistically significant differences were seen in changes in overbite, interincisal angle, distal movement of the maxillary molars and the molar relationship. Relative to the Herbst group, the Forsus group showed a significantly greater reduction in overjet (2 mm). Significant differences were also found between treatment groups with regard to maxillary dentoalveolar changes as the Forsus group showed greater retrusion of the maxillary incisors (U1 to Pt A vertical, U1 to FH, U1 to SN), and greater intrusion of the maxillary molars (U6 vertical). Both appliances had similar effects on the lower incisors including mesial movement (L1 to Pt A-pogonion), labial version (L1 to mandibular plane), and intrusion (L1 – GoMn). No statistically significant differences were observed in any of the mandibular dentoalveolar parameters between treatment groups.

When assessing changes T1 to T2 with regard to the Herbst vs. control groups, skeletally the treatment group showed a greater decrease in the ANB angle (1.4°) and a greater decrease in the Wits appraisal (3.5 mm). No vertical skeletal differences were demonstrated, with the exception of clockwise rotation of the occlusal plane (OP-SN) in the Herbst group. Dentoalveolar comparisons showed a significantly greater decrease in the overjet (2.9 mm) and overbite (2.1 mm), and a significantly greater improvement in the Class II molar relationship (2.4 mm). No significant differences were seen regarding maxillary and mandibular dentoalveolar changes, with the exception of greater mandibular incisor advancement in the Herbst group (L1 to PtA-pogonion).

When assessing changes T1 to T2 with regard to the Forsus vs. control groups, skeletally the treatment group showed a decrease in the Wits appraisal (2.8 mm) and a clockwise rotation of the occlusal plane. The only vertical skeletal difference found was

a less increase in upper anterior facial height (N to ANS) in the Forsus group. Dentoalveolar comparisons revealed that the Forsus group had a greater decrease in the overjet (4.9 mm) and overbite (2.0 mm), and a significantly greater improvement in the Class II molar relationship (2.4 mm). The Forsus group also demonstrated significantly greater maxillary incisor retrusion (U1 to Pt A vertical, U1 horizontal) and intrusion (U1 vertical), in addition to the maxillary molar distal movement (U6 horizontal) and intrusion (U6 vertical). In the Forsus group, the mandibular incisors showed significantly more forward movement, proclination and intrusion, while the mandibular molars showed more intrusion.

Descriptive statistics for comparisons of final treatment outcomes at T2 for the treatment and control groups are shown in Table 5. For skeletal comparisons between the two treatment groups, no maxillary or mandibular sagittal or vertical differences were shown. Comparison of changes in maxillary-mandibular relationships however, demonstrated significant differences between treatment groups. A greater decrease by 1.2° in the ANB angle and 2.4 mm in the Wits appraisal was found in the Herbst group when compared to the Forsus group ($p=0.029$, 0.000 respectively), in addition to a significant increase in the maxillary-mandibular differential (3.5 mm) in the Herbst group.

Dentoalveolar comparisons at T2 between treatment groups exhibited a significant reduction in the overbite (1.4 mm) for the Herbst group and significantly greater proclination of the mandibular incisors (4.7°, L1 to mandibular plane) in the Forsus group. All other maxillary and mandibular dentoalveolar parameters were similar at the end of treatment between both treatment groups.

For skeletal comparisons between the Herbst and control groups at T2, the sagittal position of the maxilla (Pt A to Nasion perp) significantly decreased in the Herbst group by 3.1 mm relative to the control, while no mandibular skeletal differences were demonstrated. Compared to the control, the Herbst group demonstrated a significantly greater reduction in the Wits appraisal (1.7 mm) in addition to the clockwise rotation of the occlusal plane.

With regards to dentoalveolar differences at T2, the Herbst group exhibited a significant reduction in the overjet (1.4 mm) and overbite (1.7 mm), and a significant improvement in the Class II molar relationship (1.6 mm) compared to the untreated control. No other significant maxillary or mandibular dentoalveolar differences were seen between the Herbst and control groups.

Sagittal skeletal comparisons between the Forsus and control groups at T2 demonstrated a significant reduction in the Forsus group in the sagittal position of the maxilla (2.5 mm, Pt A to Nasion Perp). Significant differences were also seen in the sagittal position of the mandible (Pg to Nasion perp) and in the maxillary-mandibular differential, with no significant vertical skeletal differences between either group.

As for dentoalveolar differences after comprehensive treatment, in the Forsus group, a significant improvement in the overjet (1.0 mm) and interincisal angle (7.5°) was found. The only statistically significant difference between the Forsus and control groups with regard to maxillary or mandibular dentoalveolar positions was the mandibular incisors were more proclined in the Forsus group (8.2°) at the completion of orthodontic treatment.

DISCUSSION

This study aimed to compare the skeletal and dentoalveolar treatment effects produced by two standardized Class II treatment modalities. One protocol incorporated the Herbst appliance and the other the Forsus appliance where both were used within a comprehensive orthodontic treatment approach using preadjusted fixed appliances. Main features of this study were the comparison of both treated groups with a sample of untreated Class II controls, pretreatment homogeneity of the skeletal maturation phases of all matched subjects, and the appraisal of the sagittal, vertical, and angular skeletal and dentoalveolar changes occurring after comprehensive orthodontic treatment. As assessed by the pretreatment cervical vertebral maturation, the similarity in skeletal development in all matched groups controlled for a possible susceptibility bias on the basis of pretreatment morphological characteristics.[9]

Our results show that when comparing maxillary skeletal changes T1 to T2 between treatment groups, no statistically significant differences were exhibited in any of the variables assessed. After comprehensive treatment however, the restraining effects of both appliances on the sagittal position of the maxilla was revealed when compared to untreated controls. Both appliances exert a posterior and upward force on the maxilla via the maxillary dentition—similar to a high-pull headgear—resulting in a restraint in maxillary growth. Our results are in accordance with other Herbst studies also demonstrating a restriction in the forward movement of the maxilla.[4, 12, 15, 29] Similarly, studies conducted on the Forsus appliance also show that the forward growth pattern of the maxilla is inhibited after treatment.[8, 9, 14]

Although maxillary growth was restricted, Class II correction with the Herbst or Forsus appliances did not induce differential increases in mandibular length when compared to each other or to untreated Class II controls. This is consistent with a controlled clinical study that reported no significant long term alteration of mandibular length with the utilization of functional appliances.[12] Wigal et al (2010) and Wieslander et al (1993) also found no significant long term effects of Herbst treatment on mandibular structure and position when compared to natural growth.[15, 20] Literature on the Forsus appliance similarly suggests limited effects on mandibular skeletal outcomes.[14, 19] Franchi and associates (2011) demonstrated that although the Forsus induced a significantly greater increase in the total mandibular length, growth modification did not significantly affect the sagittal position of either the bony or soft tissue chin.[9]

Skeletal assessments of maxillary-mandibular relationships showed a number of significant differences between the two treatment groups. Changes from T1 to T2, the Herbst group showed a significantly greater decrease in the ANB angle of about 1° compared to the Forsus group, and 1.4° compared to the control group. This significance was also shown comparing measurements at T2, showing a smaller ANB angle of 1.2° in the Herbst group when compared to the Forsus group. Our findings are consistent with another Herbst study which showed a decrease in the ANB angle ranging from 1.1° to 3.9° relative to a control group.[15] No statistically significant differences were seen in the ANB angle between the Forsus and control groups. The Wits appraisal showed no significant differences comparing the treatment groups, but significant differences were found relative to the control group, ranging from 2.8 to 3.5 mm from T1 to T2. Post-treatment measurements however demonstrated a significant difference between

treatment groups, with the Herbst showing a 2.4 mm reduction in the Wits appraisal discrepancy compared to the Forsus. Our findings are consistent with the 2.4 to 3.0 mm reported by other investigators.[15] Despite the significantly better Class I improvement in the maxillary-mandibular sagittal skeletal relationship of the Herbst group compared to the Forsus group, the favorable skeletal positions were not associated with an increase in total mandibular length or a more forward sagittal position of the mandible.

Skeletal assessments of vertical dimensions demonstrated no significant differences in any of the cephalometric measurements comparing treatment groups. When compared to the control group, in both treatment groups a statistically significant difference was seen with a clockwise rotation of the occlusal plane, demonstrating similar rotational effects that both appliances have on the occlusal plane. Similar to our results, VanLaecken et al (2006) also demonstrated a clockwise tipping of the occlusal plane after Herbst therapy.[6] Although Jones and associates (2008) reported a counterclockwise rotation of the occlusal plane after Forsus therapy, previous studies have also demonstrated a clockwise rotation.[13, 28] Although changes in the upper anterior facial height showed a significant difference between the Forsus and control groups from T1 to T2, no statistical significance was demonstrated after comprehensive treatment. In a study analyzing the treatment effects of the Herbst appliance, Pancherz similarly reported no post-treatment difference in the upper anterior facial height when compared to an untreated control.[3] Franchi et al (2011) also demonstrated no change in the upper anterior facial height after treatment with the Forsus appliance.[9]

Dentoalveolar changes in this study were similar to those reported in previous studies investigating fixed functional appliances, with a few exceptions. The overjet,

overbite, and Class II molar relationship underwent significant reduction from T1 to T2 in both treatment groups from T1 to T2 when compared together and to the untreated controls. Our results are in accordance with other Herbst studies that showed a significant reduction in these variables when compared to untreated controls.[5, 15, 23] Although there was a significant difference in overbite between treatment groups at T2, investigations on the Forsus also demonstrate a decrease in the overjet and overbite and an improvement in the molar relationship when comparing the Forsus to a control group [8,9] The significant differences found between treatment groups at T2 can be due to the significant differences at the outset of treatment between the Herbst and Forsus groups (see Table 2).

Although no significant differences were seen comparing the maxillary dentoalveolar parameters at T2 between treatment groups, changes from T1 to T2 showed that the maxillary incisors were retruded and uprighted in the Forsus group when compared to the Herbst group. Compared to untreated controls, the Herbst group did not show significant differences in maxillary incisor position, while the Forsus group demonstrated significantly greater retrusion and intrusion of the maxillary incisors. Our values are consistent with other Herbst studies that also showed no significant differences in maxillary incisor position after treatment with the Herbst appliance.[3, 4, 24, 25] Forsus literature also corroborates with our findings as Franchi et al (2011) and Jones et al (2008) showed a significant yet modest retrusion and palatal tipping of the maxillary incisors after Forsus treatment, although these treatment results dissipated after comprehensive treament.[9, 13]

Maxillary molars in the Herbst and Forsus groups demonstrated intrusion and distalization from T1 to T2, with the Forsus group showing a significantly greater intrusion relative to that of the Herbst group. Despite finding the changes to be significant, no differences were found in the maxillary molar positions between the treatment and control groups at T2. Our findings are similar to that of Wigal et al (2011) who showed that following initial Herbst appliance treatment and after completion of fixed appliance therapy, only 0.2 mm of maxillary distal molar movement remained.[15] Similar findings have been reported in other Herbst studies.[10, 23] Similarly, although the maxillary molars initially distalized and intruded in the Forsus group, at T2, no statistical differences were found. Our results confirm those reported by Franchi and associates (2011) who demonstrated no significant horizontal or vertical changes in the maxillary molars after comprehensive treatment with the Forsus.[8]

Treatment with both the Herbst and Forsus appliances resulted in similar sagittal and vertical mandibular incisor changes from T1 to T2, with no significant differences between treatment groups. Although more pronounced in the Forsus group, the mandibular incisors in both treatment groups moved forward, proclined, and intruded relative to the untreated controls, as both appliances applied an anterior and inferior force to the mandibular dentition. Similar findings were obtained in previous Hersbt[4, 15, 23] and Forsus[8, 9, 13] studies that demonstrated mesial movement of the mandibular arch and proclination of the lower incisors. Although the mandibular archwire was consistently cinched back distal to the molars throughout treatment in both groups, both groups demonstrated proclination lower incisors, with more pronounced effects in the Forsus

group. These mandibular dentoalveolar findings have been demonstrated in nearly all previous studies analyzing the treatment effects of fixed functional appliances.[8]

Similar to the mandibular incisors, the mandibular molars did not show significant differences between treatment groups as both treatment modalities resulted in the mesial movement of the mandibular molars. No significant differences however, were seen when comparing the treatment and control groups with regard to mandibular molar position. Our results are in corroboration with other Herbst studies that report no significant differences in mandibular molar position when compared to untreated controls[15, 23] but are different than other Forsus studies that show mesial movement of mandibular molars.[9,13] The comparison between the Forsus and control group from T1 to T2 demonstrated a significantly greater intrusion of the mandibular molars in the Forsus group; findings that are different than previous studies reporting extrusion of the mandibular molars after Forsus treatment. [9, 13]

Although for the most part our results were in accordance with previous studies, there were a number of limitations in this study. Initial comparisons between the Herbst and Forsus samples demonstrated that the Forsus group had a more severe Class II skeletal discrepancy at the outset of treatment compared to the Herbst group. Furthermore, the Forsus group also had greater initial interdental values, associated with more proclined and protrusive maxillary incisors. Another limitation of this study was the difficulty demonstrating the pure effects of functional appliance therapy, as Class II elastics and other treatment mechanics were used to finalize the occlusion, which could have masked the effects produced by the appliances.

In summary, Class II correction with the Herbst and Forsus appliances in conjunction with fixed appliances demonstrates that both functional appliances have restraining effects on the sagittal growth of the maxilla, with minimal effects on enhancing the natural growth of the mandible. Despite this, the Herbst appliance showed a modest, though significant improvement in maxillary-mandibular sagittal skeletal positions compared to the Forsus, while the Forsus demonstrated greater dentoalveolar effects compared to the Herbst appliance. Contrary to skeletal effects, dentoalveolar effects displayed highly significant changes, as both treatment protocols improved the overjet, overbite and Class II molar relationships, and resulted in the advancement of the lower incisors. It is recommended that clinicians cautiously use these appliances and select patients that would benefit from these treatment side effects.

CONCLUSION

This study compared the treatment effects of the Herbst appliance with those of the Forsus in combination with fixed orthodontic therapy. Both appliances produced similar therapeutic modifications in Class II patients, which led to the normalization of the dentoalveolar and skeletal parameters at the end of comprehensive treatment. Although both appliances restricted the sagittal advancement of the maxilla, the Herbst appliance showed a mildly enhanced skeletal effect. The Herbst appliance resulted in a significantly greater decrease in the ANB angle by 1.2° and Wits appraisal by 2.4 mm, as well as a significant increase in the maxillary-mandibular differential. No other sagittal or vertical maxillary or mandibular skeletal differences were observed between the two treatment modalities. Dentoalveolar comparisons showed forward movement of mandibular incisors in both treatment groups, with the Forsus demonstrating significantly more proclination of the mandibular incisors at the end of comprehensive treatment.

REFERENCES

1. Cozza P. Mandibular changes produced by functional appliances in class II malocclusion: a systematic review. Am J Orthod Dentofacial Orthop 2006;129:e1-599.e12.
2. McNamara JA. Components of class II malocclusion in children 8-10 years of age. Angle Orthod 1981;51:177-202.
3. Pancherz H. Treatment of class II malocclusions by jumping the bite with the herbst appliance: a cephalometric investigation. Am J Orthod 1979;76:423-442.
4. Lai M. An evaluation of two-phase treatment with the herbst appliance and preadjusted edgewise therapy. Seminars in Orthodontics 1998;4: 46-58.
5. Franchi L. Treatment and posttreatment effects of acrylic spingt herbst appliance therapy. Am J Orthod Dentofacial Orthop 1999;115:429-438.
6. VanLaecken R. Treatment effects of the edgewise herbst appliance: a cephalometric and tomographic investigation. Am J Orthod Dentofacial Orthop 2006;130:582-593.
7. Vogt W. The forsus fatigue resistant device. J Clin Ortho 2006;40:368-377.
8. Karacay S. Forsus nitinol flat spring and jasper jumper corrections of class II division 1 malocclusions. Angle Orthod 2006;76:666-672.
9. Franchi L. Effectiveness of comprehensive fixed appliance treatment used with the forsus fatigue resistant device in class II patients. Angle Orthod 2011;81:678-683.

10. O'Brian K. Effectiveness of treatment for class II malocclusion with the herbst or twin block appliances: a randomized, controlled trial. Am J Orthod Dentofacial Orthop 2003;124:128-137.
11. Schaefer A. A cephalometric comparison of treatment with the twin-block and stainless steel crown herbst appliances followed by fixed appliances therapy. Am J Orthod Dentofacial Orthop 2004;126:7-15.
12. Siara-Olds NJ. Long-term dentoskeletal changes with the bionator, herbst, twin block and MARA functional appliances. Angle Orthod 2010;80:18-28.
13. Jones G. Class II non-extraction patients treated with the forsus fatigue resistant device versus intermaxillary elastics. Angle Ortho 2008;78: 332-338.
14. Bilgic F. Comparison of the effects of fixed and removable functional appliances on the skeletal and dentoalveolar structures. Australian Orthod J 2011;27:110-116.
15. Wigal TG. Stability of class II treatment with an edgewise crowned herbst appliance in the early mixed dentition: skeletal and dental changes. Am J Orthod Dentofacial Orthop 2011;140:210-223.
16. Baccetti T. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. Semin Orthod. 2005; 11:119-129.
17. Rodrigues de Almeida M. Short term treatment effects produced by the herbst appliance in the mixed dentition. Angle Orthod. 2005;75:540-547.
18. Heinig N. Clinical application and effects of the forsus spring: a study of a new herbst hybrid. J Orofac Orthop 2001;62:436-50.

19. Aras A. Comparison of treatments with the forsus fatigue resistant device in relation to skeletal maturity: a cephalometric and magnetic resonance imaging study. Am J Orthod Dnetofacial Orthop 2011;140:616-625.

20. Wieslander L. Long term effect of treatment with the headgear herbst appliance in the early mixed dentition. Stability of relapse? Am J Orthod Dentofacial Orthop 1993; 104:319-329.

21. McNamara JA Jr. A method of cephalometric evaluation. Am J Orthod. 1984;86:449-469.

22. Hansen K. Long term effects of the Herbst appliance in relation to the treatment growth period: a cephalometric study. Eur J Orthod 1991;13:471-481.

23. Croft R. A cephalometric and tomographic evaluation of herbst treatment in the mixed dentition. Am J Orthod Dentofacial Orthop 1999;116:435-443.

24. Pancherz H. The herbst appliance—its biological effects and clinical use. Am J Orthod 1985;87:1-20.

25. Valant JR. Treatment effects of the herbst appliance. Am J Orthod Dentofacial Orthop 1989;138-147.

26. Hagg U. Initial and late treatment effects of headgear-herbst appliance with mandibular step-by-step advancement. Am J Orthod Dentofacial Orthop 2002;122:477-485.

27. Pancherz H. Occlusal changes during and after herbst treatment: a cephalometric investigation. Eur J Orthod 1986;8:215-228.

28. Ellen EK. A comparative study of anchorage in bioprogressive versus standard edgewise treatment in Class II correction with intermaxillary elastic force. Am J Orthod Dentofacial Orthop 1996;114-430.

29. Hansen K. Long-term effects of Herbst treatment in relation to normal growth development: a cephalometric study. Eur J Orthod 1992;14:285-95.

30. http://www.aaoflegacycollection.org/aaof

FIGURE LEGENDS

Figure 1: Herbst appliance prior to fixed orthodontic therapy.

Figure 2: Forsus Appliance in association with fixed orthodontic appliances.

Figure 3: Cephalometric Landmarks Used.

Figure 1.

Figure 2.

Figure 3.

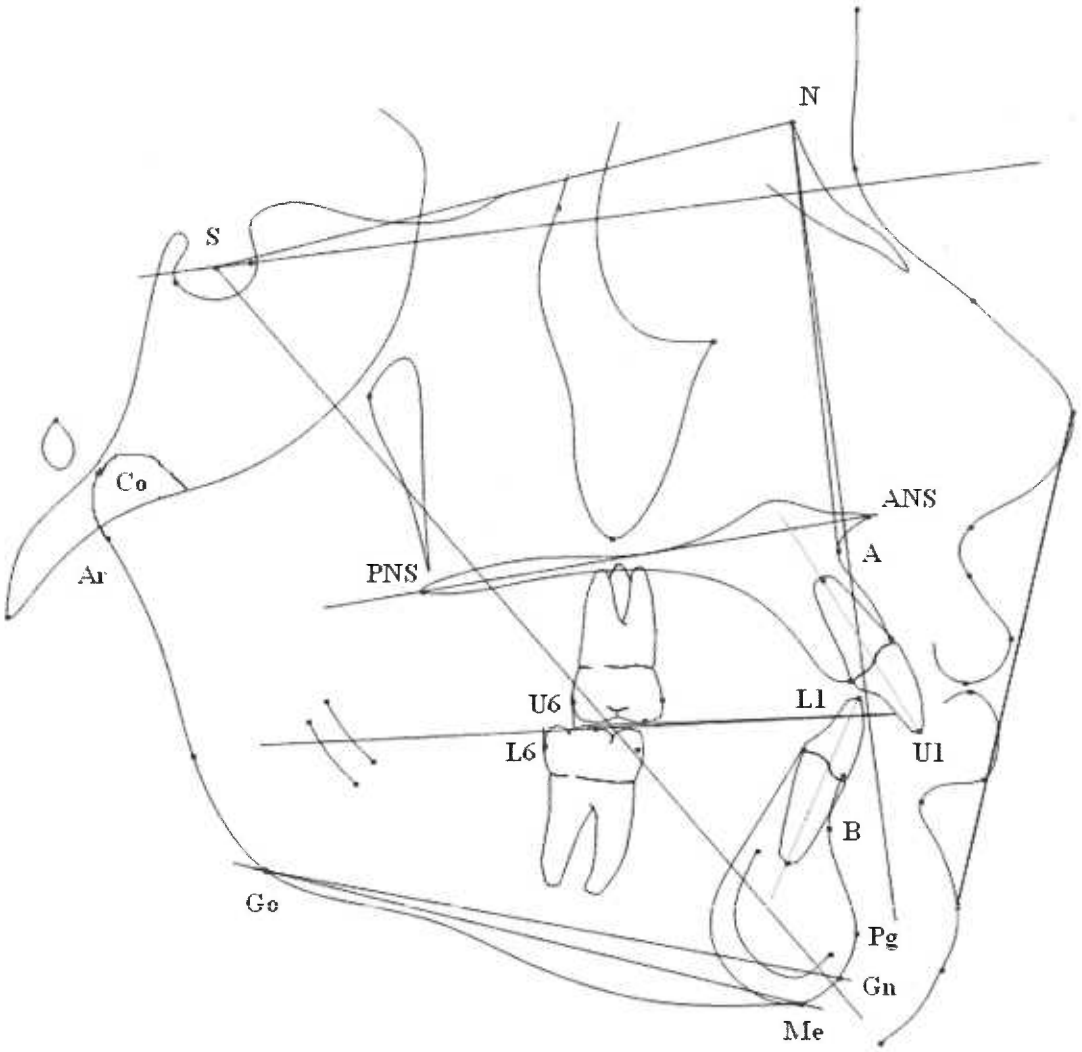

Table 1: **Method error of all parameters analyzed.**

Cephalometric Measures	Error
Cranial Base	
Ba-S-N (°)	0.6
Maxillary Skeletal	
SNA (°)	0.5
Pt A to Nasion perp, mm	0.6
Co-Pt A, mm	0.8
Mandibular Skeletal	
SNB (°)	0.6
Pg to Nasion perp, mm	1.2
Co-Gn, mm	1.0
Co-Go, mm	0.6
Maxillary/Mandibular	
ANB, °	0.3
WITS, mm	0.5
Maxillary/mandibular difference, mm	0.9
Vertical Skeletal	
FH to palatal plane, °	0.5
FH to mandibular plane, °	0.4
Palatal plane to mandibular plane, °	0.7
ArGoMe, °	0.8
CoGoMe, °	0.7
N to ANS, mm	1.6
ANS to Me, mm	1.0
OP - SN, °	0.5
Interdental	
Overjet, mm	0.5
Overbite, mm	0.4
Interincisal angle, °	1.7
Molar relationship, mm	0.4
Maxillary Dentoalveolar	
U1 to Pt A vertical, mm	0.8
U1 to FH, °	0.9
U1 - SN, °	0.8
U1 horizontal, mm	1.0
U1 vertical, mm	1.2
U1 - ANSPNS, mm	0.8
U6 horizontal, mm	1.1
U6 vertical, mm	1.3

U6 - ANSPNS, mm	0.8
Mandibular Dentoalveolar	
L1 to Pt A-pogonion, mm	0.5
L1 to mandibular plane, °	0.9
L1 horizontal, mm	1.1
L1 vertical, mm	1.2
L1 - GoMe, mm	1.1
L6 horizontal, mm	1.0
L6 vertical, mm	1.1
L6 - GoMe, mm	0.9

Table 2: **Distribution of subjects based on the stages of cervical vertebral maturation.**

CVM	No. of Subjects
1	8
2	6
3	8
4	6
5	5
6	5

Table 3: **Comparison of pre-treatment (T1) parameters between treatment and control groups.**

	Herbst Group Mean (Std Dev)	Forsus Group Mean (Std Dev)	Control Group Mean (Std Dev)	Mean Difference H/F (Std Dev)	Mean Difference H/C (Std Dev)	Mean Difference F/C (Std Dev)
Cephalometric Measurements						
Cranial Base						
Ba-S-N (°)	132.5 (5.3)	131.8 (4.8)	130.2 (5.8)	0.7 (.840)	2.3 (.147)	1.6 (.385)
Maxillary Skeletal						
SNA (°)	82.0 (4.7)	81.3 (3.3)	83.2 (4.5)	0.7 (.750)	-1.2 (.418)	-1.9 (.120)
Pt A to Nasion perp, mm	-4.1 (4.4)	-4.2 (3.9)	-1.4 (4.2)	0.1 (.998)	-2.6 (.023)*	-2.7 (.016)*
Co-Pt A, mm	86.2 (12.9)	90.9 (13.4)	86.7 (16.2)	-4.7 (.328)	-0.4 (.991)	4.2 (.399)
Mandibular Skeletal						
SNB (°)	76.5 (4.4)	75.5 (3.1)	78.4 (3.7)	1.0 (.509)	-1.9 (.073)	-2.9 (.003)*
Pg to Nasion perp, mm	-16.0 (8.6)	-17.2 (9.7)	-10.2 (7.4)	1.2 (.825)	-5.8 (.015)*	-7.0 (.002)*
Co-Gn, mm	107.4 (13.7)	110.4 (14.9)	108.2 (19.5)	-3.0 (.703)	-0.8 (.977)	2.2 (.827)
Co-Go, mm	56.9 (7.1)	58.1 (8.4)	57.0 (11.4)	-1.3 (.821)	-0.2 (.996)	1.1 (.864)
Maxillary/Mandibular						
ANB, °	5.5 (2.1)	5.8 (1.9)	4.8 (2.7)	-0.3 (.868)	0.7 (.375)	1.0 (.158)
WITS, mm	3.3 (2.9)	5.0 (2.3)	1.4 (3.1)	-1.7 (.020)*	1.8 (.016)*	3.6 (.000)*
Maxillary/mandibular diff., mm	21.2 (3.2)	19.5 (4.3)	21.5 (5.7)	1.7 (.232)	-0.3 (.942)	-2.0 (.122)
Vertical Skeletal						
FH to palatal plane, °	3.5 (4.8)	2.4 (4.3)	-0.2 (4.9)	1.1 (.587)	3.7 (.003)*	2.6 (.045)*
FH to mandibular plane, °	28.9 (6.3)	27.0 (7.2)	27.0 (5.0)	2.0 (.361)	2.0 (.351)	0.0 (1.000)
Palatal plane-mandibular plane, °	22.6 (5.8)	21.7 (6.2)	24.2 (5.6)	0.9 (.797)	-1.6 (.464)	-2.5 (.165)
ArGoMe, °	133.2 (5.6)	131.2 (7.1)	133.6 (5.6)	1.9 (.359)	-0.5 (.944)	-2.4 (.211)
CoGoMe, °	128.0 (6.2)	126.6 (7.4)	129.2 (5.4)	1.4 (.605)	-1.2 (.678)	-2.6 (.174)
N to ANS, mm	51.8 (7.5)	53.3 (8.0)	48.8 (9.5)	-1.6 (.692)	3.0 (.283)	4.6 (.049)*
ANS to Me, mm	61.3 (8.2)	61.7 (9.8)	61.7 (12.0)	-0.4 (.983)	-0.5 (.980)	0.0 (1.000)
OP - SN, °	17.0 (5.5)	15.7 (4.1)	16.8 (4.0)	1.3 (.440)	0.2 (.981)	-1.1 (.552)
Interdental						
Overjet, mm	6.2 (2.9)	8.6 (3.7)	4.8 (2.0)	-2.4 (.002)*	1.5 (.097)	3.9 (.000)*
Overbite, mm	3.2 (2.4)	4.5 (2.3)	2.8 (2.4)	-1.3 (.048)*	0.4 (.748)	1.7 (.006)*
Interincisal angle, °	134.3 (10.5)	129.0 (9.6)	135.0 (9.6)	5.3 (.056)	-0.7 (.946)	-6.0 (.025)*
Molar relationship, mm	1.1 (1.6)	2.0 (1.4)	0.3 (1.5)	-0.9 (.033)*	0.8 (.071)	1.7 (.000)*
Maxillary Dentoalveolar						
U1 to Pt A vertical, mm	1.0 (3.5)	3.1 (2.9)	1.7 (2.8)	-2.2 (.007)*	-0.8 (.521)	1.4 (.119)
U1 to FH, °	103.8 (9.5)	109.0 (8.5)	106.4 (7.6)	-5.2 (.024)*	-2.7 (.367)	2.5 (.399)
U1 – SN, °	99.7 (8.4)	104.2 (8.0)	101.1 (6.7)	-4.4 (.036)*	-1.4 (.707)	3.0 (.206)
U1 horizontal, mm	79.7 (11.0)	82.5 (12.9)	77.1 (14.4)	-2.8 (.612)	2.6 (.660)	5.4 (.161)
U1 vertical, mm	72.5 (11.0)	76.4 (11.7)	72.0 (13.1)	-3.9 (.339)	0.5 (.984)	4.4 (.255)
U1 - ANSPNS, mm	28.1 (4.6)	29.1 (5.5)	28.2 (5.5)	-1.1 (.640)	-0.1 (.992)	0.9 (.717)
U6 horizontal, mm	42.0 (7.1)	42.2 (6.4)	42.2 (7.7)	-0.3 (.987)	-0.2 (.990)	0.0 (1.000)
U6 vertical, mm	70.9 (8.6)	73.4 (9.9)	69.0 (12.9)	-2.4 (.578)	1.9 (.728)	4.3 (.180)
U6 - ANSPNS, mm	19.8 (3.0)	20.3 (2.9)	19.0 (4.0)	-0.5 (.790)	0.8 (.566)	1.3 (.211)
Mandibular Dentoalveolar						

L1 to Pt A-pogonion, mm	0.0 (2.2)	0.2 (2.1)	0.9 (2.3)	-0.2 (.936)	-0.9 (.201)	-0.7 (.332)
L1 to mandibular plane, °	93.0 (5.9)	95.1 (6.8)	91.6 (6.0)	-2.0 (.334)	1.4 (.600)	3.4 (.049)*
L1 horizontal, mm	75.4 (10.3)	76.6 (12.3)	73.5 (14.3)	-1.2 (.910)	2.0 (.780)	3.2 (.512)
L1 vertical, mm	66.9 (10.0)	68.6 (9.7)	67.8 (12.2)	-1.7 (.773)	-0.9 (.932)	0.8 (.946)
L1 - GoMe, mm	39.3 (5.5)	40.7 (6.5)	38.8 (7.2)	-1.3 (.634)	0.6 (.923)	1.9 (.396)
L6 horizontal, mm	39.8 (7.1)	39.3 (5.8)	40.8 (7.5)	0.5 (.939)	-1.0 (.818)	-1.5 (.606)
L6 vertical, mm	72.0 (8.6)	73.9 (10.0)	69.9 (12.9)	-2.0 (.696)	2.0 (.695)	4.0 (.230)
L6 - GoMe, mm	28.6 (4.0)	28.8 (4.9)	28.5 (5.3)	-0.2 (.975)	0.1 (.997)	0.3 (.954)

* $p \leq 0.05$

Table 4: **Comparison of T1 – T2 changes among treatment and control groups.**

	Herbst Group Mean (Std Dev)	Forsus Group Mean (Std Dev)	Control Group Mean (Std Dev)	Mean Difference H/F (Std Dev)	Mean Difference H/C (Std Dev)	Mean Difference F/C (Std Dev)
Cephalometric Measurements						
Cranial Base						
Ba-S-N (°)	-1.2 (5.9)	0.3 (2.9)	0.1 (4.0)	-1.5 (.295)	-1.3 (.427)	.3 (.966)
Maxillary Skeletal						
SNA (°)	-1.2 (3.0)	-0.4 (2.2)	-0.8 (3.3)	-0.8 (.441)	-0.4 (.809)	.4 (.818)
Pt A to Nasion perp, mm	-1.6 (3.7)	-1.0 (3.1)	-1.2 (3.4)	-0.7 (.674)	-0.5 (.839)	.2 (.961)
Co-Pt A, mm	-1.3 (8.5)	-4.8 (8.3)	-0.4 (10.7)	3.5 (.230)	-0.9 (.909)	-4.4 (.100)
Mandibular Skeletal						
SNB (°)	0.9 (2.7)	0.8 (2.1)	-0.1 (2.4)	0.1 (.969)	1.0 (.188)	.8 (.284)
Pg to Nasion perp, mm	0.7 (6.6)	0.9 (5.8)	-0.6 (5.7)	-0.2 (.986)	1.2 (.671)	1.4 (.556)
Co-Gn, mm	2.2 (10.8)	-3.1 (10.9)	2.1 (14.6)	5.3 (.144)	0.1 (.999)	-5.2 (.158)
Co-Go, mm	1.9 (7.3)	-0.9 (7.2)	2.0 (9.6)	2.8 (.294)	-0.2 (.996)	-3.0 (.254)
Maxillary/Mandibular						
ANB, °	-2.1 (1.8)	-1.2 (1.2)	-0.7 (1.8)	0.9 (.038)*	1.4 (.001)*	-.5 (.437)
WITS, mm	-3.5 (2.6)	-2.9 (1.9)	0.0 (2.0)	-0.7 (.356)	3.5 (.000)*	2.8 (.000)*
Maxillary/mandibular diff., mm	3.5 (3.8)	1.7 (3.2)	2.5 (5.2)	1.8 (.139)	1.0 (.530)	-.8 (.692)
Vertical Skeletal						
FH to palatal plane, °	0.5 (3.4)	0.8 (3.4)	1.5 (3.1)	-0.3 (.918)	-0.9 (.452)	-.6 (.696)
FH to mandibular plane, °	0.2 (3.5)	0.5 (3.8)	0.4 (3.2)	-0.3 (.923)	-0.2 (.972)	.1 (.987)
Palatal plane-mandibular plane, °	-0.1 (2.9)	-0.4 (2.2)	-1.1 (2.5)	0.2 (.908)	1.0 (.193)	.8 (.382)
ArGoMe, °	-0.8 (4.2)	-1.3 (2.8)	-0.6 (3.7)	0.5 (.783)	-0.2 (.981)	-.7 (.670)
CoGoMe, °	-0.2 (4.6)	-0.8 (2.7)	-0.8 (3.3)	0.6 (.761)	0.5 (.799)	-.1 (.998)
N to ANS, mm	0.6 (4.4)	-2.2 (5.2)	1.3 (6.3)	2.8 (.063)	-0.8 (.822)	3.5 (.013)*
ANS to Me, mm	1.2 (5.9)	-1.9 (6.2)	1.0 (8.8)	3.0 (.149)	0.2 (.995)	-2.9 (.179)
OP - SN, °	1.4 (3.8)	1.8 (2.8)	-0.9 (3.4)	-0.4 (.867)	-2.3 (.010)*	-2.7 (.002)*
Interdental						
Overjet, mm	-3.4 (2.9)	-5.4 (3.4)	-0.6 (1.8)	-2.0 (.006)*	2.9 (.000)*	4.9 (.000)*
Overbite, mm	-2.3 (2.3)	-2.2 (2.2)	-0.2 (1.9)	-0.1 (.986)	2.1 (.000)*	2.0 (.000)*
Interincisal angle, °	-3.8 (11.9)	-0.9 (12.8)	0.5 (5.1)	-2.9 (.443)	-4.4 (.166)	-1.5 (.818)
Molar relationship, mm	-2.6 (2.1)	-2.6 (1.9)	-0.2 (1.8)	0.0 (.994)	2.4 (.000)*	2.4 (.000)*
Maxillary Dentoalveolar						
U1 to Pt A vertical, mm	0.2 (2.6)	-2.5 (2.9)	0.0 (2.1)	-2.7 (.000)*	0.1 (.972)	2.5 (.000)*
U1 to FH, °	1.3 (8.7)	-4.5 (10.1)	-1.2 (5.6)	-5.7 (.009)*	2.5 (.398)	-3.3 (.209)
U1 - SN, °	1.7 (8.4)	-3.8 (10.5)	-0.9 (4.9)	-5.5 (.013)*	2.6 (.365)	-2.9 (.283)
U1 horizontal, mm	0.5 (6.7)	-3.7 (7.5)	1.2 (10.0)	4.2 (.070)	-0.6 (.940)	4.9 (.030)*
U1 vertical, mm	-2.3 (8.1)	-6.9 (8.0)	-1.1 (9.3)	4.6 (.052)	-1.2 (.815)	5.8 (.010)*
U1 - ANSPNS, mm	-0.1 (3.2)	-1.4 (2.9)	-0.1 (4.1)	1.3 (.225)	0.0 (1.00)	-1.3 (.228)
U6 horizontal, mm	-0.1 (4.8)	-1.9 (4.9)	1.3 (5.5)	1.9 (.249)	-1.4 (.491)	3.2 (.018)*
U6 vertical, mm	1.2 (5.7)	-2.7 (6.7)	2.1 (8.8)	-4.0 (.045)*	-0.9 (.851)	4.9 (.010)*
U6 - ANSPNS, mm	0.7 (2.1)	-0.5 (2.2)	1.6 (3.2)	1.1 (.125)	-1.0 (.244)	2.1 (.001)*
Mandibular Dentoalveolar						

L1 to Pt A-pogonion, mm	2.4 (2.5)	2.3 (1.8)	0.3 (1.3)	0.2 (.912)	-2.1 (.000)*	-1.9 (.000)*
L1 to mandibular plane, °	2.3 (7.9)	5.0 (6.4)	0.2 (4.1)	-2.6 (.172)	2.1 (.312)	-4.7 (.004)*
L1 horizontal, mm	3.3 (6.7)	-0.7 (7.5)	1.5 (9.8)	4.0 (.085)	1.8 (.604)	-2.2 (.477)
L1 vertical, mm	0.7 (7.9)	-1.8 (7.1)	-0.6 (8.7)	2.5 (.348)	1.3 (.759)	-1.2 (.783)
L1 - GoMe, mm	-1.3 (4.1)	-3.1 (3.8)	0.4 (5.2)	1.9 (.151)	-1.7 (.236)	3.6 (.002)*
L6 horizontal, mm	2.5 (4.8)	0.6 (5.3)	1.9 (6.1)	2.0 (.260)	0.6 (.867)	-1.3 (.545)
L6 vertical, mm	1.6 (5.9)	-2.1 (6.8)	2.4 (9.1)	3.8 (.071)	-0.7 (.906)	4.5 (.024)*
L6 - GoMe, mm	0.9 (2.9)	-0.5 (3.5)	0.8 (4.4)	1.4 (.235)	0.1 (.991)	-1.3 (.293)

* $p \leq 0.05$

Table 5: **Comparison of post-treatment (T2) parameters among treatment and control groups after comprehensive treatment.**

	Herbst Group Mean (Std Dev)	Forsus Group Mean (Std Dev)	Control Group Mean (Std Dev)	Mean Difference H/F (Std Dev)	Mean Difference H/C (Std Dev)	Mean Difference F/C (Std Dev)
Cephalometric Measurements						
Cranial Base						
Ba-S-N (°)	131.3 (4.9)	132.1 (4.8)	130.2 (5.2)	-0.9 (.737)	1.0 (.648)	1.9 (.235)
Maxillary Skeletal						
SNA (°)	80.8 (3.6)	80.9 (3.5)	82.4 (4.1)	-0.1 (.992)	-1.6 (.146)	-1.5 (.184)
Pt A to Nasion perp, mm	-5.7 (4.5)	-5.1 (4.7)	-2.6 (3.8)	-0.6 (.821)	-3.1 (.010)*	-2.5 (.038)*
Co-Pt A, mm	84.9 (12.8)	86.1 (12.7)	86.2 (13.9)	-1.2 (.919)	-1.3 (.902)	-0.2 (.998)
Mandibular Skeletal						
SNB (°)	77.4 (3.9)	76.3 (3.5)	78.3 (3.7)	1.1 (.412)	-0.9 (.520)	-2.0 (.051)
Pg to Nasion perp, mm	-15.4 (9.3)	-16.3 (11.0)	-10.8 (6.4)	0.9 (.892)	-4.6 (.091)	-5.5 (.024)*
Co-Gn, mm	109.6 (14.5)	107.2 (13.5)	110.2 (17.0)	2.3 (.778)	-0.7 (.981)	-3.0 (.662)
Co-Go, mm	58.7 (8.8)	57.2 (7.1)	59.1 (10.1)	1.5 (.727)	-0.3 (.985)	-1.9 (.623)
Maxillary/Mandibular						
ANB, °	3.4 (2.0)	4.6 (1.9)	4.1 (2.1)	-1.2 (.029)*	-0.7 (.296)	0.5 (.522)
WITS, mm	-0.3 (2.7)	2.2 (2.1)	1.4 (2.6)	-2.4 (.000)*	-1.7 (.013)*	0.8 (.374)
Maxillary/mandibular diff., mm	24.7 (4.4)	21.2 (4.1)	24.0 (6.6)	3.5 (.010)*	0.7 (.832)	-2.8 (.048)*
Vertical Skeletal						
FH to palatal plane, °	4.0 (5.1)	3.3 (4.8)	1.3 (5.3)	0.8 (.792)	2.7 (.054)	2.0 (.212)
FH to mandibular plane, °	29.1 (6.5)	27.5 (7.9)	27.3 (4.6)	1.6 (.510)	1.8 (.449)	0.1 (.994)
Palatal plane-mandibular plane, °	22.5 (5.7)	21.4 (6.3)	23.0 (6.1)	1.1 (.705)	-0.6 (.912)	-1.7 (.451)
ArGoMe, °	132.4 (5.9)	129.9 (6.3)	133.0 (5.0)	2.5 (.150)	-0.6 (.890)	-3.1 (.055)
CoGoMe, °	127.8 (6.9)	125.8 (6.6)	128.5 (5.4)	2.0 (.362)	-0.7 (.880)	-2.7 (.159)
N to ANS, mm	52.3 (7.8)	51.1 (6.8)	50.1 (8.0)	1.2 (.758)	2.2 (.414)	1.0 (.824)
ANS to Me, mm	62.5 (9.6)	59.8 (9.0)	62.8 (11.3)	2.6 (.486)	-0.3 (.991)	-2.9 (.409)
OP - SN, °	18.4 (5.1)	17.5 (4.0)	15.9 (4.4)	0.9 (.659)	2.5 (.047)*	1.6 (.282)
Interdental						
Overjet, mm	2.8 (1.6)	3.2 (1.1)	4.2 (2.0)	-0.4 (.542)	-1.4 (.001)*	-1.0 (.022)*
Overbite, mm	0.9 (1.2)	2.3 (1.1)	2.6 (2.1)	-1.4 (.000)*	-1.7 (.000)*	-0.3 (.613)
Interincisal angle, °	130.4 (10.7)	128.1 (7.7)	135.5 (10.4)	2.4 (.540)	-5.1 (.059)	-7.5 (.003)*
Molar relationship, mm	-1.6 (2.1)	-0.6 (1.4)	0.1 (1.7)	-0.9 (.061)	-1.6 (.000)*	-0.7 (.166)
Maxillary Dentoalveolar						
U1 to Pt A vertical, mm	1.1 (2.4)	0.6 (2.7)	1.8 (2.4)	0.5 (.678)	-0.7 (.516)	-1.1 (.122)
U1 to FH, °	105.0 (5.4)	104.5 (7.4)	105.2 (6.6)	0.5 (.933)	-0.2 (.992)	-0.7 (.885)
U1 - SN, °	101.4 (4.8)	100.4 (6.7)	100.3 (7.1)	1.0 (.758)	1.2 (.699)	0.1 (.995)
U1 horizontal, mm	80.2 (12.0)	78.8 (11.0)	78.3 (12.1)	1.4 (.857)	2.0 (.752)	0.6 (.976)
U1 vertical, mm	70.2 (9.9)	69.5 (9.8)	70.9 (12.1)	0.7 (.954)	-0.7 (.954)	-1.4 (.825)
U1 - ANSPNS, mm	28.0 (5.1)	27.8 (4.8)	28.1 (4.9)	0.2 (.979)	-0.1 (.992)	-0.4 (.944)
U6 horizontal, mm	41.9 (5.7)	40.3 (6.7)	43.5 (7.5)	1.6 (.544)	-1.6 (.574)	-3.2 (.096)
U6 vertical, mm	72.2 (9.4)	70.6 (8.6)	71.2 (11.3)	1.5 (.778)	1.0 (.903)	-0.5 (.970)

U6 - ANSPNS, mm	20.4 (3.2)	19.8 (2.7)	20.6 (4.0)	0.7 (.676)	-0.2 (.974)	-0.8 (.537)
Mandibular Dentoalveolar						
L1 to Pt A-pogonion, mm	2.4 (3.1)	2.4 (2.2)	1.2 (2.4)	0.0 (1.000)	1.2 (.105)	1.2 (.099)
L1 to mandibular plane, °	95.4 (7.1)	100.0 (6.3)	91.9 (7.1)	-4.7 (.010)*	3.5 (.070)	8.2 (.000)*
L1 horizontal, mm	78.8 (11.8)	76.0 (10.7)	75.0 (12.2)	2.8 (.542)	3.8 (.347)	1.0 (.926)
L1 vertical, mm	67.6 (9.9)	66.8 (9.6)	67.2 (11.4)	0.8 (.933)	0.4 (.984)	-0.4 (.982)
L1 - GoMe, mm	38.1 (6.4)	37.5 (5.6)	39.2 (6.3)	0.5 (.920)	-1.1 (.723)	-1.7 (.470)
L6 horizontal, mm	42.4 (6.4)	39.9 (6.9)	42.7 (8.1)	2.5 (.292)	-0.3 (.980)	-2.8 (.209)
L6 vertical, mm	73.6 (9.8)	71.8 (8.9)	72.3 (11.6)	1.8 (.728)	1.3 (.847)	-0.5 (.978)
L6 - GoMe, mm	29.5 (4.4)	28.4 (4.1)	29.3 (4.9)	1.1 (.512)	0.2 (.981)	-0.9 (.631)

* $p \leq 0.05$

LITERATURE REVIEW

Class II Malocclusions

Class II malocclusions are the most frequent sagittal irregularities dealt with in the field of orthodontics. According to the National Health and Nutritional Examination Survey (NHANES III), there is an 11% prevalence of Class II malocclusion with an overjet greater than 4 mm in the United States population.[1] Other studies have reported that approximately 15-30% of American children present with Class II malocclusions, encompassing about 20-30% of all orthodontic patients, and 12-49% of all orthodontic disorders.[2] Furthermore, the frequency of this occlusal disharmony has been found to be about 37% among children between 6 and 15 years of age.[3] According to McNamara, the most common single characteristic associated with Class II malocclusions is mandibular skeletal retrognathia.[4] He demonstrated that 80% of the White population display mandibular deficiencies, while 20% express excessive maxillary development.[5] With this awareness, numerous orthodontic appliances and surgical procedures have been developed to treat the skeletal and dentoalveolar irregularities associated with Class II patients including interarch elastics, extra-oral appliances, removable and fixed functional appliances, selective extraction patterns, and surgical repositioning of the jaws.[1]

History of the Herbst Appliance

Introduced by Emil Herbst at the International Dental Congress in 1909, the Herbst appliance was the first fixed functional appliance for the treatment of Class II malocclusions. Herbst presented his appliance as a fixed bite jumping device that keeps the mandible in a continuous anterior forced position both on jaw closure and opening.[6] Herbst believed that due to the forced anterior repositioning of the mandible, mandibular jaw and muscle function could therefore be altered.[6] After several years of experience with his functional appliance, Herbst presented a series of articles in 1934 presenting his clinical results. After these publications, however, very few studies were published on this subject until 1979, when Hans Pancherz reintroduced the appliance and brought to attention the possibility of stimulating mandibular condylar growth by means of the Herbst appliance.[6] Pancherz conducted several short and long term studies, analyzing the effects of the Herbst appliance on occlusion, the dentofacial complex, and the masticatory system.[6] These studies led to an increase in popularity of the appliance throughout Europe and the United States, in addition to the publication of a myriad of clinical and scientific studies on the Herbst appliance.

As explained by Pancherz, the Herbst appliance is similar to an artificial joint situated between the maxilla and mandible. Although there are several different Herbst designs (orthodontic bands, stainless steel crowns, cast splint, acrylic splint), the mechanism of action remains the same regardless of the anchorage system used: on closing, the mandible is kept in a continuous protrusive position through a bilateral telescoping mechanism which attaches the maxillary permanent first molars to the mandibular permanent first molars and premolars. Each telescope consists of a tube

(attached to the maxillary molar) and a plunger (attached to the mandibular premolar) which fit together and freely rotate around their point of attachment.[6] When the jaw is closed, the telescoping system produces a posteriorly directed force on the maxillary posterior dentition and an anteriorly directed force on the mandibular anterior dentition.

In 1979, Pancherz prospectively investigated the effect of continuous bite jumping with the Herbst appliance on occlusion and the craniofacial complex. Twenty growing boys with Class II division I malocclusion were selected, half of which were treated with the Herbst appliance for 6 months, while the other half served as the control. Treatment results showed that maxillary growth was inhibited/redirected, mandibular growth was greater than average, mandibular length increased, lower facial height increased, and the convexity of the soft/hard tissue profile was reduced.[6] Following this study, Pancherz published a series of studies analyzing the effects of the Herbst appliance on masticatory muscle activity, the dentofacial complex, facial asymmetries, and overall growth and development.[7] Later in 1997 he published a study summarizing the existing scientific data with respect to short and long term effects of the Herbst appliance on occlusion and the maxillo-mandibular complex based on all his previous studies. In a summary article, which reviews his findings in several of these previously published articles, he demonstrated that the Herbst appliance inhibits maxillary growth, enhances mandibular growth, moves the maxillary dentition posteriorly, and causes an anterior movement of mandibular dentition with proclination of the mandibular incisors.[7]

In 1998, Lai and McNamara retrospectively evaluated the skeletal and dental changes occurring during a two-phase treatment using the acrylic-splint Herbst appliance followed by a preadjusted edgewise appliance, aiming to assess the impact of the Herbst

appliance on mandibular growth, vertical control, and dentoalveolar movement. Forty Class II division I growing samples, with a range of ages from 11.8 years to 15.8 years were selected. Treatment changes were compared with growth changes that would have occurred without treatment through normative values derived from the University of Michigan Elementary and Secondary School Growth Study. Treatment results demonstrated an acceleration of mandibular growth during Herbst therapy that was followed by a reduced rate of mandibular growth during the edgewise phase. The significant increase in the SNB angle evident during Herbst treatment was reversed during the fixed appliance phase, resulting in no significant mandibular difference. The overall increase in mandibular length, however, was significantly greater than the control data for the entire sample. There was no significant treatment effect on lower anterior facial height or on the mandibular plane angle, either at the end of Herbst therapy or at the end of edgewise treatment. The authors explain that Class II correction achieved by the Herbst appliance was mainly due to mandibular growth, distal movement of the maxillary molars, and mesial movement of the mandibular molars and incisors. In terms of its effect on mandibular length, they conclude that the Herbst appliance can have either a modest stimulatory or transient effect on mandibular growth that diminishes with time without a significant effect on the vertical growth of the face.[8]

In 1999, Franchi, Baccetti, and McNamara retrospectively evaluated the skeletal and dentoalveolar changes induced by the acrylic splint Herbst appliance in the correction of Class II malocclusion in 55 growing patients. Their study demonstrated overjet and molar correction via skeletal and dentoalveolar changes. Results indicated changes in the mandibular sagittal position and in mandibular dimensions (significant increases in total

mandibular length and in mandibular ramus height), and mesial movement of the mandibular dental arch.[9] They argue that the increased vertical growth of the mandibular ramus was due to the presence of the acrylic splint while mandibular lengthening was associated to the induced posterior direction of condylar growth. Regarding maxillary dentoskeletal effects, the only significant change was the distal movement of the maxillary molars. Mesial movement of the mandibular dentition represented the only significant mandibular dental change, and the authors explain that this movement substantially contributed to the correction of both overjet and molar relation. Lastly, the authors express that the amount of relapse occurring during the posttreatment period was mainly attributed to the mesial movement of the maxillary molars.[9]

Hiyama and McNamara conducted a longitudinal study in 2000 examining the neuromuscular and skeletal adaptations to changes in sagittal jaw relationships induced by the Herbst appliance in 6 Class II division I growing patients. Study results demonstrated a decrease in overbite, overjet, and ANB angle, lingual tipping of maxillary incisors, and labial tipping of mandibular incisors. Regarding condylar movements and lateral pterygoid activity, the condyles of all the patients were positioned anteroinferiorly with an increased muscular activity. However 4-6 months after appliance delivery, the condyles of all patients tended to closely approach, but were slightly forward, of their original positions at stage I, while lateral pterygoid muscle activity decreased to the level observed at stage I. At the end of Herbst treatment, the condyles of three out of six patients remained more anteroinferior compared to their initial positions while lateral pterygoid muscle activity was increased slightly in all patients. 2 weeks after appliance removal, the condyle of only one patient remained more anteroinferior while muscle

activity in three patients decreased to the initial level. Through their observations, the authors demonstrate that adaptive changes in muscle function occurs within a relatively short period (4 to 6 months) and precedes the compensatory morphological changes in the anatomical relationship between the condyle and the glenoid fossa induced by the Herbst appliance.[10]

In a randomized controlled clinical trial conducted by O'Brian et al in 2003, the authors evaluated the effectiveness of the Herbst and Twin block appliances for Class II division I malocclusion correction in 215 patients. Results demonstrated no difference in the total duration of treatment between both groups. However, patients who wore the Twin block spent more time in the functional appliance phase of treatment compared to the Herbst patients, while the Herbst appliance was associated with more breakage or debonding and hence more appointment time. Regarding patient cooperation, the authors demonstrated that cooperation was greater with the Herbst than the Twin block, as the non-completion rate with the Twin block was twice that of the Herbst. It was also demonstrated that the Herbst appliance was more effective in overjet reduction in phase I of treatment. Despite this, treatment time was not shorter for Herbst patients because the second phase of fixed appliance treatment was longer than with the Twin block. This was most likely associated with the ability of the Twin block to correct the posterior dental features during the later months of phase I orthopedic treatment via trimming of the appliance. In contrast to the Twin block, fixed appliance therapy after Herbst removal was more complex due to the persistence of dental features, such as posterior lateral open bites. Regarding the morphologic changes, the authors showed no differences in skeletal and dental changes between the appliances, but that the final occlusal result and skeletal

discrepancy were more ideal for girls than for boys. They demonstrated that most of the changes associated with the appliances were dental: maxillary incisors were retracted and mandibular incisors were proclined. The authors concluded that because of the high cooperation rates, the Herbst appliance can be the appliance of choice for treating adolescents with Class II division I malocclusions.[11]

Another similar study was conducted by Schaefer and Baccetti in 2004 comparing the effects of the Twin block and Herbst appliances followed by fixed appliance therapy. In this retrospective study of 56 Class II division I growing patients, results demonstrated that there was no significant difference in the increase in mandibular length between the two treatment groups during the orthopedic phase of treatment. The Twin block group, however, underwent greater mandibular advancement in addition to a greater reduction in the ANB angle as compared to the Herbst group. Furthermore, the Twin block group showed a larger increase in the height of the mandibular ramus, a greater reduction of overjet, and a significantly greater correction in molar relationship. Both groups showed labial tipping and mesial movement of mandibular incisors and mandibular molars respectively. Soft tissue changes were also similar between both groups, with a significantly larger increase in the nasolabial angle in the Twin block group. Overall, the authors demonstrated that both treatment modalities produced similar therapeutic changes in Class II patients and produced a normalization of the maxillary and mandibular dentoskeletal relationships at the end of treatment.[12]

In a prospective study conducted by Almeida and McNamara, the authors aimed to evaluate the dentoalveolar and skeletal changes produced by the Herbst appliance during treatment of 30 mixed dentition patients with Class II division I malocclusion.

Treated patients were compared to 30 untreated Class II children who were followed for 12 months without treatment. In terms of skeletal changes resulting from orthopedic treatment, the authors found no statistically significant differences between the Herbst and control groups in maxillary skeletal measurements. Similar to the control group, the maxillae of the Herbst group grew downward and forward at the same rate; therefore showing no statistically significant changes in forward growth of the maxilla. Regarding the mandible however, there was a modest but statistically significant increase in mandibular length for the treated group as compared to the control group. In terms of maxillo-mandibular relationships, the ANB angle decreased significantly more in the Herbst group, demonstrating an improvement of the anteroposterior relationship between the maxillary and mandibular dentition. The mandibular plane, palatal plane, lower anterior facial height, and posterior facial height, however, were unaffected by treatment. Dentoalveolar effects demonstrated lingual inclination and retrusion of maxillary incisors and an inhibition of maxillary molar eruption. The mandibular incisors showed significant labial tipping and protrusion, while mandibular molars showed slight extrusion. Despite the statistically significant difference regarding the effects of the Herbst appliance on mandibular growth, the authors conclude that although the differences exist between treated subjects and controls, the apparent significance is not clinically relevant.[13]

VanLaecken et al conducted a retrospective study in 2006 investigating the short term and follow-up skeletal and dental changes of 32 patients treated with the edgewise Herbst appliance. Patients were treated orthopedically with the Herbst appliance for eight months, and were followed for another 16 months after removal of the appliance. During

this observational period, mixed dentition patients were treated with 2x4 appliances, while permanent dentition patients were treated with full appliances. Comparing treatment results immediately after Herbst removal (T2) to the follow-up period of 16 months (T3), sagittal changes demonstrated a net restraint of maxillary forward growth, an increase in mandibular length, and a net forward movement of the mandible relative to cranial base, altogether resulting in a net decrease in the ANB angle. Dentally, maxillary incisors showed a net forward and labial movement, mandibular incisors a net forward and proclined movement, maxillary molars a net backwards movement, and mandibular molars a net forward movement. The molar relationship was hence corrected with an overall backwards movement of the maxillary molars and forward movement of the mandibular molars. Vertical changes demonstrate a downward movement of the maxilla, a decrease in the lower facial height, a downward movement of the palatal plane, and a clockwise tipping of the occlusal plane. The maxillary incisors exhibited an extrusive movement and the mandibular incisors an intrusive movement, while the maxillary molars showed an intrusive movement and the mandibular molars an extrusive movement, overall demonstrating a decrease in the overbite. The authors argue that after eight months of Herbst appliance treatment, correction of overjet and molar relationship by edgewise Herbst treatment was due to a combination of several factors including: the posterior movement of the maxilla and maxillary dentition, increased horizontal component of condylar growth, anterior displacement of the mandible, and possible remodeling of the glenoid fossa. However, during the 16 months of post-Herbst treatment, although part of the initial skeletal correction was lost, the net effects of the

treatment were in fact skeletal, suggesting that the advantage of edgewise treatment combined with Herbst treatment can maximize this skeletal outcome.[14]

Cozza, Baccetti, and McNamara conducted a systematic review assessing the scientific evidence on the efficiency of functional appliances in enhancing mandibular growth in Class II subjects. Using the Medline database from January 1966 to January 2005, their search obtained 704 articles, only 22 of which were included due to their stringent inclusion/exclusion criteria. Out of these 22 articles, four were randomized clinical trials, two were prospective controlled clinical trials, and 16 were retrospective controlled clinical trials. Analysis of the included studies demonstrated that functional appliances produce a statistically significant annualized supplementary elongation in 23 out of 33 samples for total mandibular length, in 12 of 17 samples for mandibular ramus height, and in 8 of 23 samples for mandibular body length. Study results revealed that the Herbst appliance had a coefficient of efficiency (calculated by dividing the supplementary elongation of the mandible obtained during the overall treatment period with the functional appliance by the number of months of active treatment) of 0.28 mm per month, followed by 0.23 for the Twin block, and 0.17 for the Bionator. It is interesting to note that none of the four randomized clinical trials reported a clinically significant change in mandibular length induced by any of the functional appliances. All the studies pointed out that mandibular position relative to cranial base, as measured by the SNB angle, was not impacted in a clinically significant way by functional jaw orthopedics. The authors affirm that the SNB angle is a poor indicator of the effectiveness of functional jaw orthopedics. They explain that in most patients, the initial correction of a Class II relationship involves not only the forward posturing of the

mandible, but also a vertical opening of the bite. Therefore, the authors emphasize that a one mm increase in lower anterior facial height camouflages a one mm increase in mandibular length, and hence the advancement of the chin point at pogonion might not be evident if the vertical dimension is increased along with mandibular length. With this known, the authors explain that the short term amount of supplementary mandibular growth appears to be significantly larger when functional treatment is performed during the adolescent growth spurt. This can possibly explain why the randomized clinical trials failed to show changes in mandibular length, as three out of four of the trials described outcomes of treatment at a prepubertal stage of skeletal maturity. Overall, the authors conclude that two-thirds of the samples in their included studies reported clinically significant supplementary elongation in total mandibular length as a result of overall active treatment with functional appliances, with the Herbst appliance showing the highest coefficient of efficiency.[15]

In another systematic review conducted by Flores-Mir et al in 2007, the authors investigated the skeletal and dental changes in growing individuals through lateral cephalograms obtained after the sole use of the splint type Herbst appliance to correct Class II division I malocclusions. Several electronic databases were used to search for studies from 1966 to January 2006. From the 438 studies obtained, three studies passed the rigorous inclusion/exclusion criteria. Study results revealed an increased mandibular anteroposterior length, increased vertical ramus height, increased lower facial height, mandibular incisor proclination, mesial movement of mandibular molars, and distal movement of maxillary molars. Furthermore, they explain that although the magnitudes of the reported differences were significant in several cases, they were however, not

clinically significant. Rather, the overall position change reported is due to the combination of several small changes in different skeletal and dental areas. The authors explain that conducting a systematic review in the context of functional appliances presents a great challenge in that investigations generally use different variables and reference points in cephalometric analyses, hence drastically affecting the number of studies that can be included in review. This fact can explain why the generation of a meta-analysis in this area of interest is almost close to impossible.[16]

Siara-Olds et al conducted a retrospective study in 2010 to assess the treatment outcome of different tooth-borne functional appliances including the Bionator, Herbst, Twin block, and Mandibular Anterior Repositioning Appliance (MARA), and to analyze their stability over time and after fixed appliance therapy. The treatment sample consisted of 80 patients with similar Class II skeletal characteristics. Results of each functional appliance were compared to each other and to untreated controls with similar Class II malocclusions. Study results demonstrated no significant long term dento-skeletal differences between the various treatment groups and matched controls. Comparison of different treatment modalities revealed that the Herbst and MARA appliances significantly restricted maxillary growth and produced a steeper occlusal plane, while the Twin block was most effective in controlling the mandibular plane angle and had the greatest long term effect on labial tipping of the mandibular incisors. They demonstrated that the Herbst group showed a significant decrease of the Wits and a decrease in overbite and overjet at the end of treatment.[17]

In 2011, Wigal et al conducted a retrospective study aiming to investigate the skeletal and dental changes of Class II patients treated in the early mixed dentition with

the crowned Herbst appliance. They also aimed to assess the stability of the changes after a second phase of fixed appliance therapy. Their sample consisted of 22 mixed dentition subjects with a mean age of 8.4 years, all of which were matched with untreated controls according to sex, age, and craniofacial morphology. In addition to the Herbst appliance, brackets were bonded to the maxillary and mandibular incisors. After Herbst removal, 2x4 appliances were continued until anterior occlusion, overbite, and incisor torque was corrected. Upon appliance removal, maxillary and mandibular lingual holding arches were placed until the subjects were ready for comprehensive orthodontic treatment. Treatment results demonstrated a restraint in the forward movement of the maxilla and a significant advancement in the position of the mandibular base upon Herbst removal. However, after fixed appliance therapy, the mandible moved backward when compared with the control group, suggesting that the forward positioning of the mandibular base was not maintained after phase 2 treatment. Dentally, the authors explain that due to the posterior superior force on the maxillary dentition and the anterior inferior force on the mandibular dentition, the forces resulted in the distalization of the maxillary molars, retroclination of the maxillary incisors, mesial movement of the mandibular molars, and proclination of the mandibular incisors. No significant differences were found in the mandibular plane angle and in anterior lower facial height. Overall, the authors suggest that the treatment of Class II patients with the Herbst appliance in the early mixed dentition resulted in Class II correction that was stable after fixed appliance treatment. They explain that the continuous restraint in the forward growth of the maxilla contributed toward maintaining the corrected overjet and molar position observed, although the mandible returned to the pretreatment position after fixed appliance therapy.

The backward movement of the maxillary incisors and forward movement of the mandibular incisors were maintained after fixed appliance therapy, also contributing to the changes in overjet and molar relationship. Distalization of the maxillary molars and forward movement of the mandibular incisors returned to pretreatment positions after fixed appliance therapy.[18]

History of the Forsus Fatigue Resistant Device

Developed by Bill Vogt in 2001, the Forsus Fatigue Resistance Device (Forsus)—also known as the Forsus spring—is an increasingly popular fixed functional appliance used for Class II correction. As described by Vogt in the clinical application of his device in 2006, the Forsus consists of a semirigid telescoping system that incorporates a superelastic nickel-titanium interarch push spring which produces about 200g of force, similar to that of heavy Class II elastics.[19] The appliance can be assembled chairside and can be used in conjunction with complete orthodontic appliances.[20] The Forsus attaches at the maxillary first molar bands and directly onto the mandibular archwire, just distal to either the mandibular canine or first premolar brackets. Due to its relatively simple design, it is easy and quick to assemble, quite comfortable, and less visible than other appliances.[2] As the patient's mouth closes, the coil is compressed and opposing forces are transmitted to the sites of attachment, hence keeping the mandible in a forward protrusive position.[19] Although this fixed functional appliance is relatively new compared to other Class II correctors, it has received tremendous clinical attention since its discovery.

First documented in 2001 by Heinig et al in a retrospective study, the authors aimed to clarify specific changes on lateral cephalograms and on plaster models after the application of the Forsus for four months in 13 growing Class II patients. They also aimed to elucidate specific clinical problems associated with this novel appliance via patient questionnaires. Study results demonstrated that the SNA angle remained constant, while the SNB angle increased, resulting in a decreased ANB angle. Statistically significant changes were found in all of the following: bite opening via an increase in occlusal plane angle, a forward shift of pogonion, an increase in mandibular length,

retrusion of the maxillary anterior segment, and protrusion of the mandibular anterior segment. Dentally, the authors recorded retrusion of the maxillary incisors, protrusion of the mandibular incisors, distal movement of the maxillary molars, and mesial movement of the mandibular molars—all resulting in a decrease in overjet and an improvement of the molar relationship. The SN-MeGo angle, angle of inclination, basal plane angle, Y-axis, and facial height ratio all remained largely unchanged. Regarding the dental cast analysis, models exhibited broadening of the maxillary and mandibular arches, and a reduction of overjet and overbite. In terms of the patient questionnaire, patients did not experience any dental or temporomandibular joint pain or any sleep disturbances during treatment. They did however, complain of minor speech problems, limited mouth opening, soreness of the cheeks, increased oral hygiene difficulties, and an interference with yawning. Overall, the authors explain that malocclusion correction via the Forsus is mainly due to dentoalveolar effects and to a lesser extent, the altered position of the mandible. They conclude that the appliance provides an alternative to other fixed functional appliances and that together with dental effects, the mandibular displacement achieved can lead to an improvement in Class II sagittal discrepancy.[21]

After Vogt's discovery of the Forsus in 2001 and its clinical application by Heinig et al,[21] Vogt presented his findings in 2006 in a case study exhibiting the general design and installation of the appliance.[19] As Vogt explains, in a full cusp Class II case the Forsus should be continued until the incisors are edge-to-edge, but caution must be taken to prevent overcorrection into crossbite. In a Class II case that is a half cusp or less, however, the occlusion should not be overcorrected past a Class I position. Vogt states that his appliance can be used instead of Class II elastics in mild cases and instead of the

Herbst appliance in severe cases. He explains that the Forsus works best in patients with convex profiles, but that it can be used for any Class II patient except those with normal mandibles and protrusive maxillae, or with protrusive or overly large mandibles relative to the other cranial structures. He states that although the Forsus can serve as a last-resort appliance in cases of non-compliance, it is preferable for the orthodontist to incorporate the appliance into the treatment plan early on, especially because patient cooperation is largely eliminated.[19]

In 2006 Karacay et al prospectively compared the effects of the Forsus and the Jasper Jumper (JJ) appliance in the correction of Class II division I malocclusions.[3] The sample included 48 growing patients with retrognathic mandibles who were randomly assigned to the Forsus group, JJ appliance group, or control group. Study results demonstrated that a Class I molar relationship was achieved through the use of both appliances. The Forsus and JJ appliances both stimulated mandibular growth and inhibited maxillary growth. In terms of the dentoalveolar effects, the appliances retruded, extruded, and uprighted the maxillary incisors, whereas the mandibular incisors were protruded, intruded, and tipped labially. The maxillary molars were distalized and intruded while mandibular molars moved mesially and were extruded. In addition to a decreased overbite and overjet, a posterior rotation of the occlusal plane was also exhibited. Furthermore, the authors noted an improvement in profile due to the protrusion of the lower lip and soft tissue pogonion. Lastly, study models revealed an increase in the maxillary and mandibular intermolar and intercanine widths in both treatment groups. The authors conclude that both the Forsus and the Jasper Jumper appliances stimulate

mandibular growth and inhibit maxillary growth and that although they induce skeletal changes, dentoalveolar changes are much more pervasive.[3]

In 2008, Jones et al retrospectively determined the skeletal and dental effects produced during Class II correction with the Forsus versus Class II elastics. There study consisted of a sample of 34 nonextraction patients treated with Forsus who were matched with a sample of 34 nonextraction patients treated with Class II elastics. Study results demonstrate protrusion and extrusion of maxillary incisors, and protrusion and intrusion of mandibular incisors in both groups. Furthermore, in both groups, maxillary and mandibular molars moved mesially and extruded, the occlusal plane rotated clockwise, and overjet improved. The authors explain that molar correction for patients treated with the Forsus was predominately due to forward mandibular skeletal and dental movements. They concluded that greater forward displacement of the mandible is the predominant factor contributing to success when treating Class II patients with either Class II elastics or with the Forsus and confirmed that Forsus is an acceptable substitute for Class II elastics for patients who appear to be non-compliant.[1]

Arici et al conducted a retrospective study in 2008 using computed tomography to investigate the influence of the Forsus on the condylar position in the glenoid fossa in patients with Class II division I skeletal malocclusion that were in the active growth period.[22] Their study included 60 mandibular retrognathic patients of which half were treated with the Forsus while the remaining 30 served as controls. CT scanning of the TMJ was performed in all patients. Study results demonstrated that the glenoid fossa continued to enlarge in the growth period, with no significant difference between the two groups. Although the Forsus did not significantly influence glenoid fossa growth, anterior

joint space volume significantly increased in the study group as compared to the control group. Posterior joint space volume, on the other hand, significantly decreased in the study group when compared to the control groups. Study results suggest that the Forsus caused a considerable decrease in the volume of the posterior joint space. The authors defend their findings by explaining that the decrease in the posterior joint space with the appliance might be due to the induction of the growth of the condyle in a posterior direction, rotational movement of the condyle in the glenoid fossa, and anterior remodeling of the posterior border of the glenoid fossa. The increase in volume of the anterior joint space—as demonstrated in both groups—could reflect remodeling of the articular eminence. The authors explain that in rigid fixed functional appliances—such as the Herbst appliance—the condyle cannot return to its original seated position, whereas the flexible Forsus allows the patient to function in centric occlusion. Hence, it is the flexibility of the Forsus appliance—as compared to rigid functional appliances—that results in greater effects on the condyle-fossa relationship. Overall, the Forsus significantly increased the changes in the anterior and posterior joint spaces due presumably to the continuous and elastic type of force produced.[22]

In a recent retrospective study conducted by Franchi and Baccetti in 2011, the authors assessed the dental, skeletal, and soft tissue effects of comprehensive fixed appliance treatment combined with the Forsus in 32 cirbumpubertal Class II patients.[20] The Forsus was applied at the end of the aligning and leveling phase and was used for a mean duration of 5.2 months, until which the Class II occlusion was overcorrected to an edge-to-edge incisor relationship. Compared to natural growth changes in Class II controls, study results demonstrated a significant restraint in the sagittal skeletal position

of the maxilla, an increase in the effective mandibular length, a significant decrease in the ANB angle and Wits appraisal, and an increase in the maxillo-mandibular differential. Regarding changes in the vertical skeletal relationships, the increase in lower anterior facial height was significantly greater in the treatment group compared to the untreated controls. The treatment group exhibited a significant reduction in overjet, overbite, and interincisal angle, as well as a significant improvement in the molar relationship. Maxillary incisors were retruded and extruded, mandibular incisors moved forward and were proclined and intruded, mandibular molars were extruded and moved significantly in a mesial direction. There was a significantly greater backward movement of the soft tissue A point in the Forsus group as compared to the control group. Regarding skeletal effects, the authors explain that in addition to restraining maxillary sagittal growth, there was a significantly greater increase in total mandibular length, but the increase was not associated with a significant improvement in the sagittal position of the bony and soft tissue chin. The authors express that the lack of a significant effect of the Forsus on the sagittal position of the chin might be correlated with the short duration of active treatment. Overall, the authors conclude that the Forsus led to a successful correction of Class II malocclusion by restraining maxillary sagittal advancement, and by producing a mesial movement of the mandibular incisors and first molars.[20]

Another study conducted by Bilgic et al in 2011 retrospectively compared the dental and skeletal changes obtained using either the Activator or the Forsus in the treatment of Class II division I malocclusions.[2] Patients were in treatment with either appliance for about 6 months after which appliances were removed. The Forsus group, however, continued with Class II elastics for retention of treatment results. Results

demonstrate that a dental Class I molar relationship was achieved and the overjet was decreased in both functional appliance groups. Skeletal parameters revealed similar improvements in the Forsus and Activator treatment groups. The ANB angle decreased in both groups and resulted from mandibular advancement in the Activator group and maxillary retrusion in the Forsus group. Dental changes revealed that in the Forsus group, maxillary incisors retroclined, extruded, and distally tipped, whereas mandibular incisors proclined, intruded, and were tipped labially. Maxillary molars distalized and intruded, while mandibular molars moved mesially and extruded. The dental changes were not limited to the anterior teeth but also involved a clockwise rotation of the occlusal plane. The authors conclude that the Forsus appliance provides an alternative to other functional Class II systems and that dental effects, rather than skeletal effects, were observed as corrective benefits in the Forsus group.[2]

Aras et al conducted a retrospective study in 2011 comparing the dentoskeletal changes and alterations of mandibular condyle-disc-fossa relationships in subjects at the peak and the end of the pubertal growth period treated with the Forsus.[23] The subjects included 29 Class II division I patients who were divided into two groups based on their skeletal maturity: peak pubertal group and late pubertal group. Study results demonstrated that Forsus led to an anteriorly positioned mandible with a decreased ANB angle in both groups. In the peak pubertal group, increases in mandibular length and ramus height were found to be statistically significant. Dentally at the end of the Forsus treatment, both groups showed palatal tipping and extrusion of the maxillary incisors, protrusion and intrusion with labial tipping of mandibular incisors, and mesial movement and mesial tipping of the mandibular molars. There were no significant changes in the

joint space index in either group. Although the disc showed a tendency to position protrusively in relation to the condyle in the peak pubertal group, the difference between the two groups was not statistically significant. Furthermore, although cephalometric data demonstrate augmented mandibular length or forward displacement of the mandible, the magnetic resonance images of the TMJs showed that the condyle-fossa relationship was on average unaffected by the Forsus treatment. The authors justify this finding by explaining that these mandibular changes must have been accompanied by appositional growth of the condyle and the glenoid fossa. They conclude that Class II treatment with the Forsus appliance was accompanied by skeletal and dental changes, but that increases in mandibular dimensions and advancements of the mandible were small. In late adolescents, no significant changes were observed in mandibular dimensions, but dental changes were practically the same in adolescents at the peak of puberty and in late puberty. Furthermore, they conclude that changes in the condyle positions were statistically insignificant and the appliance did not result in a nonphysiologic disc-condyle relationship. Hence, they explain that the Forsus is not a risk factor for the development of TMJ dysfunction in subjects with no signs or clinical symptoms. However, they believe that in symptomatic Class II patients, magnetic resonance images or other visual evaluations should be performed to construct a well-organized treatment plan and to select the most appropriate Class II correcting appliance.[23]

A recent prospective clinical trial was conducted in 2012 by Upadhyay et al to examine the dentoskeletal and soft tissue treatment effects of maxillary anterior tooth retraction with mini-implant anchorage in Class II division I patients undergoing extraction of only the maxillary first premolars in comparison to similar patients

undergoing treatment with a nonextraction approach using the Forsus.[5] The subjects consisted of 32 patients divided into two groups based on treatment protocol (extraction vs. nonextraction). Study results demonstrated that both methods were useful in correcting the overjet and improving the interincisal relationships. In the nonextraction Forsus group, overjet correction was obtained by retraction of the maxillary incisors and mandibular incisor flaring, whereas in the extraction group overjet was corrected by complete retraction of maxillary anterior teeth only. Both groups exhibited intrusion of maxillary molars and extrusion of mandibular molars, while total treatment time was less for the Forsus group. Furthermore, the posterior facial height to anterior facial height ratio increased for both groups. In terms of soft tissue changes, results demonstrated a decrease in lower lip projection in the extraction group, whereas an increase was noted in the Forsus group. There was also an increase in the nasolabial angle in both groups, with the extraction group showing a greater increase. Overall, the authors conclude that the two treatment protocols provide an adequate dental compensation for the Class II malocclusion, but neither treatment affected the skeletal discrepancy. In addition, there were significant differences in the dental and soft tissue treatment effects between the groups, with the Forsus group resulting in significant mandibular incisor flaring.[5]

The Herbst Appliance versus Forsus Fatigue Resistant Device

More studies are needed comparing the effects of the Forsus to the effects of various Class II correcting appliances, such as the Herbst appliance. The skeletal and dental changes produced by the Forsus may be substantially different from those produced by the Herbst appliance. Therefore, it is important that the potential differences between these appliance systems be identified and understood, subsequently allowing the orthodontist to make appropriate treatment planning decisions and alternatives.

As of yet, there has been no study assessing the effectiveness of the Forsus compared to the Herbst appliance. Furthermore, no previous study has compared both appliances to untreated Class II controls. The present study was designed to evaluate the skeletal and dentoalveolar effects produced during Class II correction with the Forsus compared to those produced with the Herbst appliance. Main features of this study include the comparison of both treated groups with matched untreated Class II controls and the appraisal of the saggital, vertical and angular skeletal and dentoalveolar changes occurring after comprehensive orthodontic treatment.

REFERENCES

1. Jones G. Class II non-extraction patients treated with the forsus fatigue resistant device versus intermaxillary elastics. Angle Ortho 2008;78(2): 332-338.
2. Bilgic F. Comparison of the effects of fixed and removable functional appliances on the skeletal and dentoalveolar structures. Australian Orthod J 2011;27(2):110-116.
3. Karacay S. Forsus nitinol flat spring and jasper jumper corrections of class II division 1 malocclusions. Angle Orthod 2006;76(4):666-672.
4. McNamara JA. Components of class II malocclusion in children 8-10 years of age. Angle Orthod 1981;51:177-202.
5. Upadhyay M. Mini-implants vs fixed functional appliances for treatment of young adult class II female patients. Angle Orthod 2012;82:294-303.
6. Pancherz H. Treatment of class II malocclusions by jumping the bite with the herbst appliance: a cephalometric investigation. Am J Orthod 1979;76(4):423-442.
7. Pancherz H. The effects, limitations, and long-term dentofacial adaptations to treatment with the herbst appliance. Seminars in Orthod 1997;3(4):232-243.
8. Lai M. An evaluation of two-phase treatment with the herbst appliance and preadjusted edgewise therapy. Seminars in Orthodontics 1998;4(1): 46-58.
9. Franchi L. Treatment and posttreatment effects of acrylic spingt herbst appliance therapy. Am J Orthod Dentofacial Orthop 1999;115:429-438.
10. Hiyama S. Neuromuscular and skeletal adaptations following mandibular forward positioning induced by the herbst appliance. Angle Orthod 2000;70(6):442-453.

11. O'Brian K. Effectiveness of treatment for class II malocclusion with the herbst or twin block appliances: a randomized, controlled trial. Am J Orthod Dentofacial Orthop 2003;124(2):128-137.

12. Schaefer A. A cephalometric comparison of treatment with the twin-block and stainless steel crown herbst appliances followed by fixed appliances therapy. Am J Orthod Dentofacial Orthop 2004;126(1):7-15.

13. Rodrigues de Almeida, M. Short-term treatment effects produced by the herbst appliance in the mixed dentition. Angle Orthod 2005;75(4):540-547.

14. VanLaecken R. Treatment effects of the edgewise herbst appliance: a cephalometric and tomographic investigation. Am J Orthod Dentofacial Orthop 2006;130(5):582-593.

15. Cozza P. Mandibular changes produced by functional appliances in class II malocclusion: a systematic review. Am J Orthod Dentofacial Orthop 2006;129(5):e1-599.e12.

16. Flores-Mir C. Skeletal and dental changes in class II division 1 malocclusions treated with splint-type herbst appliances: a systematic review. Angel Orthod 2007;77(2):376-381.

17. Siara-Olds NJ. Long-term dentoskeletal changes with the bionator, herbst, twin block and MARA functional appliances. Angle Orthod 2010;80(1):18-28.

18. Wigal TG. Stability of class II treatment with an edgewise crowned herbst appliance in the early mixed dentition: skeletal and dental changes. Am J Orthod Dentofacial Orthop 2011;140(2):210-223.

19. Vogt W. The forsus fatigue resistant device. J Clin Ortho 2006;40:368-377.

20. Franchi L. Effectiveness of comprehensive fixed appliance treatment used with the forsus fatigue resistant device in class II patients. Angle Orthod 2011;81:678-683.

21. Heinig N. Clinical application and effects of the forsus spring: a study of a new herbst hybrid. J Orofac Orthop 2001;62:436-50.

22. Arici S. Effects of fixed functional appliance treatment on the temporomandibular joint. Am J of Dentofacial Orthop 2008;133:809-814.

23. Aras A. Comparison of treatments with the forsus fatigue resistant device in relation to skeletal maturity: a cephalometric and magnetic resonance imaging study. Am J Orthod Dnetofacial Orthop 2011;140:616-625.

Appendix 1: ANOVA and Tukey Post-hoc Tests for Comparisons of Measurements at T1.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Ba-S-N (°)	HERBST	38	132.4763	5.30886	.86121	130.7313	134.2213	124.10	148.00
	FORSUS	38	131.7921	4.80194	.77898	130.2137	133.3705	122.90	142.30
	CONTROL	38	130.1816	5.75213	.93312	128.2909	132.0723	117.50	142.60
	Total	114	131.4833	5.34283	.50040	130.4919	132.4747	117.50	148.00
SNA (°)	HERBST	38	81.9974	4.66884	.75739	80.4628	83.5320	72.70	91.50
	FORSUS	38	81.3000	3.34292	.54229	80.2012	82.3988	74.80	87.80
	CONTROL	38	83.2158	4.46473	.72427	81.7483	84.6833	76.40	94.70
	Total	114	82.1711	4.23744	.39687	81.3848	82.9573	72.70	94.70
Pt A to Nasion perp, mm	HERBST	38	-4.0890	4.40308	.71427	-5.5363	-2.6418	-13.80	3.24
	FORSUS	38	-4.1521	3.92399	.63656	-5.4419	-2.8623	-10.86	4.69
	CONTROL	38	-1.4426	4.23732	.68738	-2.8354	-.0498	-12.96	8.33
	Total	114	-3.2279	4.34479	.40693	-4.0341	-2.4217	-13.80	8.33
Co-Pt A, mm	HERBST	38	86.2325	12.92632	2.09693	81.9838	90.4813	57.04	114.82
	FORSUS	38	90.9154	13.42643	2.17805	86.5022	95.3285	66.52	126.87
	CONTROL	38	86.6712	16.19086	2.62650	81.3494	91.9930	35.56	125.20
	Total	114	87.9397	14.28533	1.33794	85.2890	90.5904	35.56	126.87
SNB (°)	HERBST	38	76.4632	4.37100	.70907	75.0264	77.8999	68.70	86.90
	FORSUS	38	75.5026	3.11270	.50495	74.4795	76.5258	69.90	81.70
	CONTROL	38	78.3763	3.70802	.60152	77.1575	79.5951	71.10	85.70
	Total	114	76.7807	3.92042	.36718	76.0532	77.5082	68.70	86.90
Pg to Nasion perp, mm	HERBST	38	-16.0490	8.59638	1.39452	-18.8746	-13.2235	-33.06	-1.85
	FORSUS	38	-17.2185	9.69930	1.57343	-20.4066	-14.0304	-37.81	2.85
	CONTROL	38	-10.2347	7.37064	1.19568	-12.6574	-7.8121	-28.71	2.32
	Total	114	-14.5008	9.06635	.84914	-16.1831	-12.8185	-37.81	2.85
Co-Gn, mm	HERBST	38	107.3868	13.73391	2.22793	102.8725	111.9010	78.43	138.90
	FORSUS	38	110.3661	14.90103	2.41727	105.4683	115.2640	82.62	145.54
	CONTROL	38	108.1763	19.46548	3.15772	101.7782	114.5744	49.17	154.36
	Total	114	108.6431	16.12863	1.51058	105.6503	111.6358	49.17	154.36
Co-Go, mm	HERBST	38	56.8735	7.13957	1.15819	54.5267	59.2202	42.78	71.49
	FORSUS	38	58.1295	8.43640	1.36857	55.3565	60.9024	42.87	77.28
	CONTROL	38	57.0465	11.36484	1.84362	53.3109	60.7820	26.02	82.14
	Total	114	57.3498	9.08832	.85120	55.6634	59.0362	26.02	82.14
ANB, °	HERBST	38	5.5342	2.09868	.34045	4.8444	6.2240	2.00	10.60
	FORSUS	38	5.7974	1.92684	.31257	5.1640	6.4307	1.10	11.00
	CONTROL	38	4.8395	2.67809	.43444	3.9592	5.7197	.30	10.20

	Total	114	5.3904	2.27398	.21298	4.9684	5.8123	.30	11.00
WITS, mm	HERBST	38	3.2678	2.91406	.47272	2.3100	4.2256	-1.94	12.04
	FORSUS	38	5.0116	2.28446	.37059	4.2607	5.7625	0.00	9.75
	CONTROL	38	1.4353	3.10009	.50290	.4163	2.4543	-4.07	7.59
	Total	114	3.2382	3.12842	.29300	2.6577	3.8187	-4.07	12.04
Maxillary/mandibular difference, mm	HERBST	38	21.1542	3.17353	.51481	20.1111	22.1973	14.63	27.78
	FORSUS	38	19.4580	4.27688	.69380	18.0522	20.8638	7.73	28.61
	CONTROL	38	21.5027	5.68759	.92265	19.6332	23.3722	11.20	39.63
	Total	114	20.7050	4.54795	.42595	19.8611	21.5489	7.73	39.63
FH to palatal plane, °	HERBST	38	3.5026	4.81189	.78059	1.9210	5.0843	-6.00	13.80
	FORSUS	38	2.4421	4.34198	.70436	1.0149	3.8693	-7.70	8.70
	CONTROL	38	-.1526	4.88045	.79171	-1.7568	1.4515	-8.90	9.00
	Total	114	1.9307	4.89204	.45818	1.0230	2.8384	-8.90	13.80
FH to mandibular plane, °	HERBST	38	28.9342	6.31670	1.02470	26.8580	31.0105	14.70	41.20
	FORSUS	38	26.9816	7.15398	1.16053	24.6301	29.3330	14.30	44.50
	CONTROL	38	26.9553	5.00171	.81139	25.3112	28.5993	17.10	40.50
	Total	114	27.6237	6.23543	.58400	26.4667	28.7807	14.30	44.50
Palatal plane to mandibular plane, °	HERBST	38	22.5816	5.80330	.94142	20.6741	24.4891	7.80	34.20
	FORSUS	38	21.7184	6.16287	.99975	19.6927	23.7441	9.40	34.00
	CONTROL	38	24.1737	5.57813	.90489	22.3402	26.0072	8.00	39.20
	Total	114	22.8246	5.89027	.55167	21.7316	23.9175	7.80	39.20
ArGoMe, °	HERBST	38	133.1658	5.61741	.91126	131.3194	135.0122	121.50	146.60
	FORSUS	38	131.2289	7.08038	1.14859	128.9017	133.5562	114.00	146.20
	CONTROL	38	133.6211	5.63662	.91438	131.7683	135.4738	119.50	146.00
	Total	114	132.6719	6.18347	.57914	131.5246	133.8193	114.00	146.60
CoGoMe, °	HERBST	38	127.9974	6.19186	1.00445	125.9622	130.0326	114.60	143.40
	FORSUS	38	126.5974	7.35139	1.19255	124.1810	129.0137	108.30	144.20
	CONTROL	38	129.2289	5.42935	.88076	127.4444	131.0135	119.30	140.00
	Total	114	127.9412	6.40836	.60020	126.7521	129.1303	108.30	144.20
N to ANS, mm	HERBST	38	51.7561	7.49376	1.21565	49.2930	54.2192	36.30	70.38
	FORSUS	38	53.3261	7.96219	1.29164	50.7090	55.9432	37.81	73.78
	CONTROL	38	48.7539	9.48865	1.53926	45.6351	51.8727	18.71	69.08
	Total	114	51.2787	8.50035	.79613	49.7014	52.8560	18.71	73.78
ANS to Me, mm	HERBST	38	61.2915	8.15130	1.32231	58.6122	63.9707	38.98	81.21
	FORSUS	38	61.7029	9.82042	1.59308	58.4751	64.9308	47.75	87.22
	CONTROL	38	61.7496	12.03042	1.95159	57.7953	65.7039	28.61	92.60
	Total	114	61.5813	10.03825	.94017	59.7187	63.4440	28.61	92.60
Overjet, mm	HERBST	38	6.2432	2.92174	.47397	5.2828	7.2035	2.32	13.61
	FORSUS	38	8.6286	3.66006	.59374	7.4256	9.8317	2.85	17.02
	CONTROL	38	4.7665	2.04670	.33202	4.0937	5.4392	1.11	10.83
	Total	114	6.5461	3.33278	.31214	5.9277	7.1645	1.11	17.02
Overbite, mm	HERBST	38	3.2093	2.40078	.38946	2.4202	3.9984	-2.96	7.04

	FORSUS	38	4.5104	2.28042	.36993	3.7609	5.2600	-.09	8.56
	CONTROL	38	2.8024	2.43894	.39565	2.0007	3.6040	-4.35	9.82
	Total	114	3.5074	2.46436	.23081	3.0501	3.9646	-4.35	9.82
Interincisal angle, °	HERBST	38	134.2605	10.49341	1.70226	130.8114	137.7096	113.30	149.20
	FORSUS	38	128.9658	9.58778	1.55534	125.8144	132.1172	109.70	151.60
	CONTROL	38	134.9789	9.61168	1.55922	131.8197	138.1382	115.00	155.60
	Total	114	132.7351	10.18121	.95356	130.8459	134.6243	109.70	155.60
Molar relationship, mm	HERBST	38	1.0795	1.56531	.25393	.5650	1.5940	-2.32	5.28
	FORSUS	38	1.9514	1.42014	.23038	1.4846	2.4182	-1.47	5.15
	CONTROL	38	.2973	1.48725	.24126	-.1916	.7861	-3.61	3.61
	Total	114	1.1094	1.62707	.15239	.8075	1.4113	-3.61	5.28
U1 to Pt A vertical, mm	HERBST	38	.9504	3.45182	.55996	-.1842	2.0850	-6.85	7.32
	FORSUS	38	3.1498	2.90721	.47161	2.1942	4.1054	-5.06	7.08
	CONTROL	38	1.7423	2.83905	.46055	.8092	2.6755	-5.28	7.41
	Total	114	1.9475	3.18475	.29828	1.3566	2.5384	-6.85	7.41
U1 to FH, °	HERBST	38	103.7684	9.47426	1.53693	100.6543	106.8825	82.30	119.60
	FORSUS	38	108.9737	8.45045	1.37084	106.1961	111.7513	88.80	122.60
	CONTROL	38	106.4289	7.60469	1.23364	103.9293	108.9285	90.00	120.90
	Total	114	106.3904	8.73301	.81792	104.7699	108.0108	82.30	122.60
U1 horizontal, mm	HERBST	38	79.6969	11.00113	1.78462	76.0809	83.3129	55.56	105.38
	FORSUS	38	82.4828	12.91175	2.09456	78.2389	86.7268	62.93	117.67
	CONTROL	38	77.0578	14.37386	2.33175	72.3332	81.7824	30.84	108.62
	Total	114	79.7459	12.91570	1.20967	77.3493	82.1424	30.84	117.67
U1 vertical, mm	HERBST	38	72.5229	11.00855	1.78582	68.9044	76.1413	48.62	98.25
	FORSUS	38	76.4012	11.70714	1.89915	72.5531	80.2492	54.28	100.74
	CONTROL	38	72.0379	13.12380	2.12896	67.7242	76.3516	34.17	102.79
	Total	114	73.6540	12.03328	1.12702	71.4212	75.8868	34.17	102.79
U6 horizontal, mm	HERBST	38	41.9600	7.12388	1.15565	39.6184	44.3015	30.00	60.56
	FORSUS	38	42.2111	6.36992	1.03334	40.1173	44.3048	28.24	54.37
	CONTROL	38	42.1817	7.69852	1.24887	39.6513	44.7122	22.13	62.04
	Total	114	42.1176	7.02295	.65776	40.8145	43.4207	22.13	62.04
U6 vertical, mm	HERBST	38	70.9365	8.60893	1.39655	68.1068	73.7662	53.34	90.56
	FORSUS	38	73.3773	9.92602	1.61021	70.1147	76.6399	57.32	98.07
	CONTROL	38	69.0333	12.89364	2.09162	64.7953	73.2713	29.82	97.88
	Total	114	71.1157	10.68417	1.00066	69.1332	73.0982	29.82	98.07
L1 to Pt A-pogonion, mm	HERBST	38	-.0219	2.16690	.35152	-.7342	.6903	-4.91	6.85
	FORSUS	38	.1525	2.09348	.33961	-.5356	.8406	-5.52	6.44
	CONTROL	38	.8675	2.30244	.37351	.1107	1.6243	-3.80	7.69
	Total	114	.3327	2.20401	.20642	-.0763	.7417	-5.52	7.69
L1 to mandibular plane, °	HERBST	38	93.0263	5.91785	.96000	91.0812	94.9715	80.60	107.50
	FORSUS	38	95.0632	6.79513	1.10232	92.8297	97.2967	82.20	108.80

	CONTROL	38	91.6421	6.00755	.97455	89.6675	93.6167	78.10	107.20
	Total	114	93.2439	6.35570	.59527	92.0645	94.4232	78.10	108.80
L1 horizontal, mm	HERBST	38	75.4398	10.34247	1.67777	72.0403	78.8392	51.95	99.27
	FORSUS	38	76.6215	12.29998	1.99532	72.5786	80.6644	59.98	110.40
	CONTROL	38	73.4659	14.30590	2.32072	68.7637	78.1681	29.63	107.05
	Total	114	75.1757	12.38077	1.15957	72.8784	77.4730	29.63	110.40
L1 vertical, mm	HERBST	38	66.9132	9.95871	1.61552	63.6399	70.1866	45.47	90.84
	FORSUS	38	68.5908	9.67787	1.56996	65.4098	71.7719	48.30	88.96
	CONTROL	38	67.8100	12.23582	1.98491	63.7882	71.8318	33.06	92.51
	Total	114	67.7714	10.61306	.99400	65.8021	69.7407	33.06	92.51
L6 horizontal, mm	HERBST	38	39.8399	7.14484	1.15905	37.4915	42.1884	28.34	57.69
	FORSUS	38	39.3082	5.80768	.94213	37.3993	41.2171	26.68	50.51
	CONTROL	38	40.8098	7.46580	1.21111	38.3558	43.2637	23.61	57.60
	Total	114	39.9860	6.81172	.63798	38.7220	41.2499	23.61	57.69
L6 vertical, mm	HERBST	38	71.9526	8.62256	1.39876	69.1185	74.7868	53.80	91.12
	FORSUS	38	73.9414	9.97378	1.61796	70.6631	77.2197	57.59	98.53
	CONTROL	38	69.9081	12.94815	2.10047	65.6522	74.1641	30.10	97.69
	Total	114	71.9340	10.70267	1.00240	69.9481	73.9200	30.10	98.53
U1 - SN, °	HERBST	38	99.7395	8.35783	1.35582	96.9923	102.4866	80.30	117.40
	FORSUS	38	104.1684	8.01060	1.29949	101.5354	106.8014	85.90	119.40
	CONTROL	38	101.1447	6.65573	1.07970	98.9571	103.3324	88.00	112.60
	Total	114	101.6842	7.86343	.73648	100.2251	103.1433	80.30	119.40
U1 - ANSPNS, mm	HERBST	38	28.0554	4.56754	.74095	26.5541	29.5567	15.83	38.80
	FORSUS	38	29.1374	5.50672	.89331	27.3274	30.9474	19.87	43.88
	CONTROL	38	28.2040	5.54881	.90014	26.3802	30.0279	12.04	39.91
	Total	114	28.4656	5.20316	.48732	27.5001	29.4311	12.04	43.88
U6 - ANSPNS, mm	HERBST	38	19.7604	3.00703	.48780	18.7720	20.7487	15.09	30.47
	FORSUS	38	20.2594	2.90143	.47067	19.3057	21.2130	14.44	25.85
	CONTROL	38	18.9659	3.95595	.64174	17.6657	20.2662	10.65	28.43
	Total	114	19.6619	3.33580	.31243	19.0429	20.2809	10.65	30.47
L1 - GoMe, °	HERBST	38	39.3379	5.49256	.89101	37.5326	41.1433	27.59	53.62
	FORSUS	38	40.6809	6.47969	1.05114	38.5511	42.8108	31.19	57.78
	CONTROL	38	38.7604	7.17863	1.16453	36.4009	41.1200	17.59	56.21
	Total	114	39.5931	6.41502	.60082	38.4028	40.7834	17.59	57.78
L6 - GoMe, mm	HERBST	38	28.5915	4.04147	.65561	27.2631	29.9199	20.09	38.06
	FORSUS	38	28.8251	4.87889	.79146	27.2214	30.4287	22.17	44.16
	CONTROL	38	28.5062	5.29398	.85880	26.7661	30.2463	12.78	39.36
	Total	114	28.6409	4.72623	.44265	27.7639	29.5179	12.78	44.16
OP - SN, °	HERBST	38	16.9658	5.51819	.89517	15.1520	18.7796	2.20	31.90
	FORSUS	38	15.6711	4.14878	.67302	14.3074	17.0347	8.50	23.70

	CONTROL	38	16.7711	3.98476	.64641	15.4613	18.0808	7.90	25.10
	Total	114	16.4693	4.59710	.43056	15.6163	17.3223	2.20	31.90

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Ba-S-N (°)	Between Groups	105.485	2	52.742	1.876	.158
	Within Groups	3120.193	111	28.110		
	Total	3225.678	113			
SNA (°)	Between Groups	71.454	2	35.727	2.026	.137
	Within Groups	1957.560	111	17.636		
	Total	2029.014	113			
Pt A to Nasion perp, mm	Between Groups	181.752	2	90.876	5.169	.007
	Within Groups	1951.369	111	17.580		
	Total	2133.120	113			
Co-Pt A, mm	Between Groups	508.372	2	254.186	1.251	.290
	Within Groups	22551.611	111	203.168		
	Total	23059.983	113			
SNB (°)	Between Groups	162.651	2	81.325	5.735	.004
	Within Groups	1574.127	111	14.181		
	Total	1736.778	113			
Pg to Nasion perp, mm	Between Groups	1063.331	2	531.665	7.175	.001
	Within Groups	8225.121	111	74.100		
	Total	9288.451	113			
Co-Gn, mm	Between Groups	181.072	2	90.536	.344	.710
	Within Groups	29213.930	111	263.189		
	Total	29395.002	113			
Co-Go, mm	Between Groups	35.218	2	17.609	.210	.811
	Within Groups	9298.314	111	83.769		
	Total	9333.532	113			
ANB, °	Between Groups	18.613	2	9.307	1.826	.166
	Within Groups	565.706	111	5.096		

	Total	584.319	113			
WITS, mm	Between Groups	243.056	2	121.528	15.633	.000
	Within Groups	862.879	111	7.774		
	Total	1105.935	113			
Maxillary/mandibular difference, mm	Between Groups	90.939	2	45.469	2.247	.111
	Within Groups	2246.333	111	20.237		
	Total	2337.272	113			
FH to palatal plane, °	Between Groups	268.765	2	134.383	6.124	.003
	Within Groups	2435.557	111	21.942		
	Total	2704.323	113			
FH to mandibular plane, °	Between Groups	97.909	2	48.955	1.265	.286
	Within Groups	4295.597	111	38.699		
	Total	4393.506	113			
Palatal plane to mandibular plane, °	Between Groups	117.903	2	58.952	1.721	.184
	Within Groups	3802.668	111	34.258		
	Total	3920.571	113			
ArGoMe, °	Between Groups	122.623	2	61.312	1.621	.202
	Within Groups	4197.967	111	37.820		
	Total	4320.590	113			
CoGoMe, °	Between Groups	131.759	2	65.879	1.622	.202
	Within Groups	4508.818	111	40.620		
	Total	4640.576	113			
N to ANS, mm	Between Groups	410.187	2	205.093	2.936	.057
	Within Groups	7754.733	111	69.862		
	Total	8164.920	113			
ANS to Me, mm	Between Groups	4.831	2	2.415	.024	.977
	Within Groups	11381.770	111	102.538		
	Total	11386.600	113			
Overjet, mm	Between Groups	288.640	2	144.320	16.575	.000
	Within Groups	966.501	111	8.707		
	Total	1255.141	113			
Overbite, mm	Between Groups	60.495	2	30.247	5.365	.006

	Within Groups	625.762	111	5.637		
	Total	686.257	113			
Interincisal angle, °	Between Groups	819.640	2	409.820	4.176	.018
	Within Groups	10893.599	111	98.141		
	Total	11713.240	113			
Molar relationship, mm	Between Groups	52.034	2	26.017	11.686	.000
	Within Groups	247.119	111	2.226		
	Total	299.153	113			
U1 to Pt A vertical, mm	Between Groups	94.311	2	47.155	4.976	.009
	Within Groups	1051.803	111	9.476		
	Total	1146.114	113			
U1 to FH, °	Between Groups	514.885	2	257.443	3.527	.033
	Within Groups	8103.114	111	73.001		
	Total	8617.999	113			
U1 horizontal, mm	Between Groups	559.323	2	279.661	1.697	.188
	Within Groups	18290.798	111	164.782		
	Total	18850.121	113			
U1 vertical, mm	Between Groups	434.646	2	217.323	1.515	.224
	Within Groups	15927.736	111	143.493		
	Total	16362.382	113			
U6 horizontal, mm	Between Groups	1.432	2	.716	.014	.986
	Within Groups	5571.934	111	50.198		
	Total	5573.366	113			
U6 vertical, mm	Between Groups	360.361	2	180.180	1.595	.208
	Within Groups	12538.763	111	112.962		
	Total	12899.123	113			
L1 to Pt A-pogonion, mm	Between Groups	16.882	2	8.441	1.761	.177
	Within Groups	532.036	111	4.793		
	Total	548.918	113			
L1 to mandibular plane, °	Between Groups	225.066	2	112.533	2.878	.060
	Within Groups	4339.555	111	39.095		
	Total	4564.621	113			

L1 horizontal, mm	Between Groups	193.167	2	96.584	.626	.537
	Within Groups	17127.855	111	154.305		
	Total	17321.022	113			
L1 vertical, mm	Between Groups	53.557	2	26.779	.235	.791
	Within Groups	12674.435	111	114.184		
	Total	12727.993	113			
L6 horizontal, mm	Between Groups	44.056	2	22.028	.470	.626
	Within Groups	5199.096	111	46.839		
	Total	5243.152	113			
L6 vertical, mm	Between Groups	309.094	2	154.547	1.358	.261
	Within Groups	12634.734	111	113.826		
	Total	12943.828	113			
U1 - SN, °	Between Groups	389.285	2	194.642	3.275	.042
	Within Groups	6597.907	111	59.441		
	Total	6987.192	113			
U1 - ANSPNS, mm	Between Groups	26.144	2	13.072	.478	.621
	Within Groups	3033.097	111	27.325		
	Total	3059.240	113			
U6 - ANSPNS, mm	Between Groups	32.339	2	16.169	1.465	.235
	Within Groups	1225.074	111	11.037		
	Total	1257.413	113			
L1 - GoMe, °	Between Groups	73.792	2	36.896	.895	.412
	Within Groups	4576.434	111	41.229		
	Total	4650.226	113			
L6 - GoMe, mm	Between Groups	2.071	2	1.036	.046	.955
	Within Groups	2522.043	111	22.721		
	Total	2524.114	113			
OP - SN, °	Between Groups	37.041	2	18.520	.874	.420
	Within Groups	2351.022	111	21.180		
	Total	2388.063	113			

Multiple Comparisons
Tukey Post-hoc

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Ba-S-N (°)	HERBST	FORSUS	.68421	1.21633	.840	-2.2053	3.5737
		CONTROL	2.29474	1.21633	.147	-.5947	5.1842
	FORSUS	HERBST	-.68421	1.21633	.840	-3.5737	2.2053
		CONTROL	1.61053	1.21633	.385	-1.2789	4.5000
	CONTROL	HERBST	-2.29474	1.21633	.147	-5.1842	.5947
		FORSUS	-1.61053	1.21633	.385	-4.5000	1.2789
SNA (°)	HERBST	FORSUS	.69737	.96343	.750	-1.5913	2.9861
		CONTROL	-1.21842	.96343	.418	-3.5071	1.0703
	FORSUS	HERBST	-.69737	.96343	.750	-2.9861	1.5913
		CONTROL	-1.91579	.96343	.120	-4.2045	.3729
	CONTROL	HERBST	1.21842	.96343	.418	-1.0703	3.5071
		FORSUS	1.91579	.96343	.120	-.3729	4.2045
Pt A to Nasion perp, mm	HERBST	FORSUS	.06308	.96190	.998	-2.2220	2.3481
		CONTROL	-2.64641*	.96190	.019	-4.9315	-.3613
	FORSUS	HERBST	-.06308	.96190	.998	-2.3481	2.2220
		CONTROL	-2.70949*	.96190	.016	-4.9946	-.4244
	CONTROL	HERBST	2.64641*	.96190	.019	.3613	4.9315
		FORSUS	2.70949*	.96190	.016	.4244	4.9946
Co-Pt A, mm	HERBST	FORSUS	-4.68284	3.27002	.328	-12.4510	3.0853
		CONTROL	-.43863	3.27002	.990	-8.2068	7.3295
	FORSUS	HERBST	4.68284	3.27002	.328	-3.0853	12.4510
		CONTROL	4.24421	3.27002	.399	-3.5239	12.0123
	CONTROL	HERBST	.43863	3.27002	.990	-7.3295	8.2068
		FORSUS	-4.24421	3.27002	.399	-12.0123	3.5239
SNB (°)	HERBST	FORSUS	.96053	.86394	.509	-1.0918	3.0129
		CONTROL	-1.91316	.86394	.073	-3.9655	.1392
	FORSUS	HERBST	-.96053	.86394	.509	-3.0129	1.0918
		CONTROL	-2.87368*	.86394	.003	-4.9260	-.8213
	CONTROL	HERBST	1.91316	.86394	.073	-.1392	3.9655
		FORSUS	2.87368*	.86394	.003	.8213	4.9260
Pg to Nasion perp, mm	HERBST	FORSUS	1.16948	1.97484	.825	-3.5219	5.8609
		CONTROL	-5.81431*	1.97484	.011	-10.5057	-1.1229
	FORSUS	HERBST	-1.16948	1.97484	.825	-5.8609	3.5219

		CONTROL	-6.98379*	1.97484	.002	-11.6752	-2.2924
	CONTROL	HERBST	5.81431*	1.97484	.011	1.1229	10.5057
		FORSUS	6.98379*	1.97484	.002	2.2924	11.6752
Co-Gn, mm	HERBST	FORSUS	-2.97935	3.72183	.703	-11.8208	5.8621
		CONTROL	-.78954	3.72183	.976	-9.6310	8.0519
	FORSUS	HERBST	2.97935	3.72183	.703	-5.8621	11.8208
		CONTROL	2.18981	3.72183	.827	-6.6516	11.0313
	CONTROL	HERBST	.78954	3.72183	.976	-8.0519	9.6310
		FORSUS	-2.18981	3.72183	.827	-11.0313	6.6516
Co-Go, mm	HERBST	FORSUS	-1.25602	2.09973	.821	-6.2441	3.7320
		CONTROL	-.17302	2.09973	.996	-5.1611	4.8150
	FORSUS	HERBST	1.25602	2.09973	.821	-3.7320	6.2441
		CONTROL	1.08300	2.09973	.864	-3.9050	6.0710
	CONTROL	HERBST	.17302	2.09973	.996	-4.8150	5.1611
		FORSUS	-1.08300	2.09973	.864	-6.0710	3.9050
ANB, °	HERBST	FORSUS	-.26316	.51791	.868	-1.4935	.9672
		CONTROL	.69474	.51791	.375	-.5356	1.9251
	FORSUS	HERBST	.26316	.51791	.868	-.9672	1.4935
		CONTROL	.95789	.51791	.158	-.2724	2.1882
	CONTROL	HERBST	-.69474	.51791	.375	-1.9251	.5356
		FORSUS	-.95789	.51791	.158	-2.1882	.2724
WITS, mm	HERBST	FORSUS	-1.74377*	.63964	.020	-3.2633	-.2243
		CONTROL	1.83251*	.63964	.014	.3130	3.3520
	FORSUS	HERBST	1.74377*	.63964	.020	.2243	3.2633
		CONTROL	3.57628*	.63964	.000	2.0568	5.0958
	CONTROL	HERBST	-1.83251*	.63964	.014	-3.3520	-.3130
		FORSUS	-3.57628*	.63964	.000	-5.0958	-2.0568
Maxillary/mandibular difference, mm	HERBST	FORSUS	1.69623	1.03205	.232	-.7555	4.1479
		CONTROL	-.34847	1.03205	.939	-2.8002	2.1032
	FORSUS	HERBST	-1.69623	1.03205	.232	-4.1479	.7555
		CONTROL	-2.04469	1.03205	.122	-4.4964	.4070
	CONTROL	HERBST	.34847	1.03205	.939	-2.1032	2.8002
		FORSUS	2.04469	1.03205	.122	-.4070	4.4964
FH to palatal plane, °	HERBST	FORSUS	1.06053	1.07463	.587	-1.4923	3.6134
		CONTROL	3.65526*	1.07463	.003	1.1024	6.2081
	FORSUS	HERBST	-1.06053	1.07463	.587	-3.6134	1.4923
		CONTROL	2.59474*	1.07463	.045	.0419	5.1476

	CONTROL	HERBST	-3.65526*	1.07463	.003	-6.2081	-1.1024
		FORSUS	-2.59474*	1.07463	.045	-5.1476	-.0419
FH to mandibular plane, °	HERBST	FORSUS	1.95263	1.42716	.361	-1.4377	5.3429
		CONTROL	1.97895	1.42716	.351	-1.4114	5.3693
	FORSUS	HERBST	-1.95263	1.42716	.361	-5.3429	1.4377
		CONTROL	.02632	1.42716	1.000	-3.3640	3.4166
	CONTROL	HERBST	-1.97895	1.42716	.351	-5.3693	1.4114
		FORSUS	-.02632	1.42716	1.000	-3.4166	3.3640
Palatal plane to mandibular plane, °	HERBST	FORSUS	.86316	1.34278	.797	-2.3267	4.0530
		CONTROL	-1.59211	1.34278	.464	-4.7820	1.5978
	FORSUS	HERBST	-.86316	1.34278	.797	-4.0530	2.3267
		CONTROL	-2.45526	1.34278	.165	-5.6451	.7346
	CONTROL	HERBST	1.59211	1.34278	.464	-1.5978	4.7820
		FORSUS	2.45526	1.34278	.165	-.7346	5.6451
ArGoMe, °	HERBST	FORSUS	1.93684	1.41085	.359	-1.4147	5.2884
		CONTROL	-.45526	1.41085	.944	-3.8068	2.8963
	FORSUS	HERBST	-1.93684	1.41085	.359	-5.2884	1.4147
		CONTROL	-2.39211	1.41085	.211	-5.7437	.9595
	CONTROL	HERBST	.45526	1.41085	.944	-2.8963	3.8068
		FORSUS	2.39211	1.41085	.211	-.9595	5.7437
CoGoMe, °	HERBST	FORSUS	1.40000	1.46215	.605	-2.0734	4.8734
		CONTROL	-1.23158	1.46215	.678	-4.7050	2.2419
	FORSUS	HERBST	-1.40000	1.46215	.605	-4.8734	2.0734
		CONTROL	-2.63158	1.46215	.174	-6.1050	.8419
	CONTROL	HERBST	1.23158	1.46215	.678	-2.2419	4.7050
		FORSUS	2.63158	1.46215	.174	-.8419	6.1050
N to ANS, mm	HERBST	FORSUS	-1.57002	1.91754	.692	-6.1253	2.9852
		CONTROL	3.00219	1.91754	.265	-1.5531	7.5574
	FORSUS	HERBST	1.57002	1.91754	.692	-2.9852	6.1253
		CONTROL	4.57221*	1.91754	.049	.0170	9.1274
	CONTROL	HERBST	-3.00219	1.91754	.265	-7.5574	1.5531
		FORSUS	-4.57221*	1.91754	.049	-9.1274	-.0170
ANS to Me, mm	HERBST	FORSUS	-.41149	2.32309	.983	-5.9301	5.1072
		CONTROL	-.45813	2.32309	.979	-5.9768	5.0605
	FORSUS	HERBST	.41149	2.32309	.983	-5.1072	5.9301
		CONTROL	-.04663	2.32309	1.000	-5.5653	5.4720
	CONTROL	HERBST	.45813	2.32309	.979	-5.0605	5.9768
		FORSUS	.04663	2.32309	1.000	-5.4720	5.5653
Overjet, mm	HERBST	FORSUS	-2.38544*	.67696	.002	-3.9936	-.7773

		CONTROL	1.47673	.67696	.079	-.1314	3.0849
	FORSUS	HERBST	2.38544*	.67696	.002	.7773	3.9936
		CONTROL	3.86217*	.67696	.000	2.2540	5.4703
	CONTROL	HERBST	-1.47673	.67696	.079	-3.0849	.1314
		FORSUS	-3.86217*	.67696	.000	-5.4703	-2.2540
Overbite, mm	HERBST	FORSUS	-1.30110*	.54471	.048	-2.5951	-.0071
		CONTROL	.40695	.54471	.736	-.8870	1.7009
	FORSUS	HERBST	1.30110*	.54471	.048	.0071	2.5951
		CONTROL	1.70805*	.54471	.006	.4141	3.0020
	CONTROL	HERBST	-.40695	.54471	.736	-1.7009	.8870
		FORSUS	-1.70805*	.54471	.006	-3.0020	-.4141
Interincisal angle, °	HERBST	FORSUS	5.29474	2.27273	.056	-.1043	10.6937
		CONTROL	-.71842	2.27273	.946	-6.1174	4.6806
	FORSUS	HERBST	-5.29474	2.27273	.056	-10.6937	.1043
		CONTROL	-6.01316*	2.27273	.025	-11.4122	-.6142
	CONTROL	HERBST	.71842	2.27273	.946	-4.6806	6.1174
		FORSUS	6.01316*	2.27273	.025	.6142	11.4122
Molar relationship, mm	HERBST	FORSUS	-.87185*	.34231	.033	-1.6850	-.0587
		CONTROL	.78223	.34231	.062	-.0309	1.5954
	FORSUS	HERBST	.87185*	.34231	.033	.0587	1.6850
		CONTROL	1.65407*	.34231	.000	.8409	2.4672
	CONTROL	HERBST	-.78223	.34231	.062	-1.5954	.0309
		FORSUS	-1.65407*	.34231	.000	-2.4672	-.8409
U1 to Pt A vertical, mm	HERBST	FORSUS	-2.19942*	.70620	.007	-3.8770	-.5218
		CONTROL	-.79197	.70620	.503	-2.4696	.8857
	FORSUS	HERBST	2.19942*	.70620	.007	.5218	3.8770
		CONTROL	1.40745	.70620	.119	-.2702	3.0851
	CONTROL	HERBST	.79197	.70620	.503	-.8857	2.4696
		FORSUS	-1.40745	.70620	.119	-3.0851	.2702
U1 to FH, °	HERBST	FORSUS	-5.20526*	1.96014	.024	-9.8617	-.5488
		CONTROL	-2.66053	1.96014	.367	-7.3170	1.9959
	FORSUS	HERBST	5.20526*	1.96014	.024	.5488	9.8617
		CONTROL	2.54474	1.96014	.399	-2.1117	7.2012
	CONTROL	HERBST	2.66053	1.96014	.367	-1.9959	7.3170
		FORSUS	-2.54474	1.96014	.399	-7.2012	2.1117
U1 horizontal, mm	HERBST	FORSUS	-2.78592	2.94495	.612	-9.7818	4.2100
		CONTROL	2.63910	2.94495	.644	-4.3568	9.6350

	FORSUS	HERBST	2.78592	2.94495	.612	-4.2100	9.7818
		CONTROL	5.42502	2.94495	.161	-1.5709	12.4209
	CONTROL	HERBST	-2.63910	2.94495	.644	-9.6350	4.3568
		FORSUS	-5.42502	2.94495	.161	-12.4209	1.5709
U1 vertical, mm	HERBST	FORSUS	-3.87830	2.74814	.339	-10.4067	2.6501
		CONTROL	.48493	2.74814	.983	-6.0434	7.0133
	FORSUS	HERBST	3.87830	2.74814	.339	-2.6501	10.4067
		CONTROL	4.36323	2.74814	.255	-2.1651	10.8916
	CONTROL	HERBST	-.48493	2.74814	.983	-7.0133	6.0434
		FORSUS	-4.36323	2.74814	.255	-10.8916	2.1651
U6 horizontal, mm	HERBST	FORSUS	-.25107	1.62542	.987	-4.1123	3.6102
		CONTROL	-.22175	1.62542	.990	-4.0830	3.6395
	FORSUS	HERBST	.25107	1.62542	.987	-3.6102	4.1123
		CONTROL	.02932	1.62542	1.000	-3.8320	3.8906
	CONTROL	HERBST	.22175	1.62542	.990	-3.6395	4.0830
		FORSUS	-.02932	1.62542	1.000	-3.8906	3.8320
U6 vertical, mm	HERBST	FORSUS	-2.44079	2.43831	.578	-8.2331	3.3516
		CONTROL	1.90317	2.43831	.716	-3.8892	7.6955
	FORSUS	HERBST	2.44079	2.43831	.578	-3.3516	8.2331
		CONTROL	4.34396	2.43831	.180	-1.4484	10.1363
	CONTROL	HERBST	-1.90317	2.43831	.716	-7.6955	3.8892
		FORSUS	-4.34396	2.43831	.180	-10.1363	1.4484
L1 to Pt A-pogonion, mm	HERBST	FORSUS	-.17446	.50226	.936	-1.3676	1.0187
		CONTROL	-.88945	.50226	.184	-2.0826	.3037
	FORSUS	HERBST	.17446	.50226	.936	-1.0187	1.3676
		CONTROL	-.71499	.50226	.332	-1.9082	.4782
	CONTROL	HERBST	.88945	.50226	.184	-.3037	2.0826
		FORSUS	.71499	.50226	.332	-.4782	1.9082
L1 to mandibular plane, °	HERBST	FORSUS	-2.03684	1.43445	.334	-5.4445	1.3708
		CONTROL	1.38421	1.43445	.600	-2.0234	4.7918
	FORSUS	HERBST	2.03684	1.43445	.334	-1.3708	5.4445
		CONTROL	3.42105*	1.43445	.049	.0134	6.8287
	CONTROL	HERBST	-1.38421	1.43445	.600	-4.7918	2.0234
		FORSUS	-3.42105*	1.43445	.049	-6.8287	-.0134
L1 horizontal, mm	HERBST	FORSUS	-1.18172	2.84979	.910	-7.9516	5.5881
		CONTROL	1.97384	2.84979	.768	-4.7960	8.7437
	FORSUS	HERBST	1.18172	2.84979	.910	-5.5881	7.9516

		CONTROL	3.15556	2.84979	.512	-3.6143	9.9254
	CONTROL	HERBST	-1.97384	2.84979	.768	-8.7437	4.7960
		FORSUS	-3.15556	2.84979	.512	-9.9254	3.6143
L1 vertical, mm	HERBST	FORSUS	-1.67759	2.45147	.773	-7.5012	4.1460
		CONTROL	-.89676	2.45147	.929	-6.7204	4.9269
	FORSUS	HERBST	1.67759	2.45147	.773	-4.1460	7.5012
		CONTROL	.78084	2.45147	.946	-5.0428	6.6045
	CONTROL	HERBST	.89676	2.45147	.929	-4.9269	6.7204
		FORSUS	-.78084	2.45147	.946	-6.6045	5.0428
L6 horizontal, mm	HERBST	FORSUS	.53172	1.57009	.939	-3.1981	4.2616
		CONTROL	-.96986	1.57009	.811	-4.6997	2.7600
	FORSUS	HERBST	-.53172	1.57009	.939	-4.2616	3.1981
		CONTROL	-1.50158	1.57009	.606	-5.2314	2.2283
	CONTROL	HERBST	.96986	1.57009	.811	-2.7600	4.6997
		FORSUS	1.50158	1.57009	.606	-2.2283	5.2314
L6 vertical, mm	HERBST	FORSUS	-1.98873	2.44762	.696	-7.8032	3.8258
		CONTROL	2.04451	2.44762	.682	-3.7700	7.8590
	FORSUS	HERBST	1.98873	2.44762	.696	-3.8258	7.8032
		CONTROL	4.03324	2.44762	.230	-1.7812	9.8477
	CONTROL	HERBST	-2.04451	2.44762	.682	-7.8590	3.7700
		FORSUS	-4.03324	2.44762	.230	-9.8477	1.7812
U1 - SN, °	HERBST	FORSUS	-4.42895*	1.76874	.036	-8.6307	-.2272
		CONTROL	-1.40526	1.76874	.707	-5.6070	2.7965
	FORSUS	HERBST	4.42895*	1.76874	.036	.2272	8.6307
		CONTROL	3.02368	1.76874	.206	-1.1781	7.2254
	CONTROL	HERBST	1.40526	1.76874	.707	-2.7965	5.6070
		FORSUS	-3.02368	1.76874	.206	-7.2254	1.1781
U1 - ANSPNS, mm	HERBST	FORSUS	-1.08201	1.19924	.640	-3.9309	1.7669
		CONTROL	-.14865	1.19924	.992	-2.9975	2.7002
	FORSUS	HERBST	1.08201	1.19924	.640	-1.7669	3.9309
		CONTROL	.93336	1.19924	.717	-1.9155	3.7822
	CONTROL	HERBST	.14865	1.19924	.992	-2.7002	2.9975
		FORSUS	-.93336	1.19924	.717	-3.7822	1.9155
U6 - ANSPNS, mm	HERBST	FORSUS	-.49902	.76215	.790	-2.3096	1.3115
		CONTROL	.79441	.76215	.552	-1.0161	2.6050
	FORSUS	HERBST	.49902	.76215	.790	-1.3115	2.3096
		CONTROL	1.29343	.76215	.211	-.5171	3.1040
	CONTROL	HERBST	-.79441	.76215	.552	-2.6050	1.0161
		FORSUS	-1.29343	.76215	.211	-3.1040	.5171

L1 - GoMe, °	HERBST	FORSUS	-1.34301	1.47308	.634	-4.8424	2.1564
		CONTROL	.57753	1.47308	.919	-2.9219	4.0769
	FORSUS	HERBST	1.34301	1.47308	.634	-2.1564	4.8424
		CONTROL	1.92054*	1.47308	.396	-1.5788	5.4199
	CONTROL	HERBST	-.57753	1.47308	.919	-4.0769	2.9219
		FORSUS	-1.92054*	1.47308	.396	-5.4199	1.5788
L6 - GoMe, mm	HERBST	FORSUS	-.23358	1.09355	.975	-2.8314	2.3642
		CONTROL	.08529	1.09355	.997	-2.5125	2.6831
	FORSUS	HERBST	.23358	1.09355	.975	-2.3642	2.8314
		CONTROL	.31887	1.09355	.954	-2.2789	2.9167
	CONTROL	HERBST	-.08529	1.09355	.997	-2.6831	2.5125
		FORSUS	-.31887	1.09355	.954	-2.9167	2.2789
OP - SN, °	HERBST	FORSUS	1.29474	1.05582	.440	-1.2134	3.8029
		CONTROL	.19474	1.05582	.981	-2.3134	2.7029
	FORSUS	HERBST	-1.29474	1.05582	.440	-3.8029	1.2134
		CONTROL	-1.10000	1.05582	.552	-3.6082	1.4082
	CONTROL	HERBST	-.19474	1.05582	.981	-2.7029	2.3134
		FORSUS	1.10000	1.05582	.552	-1.4082	3.6082

Appendix 2: ANOVA and Tukey Post-hoc Tests for Comparisons of Measurements at T2.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Ba-S-N (°)	HERBST	38	131.2632	4.89955	.79481	129.6527	132.8736	120.50	144.10
	FORSUS	38	132.1158	4.84124	.78535	130.5245	133.7071	124.70	142.20
	CONTROL	38	130.2474	5.19453	.84266	128.5400	131.9548	117.60	142.00
	Total	114	131.2088	4.99581	.46790	130.2818	132.1358	117.60	144.10
SNA (°)	HERBST	38	80.7789	3.61395	.58626	79.5911	81.9668	71.60	89.10
	FORSUS	38	80.8816	3.45612	.56066	79.7456	82.0176	74.30	89.50
	CONTROL	38	82.4026	4.12091	.66850	81.0481	83.7571	73.60	90.30
	Total	114	81.3544	3.78208	.35422	80.6526	82.0562	71.60	90.30
Pt A to Nasion perp, mm	HERBST	38	-5.7339	4.48644	.72780	-7.2085	-4.2592	-13.70	3.43
	FORSUS	38	-5.1326	4.73696	.76844	-6.6896	-3.5756	-19.04	4.23
	CONTROL	38	-2.6342	3.84761	.62416	-3.8989	-1.3695	-12.59	5.09
	Total	114	-4.5002	4.53899	.42512	-5.3425	-3.6580	-19.04	5.09
Co-Pt A, mm	HERBST	38	84.8923	12.79923	2.07631	80.6853	89.0993	62.78	118.99
	FORSUS	38	86.0757	12.66662	2.05480	81.9123	90.2391	67.16	120.15
	CONTROL	38	86.2350	13.93668	2.26083	81.6541	90.8158	59.08	118.99
	Total	114	85.7343	13.04356	1.22164	83.3140	88.1546	59.08	120.15
SNB (°)	HERBST	38	77.3763	3.94958	.64071	76.0781	78.6745	69.40	84.80
	FORSUS	38	76.2842	3.50879	.56920	75.1309	77.4375	71.00	86.60
	CONTROL	38	78.3132	3.72480	.60424	77.0888	79.5375	70.60	86.60
	Total	114	77.3246	3.79148	.35510	76.6210	78.0281	69.40	86.60
Pg to Nasion perp, mm	HERBST	38	-15.3862	9.25408	1.50121	-18.4280	-12.3445	-33.98	1.85
	FORSUS	38	-16.3348	11.01741	1.78726	-19.9562	-12.7135	-48.21	3.04
	CONTROL	38	-10.7855	6.36961	1.03329	-12.8791	-8.6918	-25.09	2.04
	Total	114	-14.1688	9.32716	.87357	-15.8995	-12.4381	-48.21	3.04
Co-Gn, mm	HERBST	38	109.5702	14.51154	2.35408	104.8003	114.3400	82.41	146.59
	FORSUS	38	107.2308	13.51317	2.19213	102.7892	111.6725	89.52	143.34
	CONTROL	38	110.2281	16.97094	2.75305	104.6499	115.8063	77.04	153.62
	Total	114	109.0097	14.99060	1.40400	106.2281	111.7913	77.04	153.62
Co-Go, mm	HERBST	38	58.7474	8.77611	1.42367	55.8628	61.6320	43.43	85.10
	FORSUS	38	57.2143	7.13828	1.15798	54.8680	59.5606	41.86	73.88
	CONTROL	38	59.0837	10.13918	1.64479	55.7510	62.4163	40.93	88.25
	Total	114	58.3485	8.73112	.81774	56.7284	59.9686	40.93	88.25
ANB, °	HERBST	38	3.4053	2.04397	.33158	2.7334	4.0771	-1.20	7.00
	FORSUS	38	4.5921	1.85040	.30017	3.9839	5.2003	1.50	8.10
	CONTROL	38	4.0921	2.09406	.33970	3.4038	4.7804	.20	9.00

	Total	114	4.0298	2.04052	.19111	3.6512	4.4085	-1.20	9.00
WITS, mm	HERBST	38	-.2754	2.74354	.44506	-1.1771	.6264	-6.57	6.02
	FORSUS	38	2.1596	2.07531	.33666	1.4774	2.8417	-1.01	7.45
	CONTROL	38	1.3963	2.56362	.41587	.5537	2.2390	-3.15	7.59
	Total	114	1.0935	2.65893	.24903	.6001	1.5869	-6.57	7.59
Maxillary/mandibular difference, mm	HERBST	38	24.6828	4.36991	.70889	23.2464	26.1191	14.91	33.43
	FORSUS	38	21.1600	4.08921	.66336	19.8159	22.5041	12.42	30.54
	CONTROL	38	23.9858	6.61410	1.07295	21.8118	26.1598	15.00	44.36
	Total	114	23.2762	5.32847	.49906	22.2875	24.2649	12.42	44.36
FH to palatal plane, °	HERBST	38	4.0368	5.13333	.83274	2.3496	5.7241	-8.50	12.30
	FORSUS	38	3.2763	4.80813	.77998	1.6959	4.8567	-6.20	13.60
	CONTROL	38	1.3000	5.31230	.86177	-.4461	3.0461	-8.80	10.60
	Total	114	2.8711	5.17499	.48468	1.9108	3.8313	-8.80	13.60
FH to mandibular plane, °	HERBST	38	29.1368	6.47479	1.05035	27.0086	31.2651	11.60	38.70
	FORSUS	38	27.4921	7.90950	1.28309	24.8923	30.0919	13.40	44.80
	CONTROL	38	27.3421	4.55748	.73932	25.8441	28.8401	16.20	37.00
	Total	114	27.9904	6.45594	.60465	26.7924	29.1883	11.60	44.80
Palatal plane to mandibular plane, °	HERBST	38	22.4737	5.74793	.93244	20.5844	24.3630	10.50	34.50
	FORSUS	38	21.3658	6.25396	1.01453	19.3102	23.4214	7.20	33.90
	CONTROL	38	23.0421	6.12905	.99426	21.0275	25.0567	7.60	37.40
	Total	114	22.2939	6.03436	.56517	21.1742	23.4136	7.20	37.40
ArGoMe, °	HERBST	38	132.4079	5.90526	.95796	130.4669	134.3489	117.50	145.50
	FORSUS	38	129.9211	6.34244	1.02888	127.8363	132.0058	113.10	146.50
	CONTROL	38	133.0184	5.00469	.81187	131.3734	134.6634	123.10	144.90
	Total	114	131.7825	5.88230	.55093	130.6910	132.8739	113.10	146.50
CoGoMe, °	HERBST	38	127.7711	6.87364	1.11505	125.5117	130.0304	109.20	143.80
	FORSUS	38	125.7842	6.60502	1.07148	123.6132	127.9552	108.40	144.50
	CONTROL	38	128.4711	5.43392	.88150	126.6850	130.2571	116.40	139.70
	Total	114	127.3421	6.38200	.59773	126.1579	128.5263	108.40	144.50
N to ANS, mm	HERBST	38	52.3093	7.78146	1.26232	49.7515	54.8670	37.50	71.58
	FORSUS	38	51.0842	6.75340	1.09555	48.8644	53.3040	41.12	69.74
	CONTROL	38	50.0600	7.97615	1.29390	47.4384	52.6817	33.15	67.51
	Total	114	51.1512	7.51293	.70365	49.7571	52.5452	33.15	71.58
ANS to Me, mm	HERBST	38	62.4733	9.60062	1.55743	59.3177	65.6290	39.91	82.41
	FORSUS	38	59.8363	8.98246	1.45715	56.8839	62.7888	46.46	87.68
	CONTROL	38	62.7755	11.29329	1.83201	59.0635	66.4875	42.04	100.10
	Total	114	61.6950	10.00587	.93714	59.8384	63.5517	39.91	100.10
Overjet, mm	HERBST	38	2.8121	1.56489	.25386	2.2978	3.3265	-.65	6.11
	FORSUS	38	3.2031	1.14326	.18546	2.8273	3.5788	1.20	6.26
	CONTROL	38	4.1987	2.00836	.32580	3.5385	4.8588	1.11	10.56
	Total	114	3.4046	1.70126	.15934	3.0889	3.7203	-.65	10.56
Overbite, mm	HERBST	38	.9309	1.20696	.19580	.5342	1.3276	-1.48	4.07

	FORSUS	38	2.3097	1.14205	.18526	1.9343	2.6851	.28	5.06
	CONTROL	38	2.6415	2.06294	.33465	1.9635	3.3196	-4.26	7.69
	Total	114	1.9607	1.68849	.15814	1.6474	2.2740	-4.26	7.69
Interincisal angle, °	HERBST	38	130.4132	10.65727	1.72884	126.9102	133.9161	108.10	162.70
	FORSUS	38	128.0605	7.65798	1.24229	125.5434	130.5776	112.00	144.00
	CONTROL	38	135.5289	10.36785	1.68189	132.1211	138.9368	118.90	150.50
	Total	114	131.3342	10.06947	.94309	129.4658	133.2026	108.10	162.70
Molar relationship, mm	HERBST	38	-1.5523	2.07367	.33639	-2.2339	-.8707	-8.52	5.00
	FORSUS	38	-.6343	1.37274	.22269	-1.0855	-.1831	-3.68	1.93
	CONTROL	38	.0975	1.72675	.28012	-.4701	.6650	-2.78	5.19
	Total	114	-.6964	1.86034	.17424	-1.0416	-.3512	-8.52	5.19
U1 to Pt A vertical, mm	HERBST	38	1.1112	2.40394	.38997	.3210	1.9014	-4.35	6.39
	FORSUS	38	.6295	2.66895	.43296	-.2478	1.5067	-4.97	6.99
	CONTROL	38	1.7618	2.39626	.38872	.9742	2.5495	-4.54	5.65
	Total	114	1.1675	2.51435	.23549	.7010	1.6341	-4.97	6.99
U1 to FH, °	HERBST	38	105.0421	5.37123	.87133	103.2766	106.8076	93.70	113.60
	FORSUS	38	104.5132	7.37846	1.19694	102.0879	106.9384	93.30	123.70
	CONTROL	38	105.2184	6.64631	1.07817	103.0338	107.4030	89.80	118.10
	Total	114	104.9246	6.46738	.60573	103.7245	106.1246	89.80	123.70
U1 horizontal, mm	HERBST	38	80.2428	12.04238	1.95353	76.2845	84.2010	58.25	106.95
	FORSUS	38	78.8174	11.03585	1.79025	75.1900	82.4448	63.39	114.54
	CONTROL	38	78.2519	12.13061	1.96784	74.2646	82.2391	51.67	106.68
	Total	114	79.1040	11.67273	1.09325	76.9381	81.2699	51.67	114.54
U1 vertical, mm	HERBST	38	70.1786	9.93463	1.61161	66.9132	73.4440	49.82	93.99
	FORSUS	38	69.4648	9.81911	1.59287	66.2374	72.6923	56.21	94.67
	CONTROL	38	70.9121	12.08107	1.95981	66.9412	74.8831	49.73	97.51
	Total	114	70.1852	10.58433	.99131	68.2212	72.1492	49.73	97.51
U6 horizontal, mm	HERBST	38	41.8796	5.70523	.92551	40.0043	43.7548	27.97	53.15
	FORSUS	38	40.2645	6.73202	1.09208	38.0518	42.4773	30.73	56.76
	CONTROL	38	43.4660	7.45430	1.20925	41.0158	45.9161	28.61	63.43
	Total	114	41.8700	6.73905	.63117	40.6196	43.1205	27.97	63.43
U6 vertical, mm	HERBST	38	72.1646	9.38420	1.52232	69.0801	75.2492	54.82	90.66
	FORSUS	38	70.6415	8.57117	1.39043	67.8242	73.4587	58.42	95.68
	CONTROL	38	71.1728	11.29325	1.83201	67.4608	74.8848	49.45	105.56
	Total	114	71.3263	9.74945	.91312	69.5173	73.1354	49.45	105.56
L1 to Pt A-pogonion, mm	HERBST	38	2.4247	3.14508	.51020	1.3909	3.4584	-6.02	11.39
	FORSUS	38	2.4162	2.16412	.35107	1.7049	3.1275	-1.56	8.83
	CONTROL	38	1.1819	2.35164	.38149	.4089	1.9548	-3.61	6.30
	Total	114	2.0076	2.63192	.24650	1.5192	2.4959	-6.02	11.39
L1 to mandibular plane, °	HERBST	38	95.3711	7.07691	1.14803	93.0449	97.6972	80.30	109.80
	FORSUS	38	100.0237	6.29227	1.02074	97.9555	102.0919	87.40	116.50

	CONTROL	38	91.8658	7.10254	1.15218	89.5312	94.2003	79.70	106.00
	Total	114	95.7535	7.55938	.70800	94.3508	97.1562	79.70	116.50
L1 horizontal, mm	HERBST	38	78.7709	11.84038	1.92076	74.8791	82.6628	56.58	103.62
	FORSUS	38	75.9605	10.66105	1.72945	72.4563	79.4647	61.82	111.50
	CONTROL	38	74.9694	12.17749	1.97545	70.9668	78.9721	49.26	110.75
	Total	114	76.5670	11.58839	1.08535	74.4167	78.7172	49.26	111.50
L1 vertical, mm	HERBST	38	67.6151	9.86745	1.60071	64.3717	70.8584	47.41	91.95
	FORSUS	38	66.7726	9.63979	1.56378	63.6041	69.9412	53.91	91.36
	CONTROL	38	67.1984	11.44103	1.85598	63.4378	70.9589	47.04	92.79
	Total	114	67.1953	10.26097	.96103	65.2914	69.0993	47.04	92.79
L6 horizontal, mm	HERBST	38	42.3572	6.42500	1.04227	40.2453	44.4690	29.54	55.00
	FORSUS	38	39.8747	6.90342	1.11988	37.6056	42.1438	31.10	55.20
	CONTROL	38	42.6789	8.10622	1.31500	40.0144	45.3433	29.26	67.51
	Total	114	41.6369	7.22641	.67681	40.2960	42.9778	29.26	67.51
L6 vertical, mm	HERBST	38	73.5878	9.77550	1.58580	70.3746	76.8009	54.73	93.25
	FORSUS	38	71.8157	8.91977	1.44698	68.8838	74.7475	59.25	98.62
	CONTROL	38	72.2792	11.59405	1.88080	68.4683	76.0900	49.91	107.69
	Total	114	72.5609	10.09571	.94555	70.6876	74.4342	49.91	107.69
U1 - SN, °	HERBST	38	101.4368	4.79817	.77837	99.8597	103.0140	93.80	111.80
	FORSUS	38	100.4132	6.71248	1.08891	98.2068	102.6195	87.20	115.50
	CONTROL	38	100.2711	7.10032	1.15182	97.9372	102.6049	85.70	113.20
	Total	114	100.7070	6.25069	.58543	99.5472	101.8669	85.70	115.50
U1 - ANSPNS, mm	HERBST	38	27.9993	5.07266	.82289	26.3320	29.6667	15.93	36.76
	FORSUS	38	27.7743	4.84684	.78626	26.1812	29.3674	20.79	44.44
	CONTROL	38	28.1431	4.92269	.79857	26.5250	29.7611	18.33	40.00
	Total	114	27.9722	4.90667	.45955	27.0618	28.8827	15.93	44.44
U6 - ANSPNS, mm	HERBST	38	20.4305	3.20316	.51962	19.3776	21.4833	13.80	27.69
	FORSUS	38	19.7800	2.68462	.43550	18.8976	20.6624	13.71	24.93
	CONTROL	38	20.6011	4.03770	.65500	19.2739	21.9282	14.82	34.91
	Total	114	20.2705	3.34423	.31322	19.6500	20.8911	13.71	34.91
L6 - GoMe, mm	HERBST	38	29.5004	4.37663	.70998	28.0618	30.9390	21.95	41.76
	FORSUS	38	28.3651	4.07998	.66186	27.0240	29.7061	23.09	42.41
	CONTROL	38	29.3055	4.92610	.79912	27.6863	30.9246	19.35	43.61
	Total	114	29.0570	4.46274	.41797	28.2289	29.8851	19.35	43.61
OP - SN, °	HERBST	38	18.3711	5.05894	.82067	16.7082	20.0339	4.10	26.60
	FORSUS	38	17.4684	4.01128	.65071	16.1499	18.7869	8.40	25.70
	CONTROL	38	15.8868	4.40026	.71382	14.4405	17.3332	7.60	25.80
	Total	114	17.2421	4.58823	.42973	16.3907	18.0935	4.10	26.60

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Ba-S-N (°)	Between Groups	66.498	2	33.249	1.340	.266
	Within Groups	2753.774	111	24.809		
	Total	2820.271	113			
SNA (°)	Between Groups	62.833	2	31.416	2.245	.111
	Within Groups	1553.530	111	13.996		
	Total	1616.363	113			
Pt A to Nasion perp, mm	Between Groups	205.345	2	102.673	5.369	.006
	Within Groups	2122.729	111	19.124		
	Total	2328.074	113			
Co-Pt A, mm	Between Groups	40.897	2	20.448	.118	.889
	Within Groups	19184.308	111	172.832		
	Total	19225.205	113			
SNB (°)	Between Groups	78.369	2	39.184	2.813	.064
	Within Groups	1546.043	111	13.928		
	Total	1624.411	113			
Pg to Nasion perp, mm	Between Groups	669.591	2	334.796	4.057	.020
	Within Groups	9160.947	111	82.531		
	Total	9830.538	113			
Co-Gn, mm	Between Groups	188.594	2	94.297	.415	.661
	Within Groups	25204.534	111	227.068		
	Total	25393.128	113			
Co-Go, mm	Between Groups	75.467	2	37.733	.491	.614
	Within Groups	8538.793	111	76.926		
	Total	8614.260	113			
ANB, °	Between Groups	26.984	2	13.492	3.377	.038
	Within Groups	443.514	111	3.996		
	Total	470.499	113			
WITS, mm	Between Groups	117.876	2	58.938	9.606	.000
	Within Groups	681.025	111	6.135		
	Total	798.901	113			

Maxillary/mandibular difference, mm	Between Groups	264.493	2	132.246	4.986	.008
	Within Groups	2943.871	111	26.521		
	Total	3208.364	113			
FH to palatal plane, °	Between Groups	151.677	2	75.839	2.929	.058
	Within Groups	2874.517	111	25.897		
	Total	3026.194	113			
FH to mandibular plane, °	Between Groups	75.351	2	37.675	.902	.409
	Within Groups	4634.389	111	41.751		
	Total	4709.739	113			
Palatal plane to mandibular plane, °	Between Groups	55.234	2	27.617	.755	.472
	Within Groups	4059.492	111	36.572		
	Total	4114.726	113			
ArGoMe, °	Between Groups	204.577	2	102.289	3.064	.051
	Within Groups	3705.388	111	33.382		
	Total	3909.965	113			
CoGoMe, °	Between Groups	147.651	2	73.826	1.839	.164
	Within Groups	4454.827	111	40.134		
	Total	4602.478	113			
N to ANS, mm	Between Groups	96.375	2	48.188	.851	.430
	Within Groups	6281.807	111	56.593		
	Total	6378.182	113			
ANS to Me, mm	Between Groups	198.662	2	99.331	.992	.374
	Within Groups	11114.608	111	100.132		
	Total	11313.270	113			
Overjet, mm	Between Groups	38.844	2	19.422	7.480	.001
	Within Groups	288.209	111	2.596		
	Total	327.053	113			
Overbite, mm	Between Groups	62.543	2	31.272	13.370	.000
	Within Groups	259.621	111	2.339		
	Total	322.164	113			
Interincisal angle, °	Between Groups	1108.124	2	554.062	5.942	.004

	Within Groups	10349.432	111	93.238		
	Total	11457.557	113			
Molar relationship, mm	Between Groups	51.931	2	25.965	8.498	.000
	Within Groups	339.148	111	3.055		
	Total	391.079	113			
U1 to Pt A vertical, mm	Between Groups	24.543	2	12.272	1.975	.144
	Within Groups	689.838	111	6.215		
	Total	714.381	113			
U1 to FH, °	Between Groups	10.238	2	5.119	.120	.887
	Within Groups	4716.213	111	42.488		
	Total	4726.451	113			
U1 horizontal, mm	Between Groups	79.993	2	39.997	.290	.749
	Within Groups	15316.546	111	137.987		
	Total	15396.539	113			
U1 vertical, mm	Between Groups	39.799	2	19.900	.175	.840
	Within Groups	12619.375	111	113.688		
	Total	12659.174	113			
U6 horizontal, mm	Between Groups	194.739	2	97.369	2.189	.117
	Within Groups	4937.141	111	44.479		
	Total	5131.879	113			
U6 vertical, mm	Between Groups	45.423	2	22.712	.236	.790
	Within Groups	10695.436	111	96.355		
	Total	10740.859	113			
L1 to Pt A-pogonion, mm	Between Groups	38.864	2	19.432	2.900	.059
	Within Groups	743.890	111	6.702		
	Total	782.754	113			
L1 to mandibular plane, °	Between Groups	1272.811	2	636.406	13.625	.000
	Within Groups	5184.492	111	46.707		
	Total	6457.304	113			
L1 horizontal, mm	Between Groups	295.536	2	147.768	1.102	.336
	Within Groups	14879.321	111	134.048		
	Total	15174.857	113			

L1 vertical, mm	Between Groups	13.484	2	6.742	.063	.939
	Within Groups	11884.009	111	107.063		
	Total	11897.494	113			
L6 horizontal, mm	Between Groups	178.969	2	89.484	1.736	.181
	Within Groups	5721.998	111	51.550		
	Total	5900.967	113			
L6 vertical, mm	Between Groups	64.188	2	32.094	.311	.733
	Within Groups	11453.154	111	103.182		
	Total	11517.341	113			
U1 - SN, °	Between Groups	30.744	2	15.372	.389	.679
	Within Groups	4384.290	111	39.498		
	Total	4415.034	113			
U1 - ANSPNS, mm	Between Groups	2.626	2	1.313	.054	.948
	Within Groups	2717.896	111	24.486		
	Total	2720.522	113			
U6 - ANSPNS, mm	Between Groups	14.267	2	7.134	.634	.533
	Within Groups	1249.508	111	11.257		
	Total	1263.776	113			
L6 - GoMe, mm	Between Groups	28.011	2	14.006	.699	.499
	Within Groups	2222.501	111	20.023		
	Total	2250.512	113			
OP - SN, °	Between Groups	120.174	2	60.087	2.953	.056
	Within Groups	2258.684	111	20.349		
	Total	2378.858	113			

Multiple Comparisons
Tukey Post-hoc

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Ba-S-N (°)	HERBST	FORSUS	-.85263	1.14268	.737	-3.5671	1.8619
		CONTROL	1.01579	1.14268	.648	-1.6987	3.7303
	FORSUS	HERBST	.85263	1.14268	.737	-1.8619	3.5671

		CONTROL	1.86842	1.14268	.235	-.8461	4.5829
	CONTROL	HERBST	-1.01579	1.14268	.648	-3.7303	1.6987
		FORSUS	-1.86842	1.14268	.235	-4.5829	.8461
SNA (°)	HERBST	FORSUS	-.10263	.85827	.992	-2.1415	1.9362
		CONTROL	-1.62368	.85827	.146	-3.6625	.4152
	FORSUS	HERBST	.10263	.85827	.992	-1.9362	2.1415
		CONTROL	-1.52105	.85827	.184	-3.5599	.5178
	CONTROL	HERBST	1.62368	.85827	.146	-.4152	3.6625
		FORSUS	1.52105	.85827	.184	-.5178	3.5599
Pt A to Nasion perp, mm	HERBST	FORSUS	-.60126	1.00325	.821	-2.9845	1.7820
		CONTROL	-3.09966*	1.00325	.007	-5.4829	-.7164
	FORSUS	HERBST	.60126	1.00325	.821	-1.7820	2.9845
		CONTROL	-2.49841*	1.00325	.038	-4.8817	-.1151
	CONTROL	HERBST	3.09966*	1.00325	.007	.7164	5.4829
		FORSUS	2.49841*	1.00325	.038	.1151	4.8817
Co-Pt A, mm	HERBST	FORSUS	-1.18342	3.01602	.919	-8.3482	5.9813
		CONTROL	-1.34270	3.01602	.897	-8.5075	5.8221
	FORSUS	HERBST	1.18342	3.01602	.919	-5.9813	8.3482
		CONTROL	-.15928	3.01602	.998	-7.3240	7.0055
	CONTROL	HERBST	1.34270	3.01602	.897	-5.8221	8.5075
		FORSUS	.15928	3.01602	.998	-7.0055	7.3240
SNB (°)	HERBST	FORSUS	1.09211	.85619	.412	-.9418	3.1260
		CONTROL	-.93684	.85619	.520	-2.9708	1.0971
	FORSUS	HERBST	-1.09211	.85619	.412	-3.1260	.9418
		CONTROL	-2.02895	.85619	.051	-4.0629	.0050
	CONTROL	HERBST	.93684	.85619	.520	-1.0971	2.9708
		FORSUS	2.02895	.85619	.051	-.0050	4.0629
Pg to Nasion perp, mm	HERBST	FORSUS	.94862	2.08416	.892	-4.0024	5.8997
		CONTROL	-4.60076	2.08416	.074	-9.5518	.3503
	FORSUS	HERBST	-.94862	2.08416	.892	-5.8997	4.0024
		CONTROL	-5.54938*	2.08416	.024	-10.5004	-.5983
	CONTROL	HERBST	4.60076	2.08416	.074	-.3503	9.5518
		FORSUS	5.54938*	2.08416	.024	.5983	10.5004
Co-Gn, mm	HERBST	FORSUS	2.33933	3.45701	.778	-5.8730	10.5517
		CONTROL	-.65795	3.45701	.980	-8.8703	7.5544
	FORSUS	HERBST	-2.33933	3.45701	.778	-10.5517	5.8730
		CONTROL	-2.99727	3.45701	.662	-11.2096	5.2151
	CONTROL	HERBST	.65795	3.45701	.980	-7.5544	8.8703

		FORSUS	2.99727	3.45701	.662	-5.2151	11.2096
Co-Go, mm	HERBST	FORSUS	1.53307	2.01215	.727	-3.2469	6.3131
		CONTROL	-.33628	2.01215	.985	-5.1163	4.4437
	FORSUS	HERBST	-1.53307	2.01215	.727	-6.3131	3.2469
		CONTROL	-1.86936	2.01215	.623	-6.6493	2.9106
	CONTROL	HERBST	.33628	2.01215	.985	-4.4437	5.1163
		FORSUS	1.86936	2.01215	.623	-2.9106	6.6493
ANB, °	HERBST	FORSUS	-1.18684*	.45858	.029	-2.2762	-.0975
		CONTROL	-.68684	.45858	.296	-1.7762	.4025
	FORSUS	HERBST	1.18684*	.45858	.029	.0975	2.2762
		CONTROL	.50000	.45858	.522	-.5894	1.5894
	CONTROL	HERBST	.68684	.45858	.296	-.4025	1.7762
		FORSUS	-.50000	.45858	.522	-1.5894	.5894
WITS, mm	HERBST	FORSUS	-2.43494*	.56825	.000	-3.7849	-1.0850
		CONTROL	-1.67167*	.56825	.011	-3.0216	-.3217
	FORSUS	HERBST	2.43494*	.56825	.000	1.0850	3.7849
		CONTROL	.76327	.56825	.374	-.5867	2.1132
	CONTROL	HERBST	1.67167*	.56825	.011	.3217	3.0216
		FORSUS	-.76327	.56825	.374	-2.1132	.5867
Maxillary/mandibular difference, mm	HERBST	FORSUS	3.52277*	1.18147	.010	.7161	6.3294
		CONTROL	.69694	1.18147	.826	-2.1097	3.5036
	FORSUS	HERBST	-3.52277*	1.18147	.010	-6.3294	-.7161
		CONTROL	-2.82584*	1.18147	.048	-5.6325	-.0192
	CONTROL	HERBST	-.69694	1.18147	.826	-3.5036	2.1097
		FORSUS	2.82584*	1.18147	.048	.0192	5.6325
FH to palatal plane, °	HERBST	FORSUS	.76053	1.16747	.792	-2.0129	3.5339
		CONTROL	2.73684	1.16747	.054	-.0365	5.5102
	FORSUS	HERBST	-.76053	1.16747	.792	-3.5339	2.0129
		CONTROL	1.97632	1.16747	.212	-.7971	4.7497
	CONTROL	HERBST	-2.73684	1.16747	.054	-5.5102	.0365
		FORSUS	-1.97632	1.16747	.212	-4.7497	.7971
FH to mandibular plane, °	HERBST	FORSUS	1.64474	1.48237	.510	-1.8767	5.1662
		CONTROL	1.79474	1.48237	.449	-1.7267	5.3162
	FORSUS	HERBST	-1.64474	1.48237	.510	-5.1662	1.8767
		CONTROL	.15000	1.48237	.994	-3.3715	3.6715
	CONTROL	HERBST	-1.79474	1.48237	.449	-5.3162	1.7267
		FORSUS	-.15000	1.48237	.994	-3.6715	3.3715
Palatal plane to	HERBST	FORSUS	1.10789	1.38739	.705	-2.1879	4.4037

mandibular plane, °		CONTROL	-.56842	1.38739	.912	-3.8642	2.7274
	FORSUS	HERBST	-1.10789	1.38739	.705	-4.4037	2.1879
		CONTROL	-1.67632	1.38739	.451	-4.9721	1.6195
	CONTROL	HERBST	.56842	1.38739	.912	-2.7274	3.8642
		FORSUS	1.67632	1.38739	.451	-1.6195	4.9721
ArGoMe, °	HERBST	FORSUS	2.48684	1.32550	.150	-.6620	5.6356
		CONTROL	-.61053	1.32550	.890	-3.7593	2.5383
	FORSUS	HERBST	-2.48684	1.32550	.150	-5.6356	.6620
		CONTROL	-3.09737	1.32550	.055	-6.2462	.0514
	CONTROL	HERBST	.61053	1.32550	.890	-2.5383	3.7593
		FORSUS	3.09737	1.32550	.055	-.0514	6.2462
CoGoMe, °	HERBST	FORSUS	1.98684	1.45337	.362	-1.4657	5.4394
		CONTROL	-.70000	1.45337	.880	-4.1526	2.7526
	FORSUS	HERBST	-1.98684	1.45337	.362	-5.4394	1.4657
		CONTROL	-2.68684	1.45337	.159	-6.1394	.7657
	CONTROL	HERBST	.70000	1.45337	.880	-2.7526	4.1526
		FORSUS	2.68684	1.45337	.159	-.7657	6.1394
N to ANS, mm	HERBST	FORSUS	1.22504	1.72585	.758	-2.8748	5.3249
		CONTROL	2.24921	1.72585	.396	-1.8507	6.3491
	FORSUS	HERBST	-1.22504	1.72585	.758	-5.3249	2.8748
		CONTROL	1.02416	1.72585	.824	-3.0757	5.1240
	CONTROL	HERBST	-2.24921	1.72585	.396	-6.3491	1.8507
		FORSUS	-1.02416	1.72585	.824	-5.1240	3.0757
ANS to Me, mm	HERBST	FORSUS	2.63701	2.29567	.486	-2.8165	8.0905
		CONTROL	-.30217	2.29567	.990	-5.7557	5.1513
	FORSUS	HERBST	-2.63701	2.29567	.486	-8.0905	2.8165
		CONTROL	-2.93917	2.29567	.409	-8.3927	2.5143
	CONTROL	HERBST	.30217	2.29567	.990	-5.1513	5.7557
		FORSUS	2.93917	2.29567	.409	-2.5143	8.3927
Overjet, mm	HERBST	FORSUS	-.39094	.36967	.542	-1.2691	.4872
		CONTROL	-1.38656*	.36967	.001	-2.2647	-.5084
	FORSUS	HERBST	.39094	.36967	.542	-.4872	1.2691
		CONTROL	-.99563*	.36967	.022	-1.8738	-.1174
	CONTROL	HERBST	1.38656*	.36967	.001	.5084	2.2647
		FORSUS	.99563*	.36967	.022	.1174	1.8738
Overbite, mm	HERBST	FORSUS	-1.37881*	.35086	.000	-2.2123	-.5453
		CONTROL	-1.71066*	.35086	.000	-2.5441	-.8772
	FORSUS	HERBST	1.37881*	.35086	.000	.5453	2.2123

		CONTROL	-.33185	.35086	.613	-1.1653	.5016
	CONTROL	HERBST	1.71066*	.35086	.000	.8772	2.5441
		FORSUS	.33185	.35086	.613	-.5016	1.1653
Interincisal angle, °	HERBST	FORSUS	2.35263	2.21524	.540	-2.9098	7.6151
		CONTROL	-5.11579	2.21524	.059	-10.3782	.1466
	FORSUS	HERBST	-2.35263	2.21524	.540	-7.6151	2.9098
		CONTROL	-7.46842*	2.21524	.003	-12.7309	-2.2060
	CONTROL	HERBST	5.11579	2.21524	.059	-.1466	10.3782
		FORSUS	7.46842*	2.21524	.003	2.2060	12.7309
Molar relationship, mm	HERBST	FORSUS	-.91795	.40101	.061	-1.8706	.0347
		CONTROL	-1.64974*	.40101	.000	-2.6024	-.6971
	FORSUS	HERBST	.91795	.40101	.061	-.0347	1.8706
		CONTROL	-.73179	.40101	.166	-1.6844	.2208
	CONTROL	HERBST	1.64974*	.40101	.000	.6971	2.6024
		FORSUS	.73179	.40101	.166	-.2208	1.6844
U1 to Pt A vertical, mm	HERBST	FORSUS	.48173	.57192	.678	-.8769	1.8404
		CONTROL	-.65064	.57192	.493	-2.0093	.7080
	FORSUS	HERBST	-.48173	.57192	.678	-1.8404	.8769
		CONTROL	-1.13236	.57192	.122	-2.4910	.2263
	CONTROL	HERBST	.65064	.57192	.493	-.7080	2.0093
		FORSUS	1.13236	.57192	.122	-.2263	2.4910
U1 to FH, °	HERBST	FORSUS	.52895	1.49540	.933	-3.0235	4.0814
		CONTROL	-.17632	1.49540	.992	-3.7287	3.3761
	FORSUS	HERBST	-.52895	1.49540	.933	-4.0814	3.0235
		CONTROL	-.70526	1.49540	.885	-4.2577	2.8472
	CONTROL	HERBST	.17632	1.49540	.992	-3.3761	3.7287
		FORSUS	.70526	1.49540	.885	-2.8472	4.2577
U1 horizontal, mm	HERBST	FORSUS	1.42541	2.69490	.857	-4.9765	7.8273
		CONTROL	1.99090	2.69490	.741	-4.4110	8.3928
	FORSUS	HERBST	-1.42541	2.69490	.857	-7.8273	4.9765
		CONTROL	.56549	2.69490	.976	-5.8364	6.9674
	CONTROL	HERBST	-1.99090	2.69490	.741	-8.3928	4.4110
		FORSUS	-.56549	2.69490	.976	-6.9674	5.8364
U1 vertical, mm	HERBST	FORSUS	.71377	2.44614	.954	-5.0972	6.5247
		CONTROL	-.73349	2.44614	.952	-6.5444	5.0775
	FORSUS	HERBST	-.71377	2.44614	.954	-6.5247	5.0972
		CONTROL	-1.44726	2.44614	.825	-7.2582	4.3637
	CONTROL	HERBST	.73349	2.44614	.952	-5.0775	6.5444
		FORSUS	1.44726	2.44614	.825	-4.3637	7.2582

U6 horizontal, mm	HERBST	FORSUS	1.61504	1.53003	.544	-2.0196	5.2497
		CONTROL	-1.58638	1.53003	.555	-5.2211	2.0483
	FORSUS	HERBST	-1.61504	1.53003	.544	-5.2497	2.0196
		CONTROL	-3.20143	1.53003	.096	-6.8361	.4333
	CONTROL	HERBST	1.58638	1.53003	.555	-2.0483	5.2211
		FORSUS	3.20143	1.53003	.096	-.4333	6.8361
U6 vertical, mm	HERBST	FORSUS	1.52317	2.25196	.778	-3.8265	6.8728
		CONTROL	.99179	2.25196	.899	-4.3579	6.3415
	FORSUS	HERBST	-1.52317	2.25196	.778	-6.8728	3.8265
		CONTROL	-.53137	2.25196	.970	-5.8810	4.8183
	CONTROL	HERBST	-.99179	2.25196	.899	-6.3415	4.3579
		FORSUS	.53137	2.25196	.970	-4.8183	5.8810
L1 to Pt A-pogonion, mm	HERBST	FORSUS	.00845	.59390	1.000	-1.4024	1.4193
		CONTROL	1.24279	.59390	.096	-.1681	2.6536
	FORSUS	HERBST	-.00845	.59390	1.000	-1.4193	1.4024
		CONTROL	1.23434	.59390	.099	-.1765	2.6452
	CONTROL	HERBST	-1.24279	.59390	.096	-2.6536	.1681
		FORSUS	-1.23434	.59390	.099	-2.6452	.1765
L1 to mandibular plane, °	HERBST	FORSUS	-4.65263*	1.56789	.010	-8.3772	-.9280
		CONTROL	3.50526	1.56789	.070	-.2194	7.2299
	FORSUS	HERBST	4.65263*	1.56789	.010	.9280	8.3772
		CONTROL	8.15789*	1.56789	.000	4.4333	11.8825
	CONTROL	HERBST	-3.50526	1.56789	.070	-7.2299	.2194
		FORSUS	-8.15789*	1.56789	.000	-11.8825	-4.4333
L1 horizontal, mm	HERBST	FORSUS	2.81039	2.65615	.542	-3.4995	9.1203
		CONTROL	3.80147	2.65615	.328	-2.5084	10.1113
	FORSUS	HERBST	-2.81039	2.65615	.542	-9.1203	3.4995
		CONTROL	.99108	2.65615	.926	-5.3188	7.3009
	CONTROL	HERBST	-3.80147	2.65615	.328	-10.1113	2.5084
		FORSUS	-.99108	2.65615	.926	-7.3009	5.3188
L1 vertical, mm	HERBST	FORSUS	.84243	2.37379	.933	-4.7967	6.4815
		CONTROL	.41670	2.37379	.983	-5.2224	6.0558
	FORSUS	HERBST	-.84243	2.37379	.933	-6.4815	4.7967
		CONTROL	-.42573	2.37379	.982	-6.0648	5.2134
	CONTROL	HERBST	-.41670	2.37379	.983	-6.0558	5.2224
		FORSUS	.42573	2.37379	.982	-5.2134	6.0648
L6 horizontal, mm	HERBST	FORSUS	2.48245	1.64716	.292	-1.4305	6.3954

		CONTROL	-.32166	1.64716	.979	-4.2346	3.5913
	FORSUS	HERBST	-2.48245	1.64716	.292	-6.3954	1.4305
		CONTROL	-2.80412	1.64716	.209	-6.7170	1.1088
	CONTROL	HERBST	.32166	1.64716	.979	-3.5913	4.2346
		FORSUS	2.80412	1.64716	.209	-1.1088	6.7170
L6 vertical, mm	HERBST	FORSUS	1.77207	2.33037	.728	-3.7639	7.3080
		CONTROL	1.30858	2.33037	.841	-4.2273	6.8445
	FORSUS	HERBST	-1.77207	2.33037	.728	-7.3080	3.7639
		CONTROL	-.46349	2.33037	.978	-5.9994	5.0724
	CONTROL	HERBST	-1.30858	2.33037	.841	-6.8445	4.2273
		FORSUS	.46349	2.33037	.978	-5.0724	5.9994
U1 - SN, °	HERBST	FORSUS	1.02368	1.44182	.758	-2.4015	4.4488
		CONTROL	1.16579	1.44182	.699	-2.2593	4.5909
	FORSUS	HERBST	-1.02368	1.44182	.758	-4.4488	2.4015
		CONTROL	.14211	1.44182	.995	-3.2830	3.5672
	CONTROL	HERBST	-1.16579	1.44182	.699	-4.5909	2.2593
		FORSUS	-.14211	1.44182	.995	-3.5672	3.2830
U1 - ANSPNS, mm	HERBST	FORSUS	.22500	1.13522	.979	-2.4718	2.9218
		CONTROL	-.14377	1.13522	.991	-2.8405	2.5530
	FORSUS	HERBST	-.22500	1.13522	.979	-2.9218	2.4718
		CONTROL	-.36877	1.13522	.944	-3.0655	2.3280
	CONTROL	HERBST	.14377	1.13522	.991	-2.5530	2.8405
		FORSUS	.36877	1.13522	.944	-2.3280	3.0655
U6 - ANSPNS, mm	HERBST	FORSUS	.65048	.76972	.676	-1.1780	2.4790
		CONTROL	-.17058	.76972	.973	-1.9991	1.6579
	FORSUS	HERBST	-.65048	.76972	.676	-2.4790	1.1780
		CONTROL	-.82106	.76972	.537	-2.6496	1.0074
	CONTROL	HERBST	.17058	.76972	.973	-1.6579	1.9991
		FORSUS	.82106	.76972	.537	-1.0074	2.6496
L6 - GoMe, mm	HERBST	FORSUS	1.13536	1.02656	.512	-1.3033	3.5740
		CONTROL	.19495	1.02656	.980	-2.2437	2.6336
	FORSUS	HERBST	-1.13536	1.02656	.512	-3.5740	1.3033
		CONTROL	-.94041	1.02656	.631	-3.3791	1.4982
	CONTROL	HERBST	-.19495	1.02656	.980	-2.6336	2.2437
		FORSUS	.94041	1.02656	.631	-1.4982	3.3791
OP - SN, °	HERBST	FORSUS	.90263	1.03488	.659	-1.5558	3.3611
		CONTROL	2.48421*	1.03488	.047	.0258	4.9426
	FORSUS	HERBST	-.90263	1.03488	.659	-3.3611	1.5558

		CONTROL	1.58158	1.03488	.282	-.8768	4.0400
	CONTROL	HERBST	-2.48421*	1.03488	.047	-4.9426	-.0258
		FORSUS	-1.58158	1.03488	.282	-4.0400	.8768

Appendix 3: ANOVA and Tukey Post-hoc Tests for Comparisons of Measurements from T1-T2.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
BaSNt1t2	HERBST	38	-1.21316	5.94439	.96431	-.7407	3.1670	-8.40	27.50
	FORSUS	38	0.323684	2.89757	.47005	-1.2761	.6287	-4.20	6.70
	CONTROL	38	0.065789	4.01095	.65066	-1.3842	1.2526	-11.20	14.00
	Total	114	-0.27456	4.47688	.41930	-.5561	1.1053	-11.20	27.50
SNAt1t2	HERBST	38	-1.21842	2.96601	.48115	.2435	2.1933	-8.80	6.90
	FORSUS	38	-0.41842	2.19838	.35663	-.3042	1.1410	-5.00	5.70
	CONTROL	38	-0.81316	3.26903	.53031	-.2613	1.8877	-5.50	13.00
	Total	114	-0.81667	2.84073	.26606	.2896	1.3438	-8.80	13.00
PtAtoNasionperpmmt1t2	HERBST	38	-1.64487	3.71527	.60270	.4237	2.8660	-8.43	8.43
	FORSUS	38	-0.98053	3.09168	.50154	-.0357	1.9967	-3.86	8.65
	CONTROL	38	-1.19162	3.41296	.55366	.0698	2.3134	-7.69	7.78
	Total	114	-1.27234	3.39720	.31818	.6420	1.9027	-8.43	8.65
CoPtAmmt1t2	HERBST	38	-1.34026	8.49721	1.37843	-1.4527	4.1332	-21.02	20.56
	FORSUS	38	-4.83968	8.30801	1.34774	2.1089	7.5705	-15.64	27.88
	CONTROL	38	-0.43619	10.74429	1.74295	-3.0954	3.9678	-40.47	27.22
	Total	114	-2.20538	9.36370	.87699	.4679	3.9429	-40.47	27.88
SNBt1t2	HERBST	38	0.913158	2.69776	.43764	-1.7999	-.0264	-10.80	4.60
	FORSUS	38	0.781579	2.07049	.33588	-1.4621	-.1010	-4.90	3.10
	CONTROL	38	-0.06316	2.44047	.39590	-.7390	.8653	-5.60	5.70
	Total	114	0.54386	2.43427	.22799	-.9955	-.0922	-10.80	5.70
PgtoNasionperpmmt1t2	HERBST	38	0.662821	6.55363	1.06314	-2.8169	1.4913	-21.39	11.02
	FORSUS	38	0.883684	5.84184	.94767	-2.8038	1.0365	-10.30	19.50
	CONTROL	38	-0.55073	5.66423	.91886	-1.3111	2.4125	-12.59	11.02
	Total	114	0.331926	6.01199	.56307	-1.4475	.7836	-21.39	19.50
CoGnmmt1t2	HERBST	38	2.18341	10.78242	1.74914	-5.7275	1.3607	-26.11	21.39
	FORSUS	38	-3.13526	10.91722	1.77101	-.4531	6.7237	-26.13	33.49
	CONTROL	38	2.051821	14.56682	2.36305	-6.8398	2.7362	-57.23	31.58
	Total	114	0.366656	12.35964	1.15759	-2.6600	1.9267	-57.23	33.49
CoGommt1t2	HERBST	38	1.873932	7.28247	1.18137	-4.2676	.5198	-16.95	15.09

	FORSUS	38	-0.91516	7.18132	1.16496	-1.4453	3.2756	-21.71	20.33
	CONTROL	38	2.0372	9.58846	1.55545	-5.1888	1.1144	-28.43	24.35
	Total	114	0.998658	8.13678	.76208	-2.5085	.5112	-28.43	24.35
ANBt1t2	HERBST	38	-2.12895	1.75112	.28407	1.5534	2.7045	-1.00	6.70
	FORSUS	38	-1.20526	1.21854	.19767	.8047	1.6058	-2.20	4.00
	CONTROL	38	-0.74737	1.82605	.29622	.1472	1.3476	-2.90	7.30
	Total	114	-1.36053	1.70738	.15991	1.0437	1.6773	-2.90	7.30
WITSmmt1t2	HERBST	38	-3.54317	2.57474	.41768	2.6969	4.3895	-1.20	8.15
	FORSUS	38	-2.852	1.90091	.30837	2.2272	3.4768	-1.47	6.90
	CONTROL	38	-0.03899	2.02346	.32825	-.6261	.7041	-5.28	3.80
	Total	114	-2.14472	2.64791	.24800	1.6534	2.6361	-5.28	8.15
Maxmanddiffmmt1t2	HERBST	38	3.528547	3.80558	.61735	-4.7794	-2.2777	-13.52	2.22
	FORSUS	38	1.702	3.20656	.52017	-2.7560	-.6480	-10.49	7.54
	CONTROL	38	2.483142	5.19479	.84271	-4.1906	-.7757	-17.59	6.39
	Total	114	2.57123	4.18446	.39191	-3.3477	-1.7948	-17.59	7.54
FHtopalatalplanet1t2	HERBST	38	0.534211	3.44739	.55924	-1.6673	.5989	-8.60	7.60
	FORSUS	38	0.834211	3.39493	.55073	-1.9501	.2817	-10.10	4.50
	CONTROL	38	1.452632	3.10455	.50362	-2.4731	-.4322	-7.90	3.80
	Total	114	0.940351	3.31189	.31019	-1.5549	-.3258	-10.10	7.60
FHtomandibularplanet1t2	HERBST	38	0.202632	3.49459	.56690	-1.3513	.9460	-7.60	7.00
	FORSUS	38	0.510526	3.76074	.61007	-1.7466	.7256	-11.80	6.00
	CONTROL	38	0.386842	3.24963	.52716	-1.4550	.6813	-8.50	6.90
	Total	114	0.366667	3.47901	.32584	-1.0122	.2789	-11.80	7.00
Palattomandplanet1t2	HERBST	38	-0.10789	2.90437	.47115	-.8467	1.0625	-7.40	7.10
	FORSUS	38	-0.35263	2.22622	.36114	-.3791	1.0844	-3.10	5.00
	CONTROL	38	-1.13158	2.48760	.40354	.3139	1.9492	-4.80	6.50
	Total	114	-0.5307	2.56967	.24067	.0539	1.0075	-7.40	7.10
ArGoMet1t2	HERBST	38	-0.75789	4.17260	.67689	-.6136	2.1294	-8.70	11.80
	FORSUS	38	-1.30789	2.75587	.44706	.4021	2.2137	-4.00	7.90
	CONTROL	38	-0.60263	3.71683	.60295	-.6191	1.8243	-16.80	5.50
	Total	114	-0.88947	3.57819	.33513	.2255	1.5534	-16.80	11.80
CoGoMet1t2	HERBST	38	-0.22632	4.57689	.74247	-1.2781	1.7307	-11.40	11.40
	FORSUS	38	-0.81316	2.73092	.44301	-.0845	1.7108	-4.20	5.40
	CONTROL	38	-0.75789	3.32880	.54000	-.3363	1.8520	-14.80	4.70
	Total	114	-0.59912	3.60554	.33769	-.0699	1.2681	-14.80	11.40

NtoANSmmt1t2	HERBST	38	0.553163	4.42240	.71741	-2.0068	.9004	-9.45	7.59
	FORSUS	38	-2.24189	5.19152	.84218	.5355	3.9483	-8.37	18.68
	CONTROL	38		6.28087	1.01889	-3.3706	.7583	-28.43	8.61
	Total	114	1.306147 -0.12753	5.52234	.51721	-.8972	1.1522	-28.43	18.68
ANStoMemmt1t2	HERBST	38	1.181868	5.88758	.95509	-3.1171	.7533	-16.30	7.69
	FORSUS	38	-1.86663	6.17451	1.00164	-.1629	3.8961	-11.13	21.53
	CONTROL	38		8.77294	1.42316	-3.9095	1.8577	-33.98	16.02
	Total	114	1.02591 0.113716	7.14257	.66896	-1.4391	1.2116	-33.98	21.53
Overjetmmt1t2	HERBST	38	-3.43107	2.87185	.46588	2.4871	4.3750	-.93	9.82
	FORSUS	38	-5.42558	3.42577	.55573	4.2996	6.5516	-1.10	14.26
	CONTROL	38		1.77692	.28825	-.0163	1.1518	-3.24	6.39
	Total	114	-0.56778 -3.14148	3.40400	.31881	2.5099	3.7731	-3.24	14.26
Overbitemmt1t2	HERBST	38	-2.27845	2.28386	.37049	1.5278	3.0291	-2.41	5.93
	FORSUS	38	-2.20074	2.24869	.36479	1.4616	2.9399	-3.50	6.53
	CONTROL	38		1.89855	.30799	-.4632	.7849	-5.56	4.17
	Total	114	-0.16083 -1.54667	2.34811	.21992	1.1110	1.9824	-5.56	6.53
Interincisalanglet1t2	HERBST	38	-3.84737	11.91478	1.93283	-.0689	7.7637	-18.30	35.00
	FORSUS	38		12.75206	2.06866	-3.2862	5.0968	-23.10	30.00
	CONTROL	38	-0.90526	5.12460	.83132	-2.2344	1.1344	-14.00	6.80
	Total	114	0.55 -1.40088	10.56896	.98987	-.5602	3.3620	-23.10	35.00
Molarrelationshipmt1t2	HERBST	38	-2.63179	2.11442	.34300	1.9368	3.3268	-2.04	9.45
	FORSUS	38	-2.58568	1.89763	.30784	1.9619	3.2094	-1.01	8.10
	CONTROL	38		1.78451	.28949	-.3867	.7864	-4.44	6.39
	Total	114	-0.19982 -1.80576	2.23315	.20915	1.3914	2.2201	-4.44	9.45
U1toPtAverticalmt1t2	HERBST	38		2.64918	.42975	-1.0316	.7099	-5.56	4.72
	FORSUS	38	0.160832 -2.52032	2.94847	.47830	1.5512	3.4895	-3.22	8.56
	CONTROL	38		2.11962	.34385	-.7162	.6772	-7.04	5.00
	Total	114	0.019495 -0.78	2.85425	.26732	.2504	1.3096	-7.04	8.56
U1toFHt1t2	HERBST	38		8.69317	1.41022	-4.1311	1.5837	-25.60	13.70
	FORSUS	38	1.273684 -4.46053	10.07439	1.63428	1.1492	7.7719	-19.30	22.20
	CONTROL	38		5.55663	.90140	-.6159	3.0369	-20.30	10.90
	Total	114	-1.21053 -1.46579	8.58186	.80376	-.1266	3.0582	-25.60	22.20
U1horizontalmmt1t2	HERBST	38		6.74941	1.09490	-2.7643	1.6726	-15.93	10.46
	FORSUS	38	0.545853 -3.66547	7.54817	1.22447	1.1845	6.1465	-7.91	24.93
	CONTROL	38		10.01346	1.62440	-4.4854	2.0973	-43.15	16.95
	Total	114	1.194053 -0.64186	8.43122	.78966	-.9226	2.2063	-43.15	24.93
U1verticalmmt1t2	HERBST	38	-2.34424	8.13406	1.31952	-.3294	5.0178	-19.63	16.39
	FORSUS	38	-6.93632	7.96799	1.29258	4.3173	9.5553	-17.48	26.13

	CONTROL	38	-1.12582	9.27147	1.50403	-1.9216	4.1733	-35.93	23.71
	Total	114	-3.46879	8.77002	.82139	1.8415	5.0961	-35.93	26.13
U6horizontalmmt1t2	HERBST	38	-0.08042	4.83739	.78473	-1.5096	1.6704	-8.61	10.65
	FORSUS	38	-1.94653	4.90715	.79604	.3336	3.5595	-11.96	12.70
	CONTROL	38	1.284216	5.45524	.88496	-3.0773	.5089	-22.78	13.61
	Total	114	-0.24758	5.20193	.48721	-.7177	1.2128	-22.78	13.61
U6verticalmmt1t2	HERBST	38	1.228168	5.65328	.91708	-3.0864	.6300	-13.80	8.98
	FORSUS	38	-2.73579	6.65946	1.08031	.5469	4.9247	-8.10	23.28
	CONTROL	38	2.139547	8.76983	1.42265	-5.0221	.7430	-38.61	14.45
	Total	114	0.210642	7.39510	.69261	-1.5828	1.1616	-38.61	23.28
L1toPtApogonionmt1t2	HERBST	38	2.446589	2.54977	.41363	-3.2847	-1.6085	-11.48	3.70
	FORSUS	38	2.263684	1.77128	.28734	-2.8459	-1.6815	-5.80	1.01
	CONTROL	38	0.314353	1.32689	.21525	-.7505	.1218	-3.24	1.76
	Total	114	1.674875	2.16145	.20244	-2.0759	-1.2738	-11.48	3.70
L1tomandibularplant1t2	HERBST	38	2.344737	7.90408	1.28221	-4.9427	.2533	-20.50	15.20
	FORSUS	38	4.960526	6.36220	1.03209	-7.0517	-2.8693	-18.80	6.60
	CONTROL	38	0.223684	4.08441	.66258	-1.5662	1.1188	-7.40	12.00
	Total	114	2.509649	6.55429	.61387	-3.7258	-1.2935	-20.50	15.20
L1horizontalmmt1t2	HERBST	38	3.331163	6.68596	1.08461	-5.5288	-1.1335	-19.91	10.00
	FORSUS	38	-0.66095	7.45787	1.20983	-1.7904	3.1123	-11.96	24.38
	CONTROL	38	1.503532	9.82866	1.59442	-4.7341	1.7271	-41.11	14.08
	Total	114	1.391249	8.19547	.76758	-2.9120	.1295	-41.11	24.38
L1verticalmmt1t2	HERBST	38	0.701811	7.86246	1.27546	-3.2861	1.8825	-24.08	16.85
	FORSUS	38	-1.81821	7.05948	1.14520	-.5022	4.1386	-18.12	18.03
	CONTROL	38	-0.61165	8.66211	1.40518	-2.2355	3.4588	-34.45	22.69
	Total	114	-0.57602	7.88644	.73863	-.8873	2.0394	-34.45	22.69
L6horizontalmmt1t2	HERBST	38	2.517258	4.79363	.77763	-4.0929	-.9416	-11.67	8.52
	FORSUS	38	0.566526	5.25381	.85228	-2.2934	1.1604	-15.46	10.58
	CONTROL	38	1.869058	6.05104	.98161	-3.8580	.1199	-23.80	13.89
	Total	114	1.650947	5.40508	.50623	-2.6539	-.6480	-23.80	13.89
L6verticalmmt1t2	HERBST	38	1.635121	5.90800	.95840	-3.5770	.3068	-15.19	9.35
	FORSUS	38	-2.12568	6.78905	1.10133	-.1058	4.3572	-8.37	23.46

	CONTROL	38	2.371047	9.05131	1.46832	-5.3461	.6040	-39.54	15.09
	Total	114	0.626828	7.56696	.70871	-2.0309	.7773	-39.54	23.46
U1SNt1t2	HERBST	38	1.697368	8.37759	1.35902	-4.4510	1.0563	-24.10	15.80
	FORSUS	38	-3.75526	10.45117	1.69540	.3201	7.1905	-18.00	18.10
	CONTROL	38	-0.87368	4.89797	.79456	-.7362	2.4836	-14.30	11.60
	Total	114	-0.97719	8.46196	.79254	-.5930	2.5473	-24.10	18.10
U1ANSPNSmt1t2	HERBST	38	-0.05605	3.16283	.51308	-.9836	1.0956	-7.96	4.82
	FORSUS	38	-1.36305	2.87774	.46683	.4172	2.3089	-4.78	9.75
	CONTROL	38	-0.06092	4.12697	.66948	-1.2956	1.4174	-14.91	8.33
	Total	114	-0.49334	3.45622	.32370	-.1480	1.1347	-14.91	9.75
U6ANSPNSmt1t2	HERBST	38	0.670132	2.12162	.34417	-1.3675	.0272	-4.91	2.87
	FORSUS	38	-0.47937	2.20065	.35699	-.2440	1.2027	-4.42	4.88
	CONTROL	38	1.635121	3.18356	.51644	-2.6815	-.5887	-12.04	3.89
	Total	114	0.608628	2.67054	.25012	-1.1042	-.1131	-12.04	4.88
L1GoMet1t2	HERBST	38	2.344737	7.90408	1.28221	-4.9427	.2533	-20.50	15.20
	FORSUS	38	4.960526	6.36220	1.03209	-7.0517	-2.8693	-18.80	6.60
	CONTROL	38	0.223684	4.08441	.66258	-1.5662	1.1188	-7.40	12.00
	Total	114	2.509649	6.55429	.61387	-3.7258	-1.2935	-20.50	15.20
L1GoMemmt1t2	HERBST	38	-1.25497	4.07984	.66184	-.0860	2.5960	-10.46	6.85
	FORSUS	38	-3.14495	3.79801	.61612	1.8966	4.3933	-5.43	14.26
	CONTROL	38	0.428884	5.17743	.83989	-2.1307	1.2729	-21.11	10.83
	Total	114	-1.32368	4.59352	.43022	.4713	2.1760	-21.11	14.26
L6GoMemmt1t2	HERBST	38	0.908942	2.94766	.47817	-1.8778	.0599	-7.78	5.19
	FORSUS	38	-0.46	3.48401	.56518	-.6852	1.6052	-7.73	11.96
	CONTROL	38	0.799284	4.37196	.70923	-2.2363	.6377	-15.46	8.15
	Total	114	0.416075	3.66977	.34371	-1.0970	.2649	-15.46	11.96
OPSNt1t2	HERBST	38	1.405263	3.82071	.61980	-2.6611	-.1494	-8.50	9.60
	FORSUS	38	1.797368	2.79493	.45340	-2.7160	-.8787	-8.80	2.20
	CONTROL	38	-0.88421	3.35708	.54459	-.2192	1.9877	-6.00	10.50
	Total	114	0.772807	3.52684	.33032	-1.4272	-.1184	-8.80	10.50

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.

BaSNt1t2	Between Groups	51.479	2	25.739	1.291	.279
	Within Groups	2213.318	111	19.940		
	Total	2264.796	113			
SNAt1t2	Between Groups	12.161	2	6.080	.750	.475
	Within Groups	899.718	111	8.106		
	Total	911.878	113			
PtAtoNasionperpmmt1t2	Between Groups	8.757	2	4.379	.375	.688
	Within Groups	1295.372	111	11.670		
	Total	1304.129	113			
CoPtAmmt1t2	Between Groups	411.084	2	205.542	2.402	.095
	Within Groups	9496.623	111	85.555		
	Total	9907.707	113			
SNBt1t2	Between Groups	21.332	2	10.666	1.826	.166
	Within Groups	648.269	111	5.840		
	Total	669.601	113			
PgtoNasionperpmmt1t2	Between Groups	45.334	2	22.667	.623	.538
	Within Groups	4038.943	111	36.387		
	Total	4084.278	113			
CoGnmmt1t2	Between Groups	699.345	2	349.673	2.343	.101
	Within Groups	16562.622	111	149.213		
	Total	17261.967	113			
CoGommt1t2	Between Groups	209.280	2	104.640	1.597	.207
	Within Groups	7272.140	111	65.515		
	Total	7481.420	113			
ANBt1t2	Between Groups	37.641	2	18.820	7.160	.001
	Within Groups	291.772	111	2.629		
	Total	329.412	113			
WITSmmt1t2	Between Groups	261.820	2	130.910	27.393	.000
	Within Groups	530.474	111	4.779		
	Total	792.294	113			
Maxmanddiffmmt1t2	Between Groups	63.832	2	31.916	1.850	.162

	Within Groups	1914.763	111	17.250		
	Total	1978.594	113			
FHtopalatalplanet1t2	Between Groups	16.669	2	8.334	.757	.472
	Within Groups	1222.786	111	11.016		
	Total	1239.454	113			
FHtomandibularplanet1t2	Between Groups	1.824	2	.912	.074	.929
	Within Groups	1365.869	111	12.305		
	Total	1367.693	113			
Palattomandplanet1t2	Between Groups	21.718	2	10.859	1.664	.194
	Within Groups	724.444	111	6.527		
	Total	746.163	113			
ArGoMet1t2	Between Groups	10.437	2	5.219	.403	.669
	Within Groups	1436.350	111	12.940		
	Total	1446.787	113			
CoGoMet1t2	Between Groups	7.980	2	3.990	.303	.739
	Within Groups	1461.010	111	13.162		
	Total	1468.990	113			
NtoANSmmt1t2	Between Groups	265.594	2	132.797	4.635	.012
	Within Groups	3180.477	111	28.653		
	Total	3446.071	113			
ANStoMemmt1t2	Between Groups	224.003	2	112.002	2.244	.111
	Within Groups	5540.844	111	49.918		
	Total	5764.848	113			
Overjetmmt1t2	Between Groups	453.146	2	226.573	29.373	.000
	Within Groups	856.211	111	7.714		
	Total	1309.357	113			
Overbitemmt1t2	Between Groups	109.586	2	54.793	11.845	.000
	Within Groups	513.454	111	4.626		
	Total	623.040	113			
Interincisalanglet1t2	Between Groups	381.401	2	190.701	1.729	.182
	Within Groups	12241.029	111	110.280		
	Total	12622.430	113			

Molarrelationshipmt1t2	Between Groups	147.047	2	73.523	19.595	.000
	Within Groups	416.481	111	3.752		
	Total	563.527	113			
U1toPtAverticalmt1t2	Between Groups	173.016	2	86.508	12.845	.000
	Within Groups	747.564	111	6.735		
	Total	920.580	113			
U1toFHt1t2	Between Groups	628.456	2	314.228	4.533	.013
	Within Groups	7693.800	111	69.314		
	Total	8322.257	113			
U1horizontalmmt1t2	Between Groups	529.092	2	264.546	3.913	.023
	Within Groups	7503.559	111	67.600		
	Total	8032.651	113			
U1verticalmmt1t2	Between Groups	713.558	2	356.779	4.964	.009
	Within Groups	7977.643	111	71.871		
	Total	8691.201	113			
U6horizontalmmt1t2	Between Groups	199.909	2	99.954	3.882	.023
	Within Groups	2857.882	111	25.747		
	Total	3057.791	113			
U6verticalmmt1t2	Between Groups	510.625	2	255.312	4.999	.008
	Within Groups	5669.067	111	51.073		
	Total	6179.691	113			
L1toPtApogonionmt1t2	Between Groups	106.144	2	53.072	13.967	.000
	Within Groups	421.778	111	3.800		
	Total	527.921	113			
L1tomandibularplant1t2	Between Groups	427.866	2	213.933	5.365	.006
	Within Groups	4426.473	111	39.878		
	Total	4854.339	113			
L1horizontalmmt1t2	Between Groups	303.521	2	151.760	2.312	.104
	Within Groups	7286.204	111	65.641		
	Total	7589.725	113			
L1verticalmmt1t2	Between Groups	120.732	2	60.366	.970	.382

	Within Groups	6907.408	111	62.229		
	Total	7028.140	113			
L6horizontalmmt1t2	Between Groups	75.013	2	37.507	1.290	.279
	Within Groups	3226.270	111	29.065		
	Total	3301.283	113			
L6verticalmmt1t2	Between Groups	442.141	2	221.070	4.071	.020
	Within Groups	6028.113	111	54.307		
	Total	6470.254	113			
U1SNt1t2	Between Groups	565.503	2	282.752	4.170	.018
	Within Groups	7525.837	111	67.800		
	Total	8091.341	113			
U1ANSPNSmt1t2	Between Groups	43.115	2	21.558	1.831	.165
	Within Groups	1306.722	111	11.772		
	Total	1349.838	113			
U6ANSPNSmt1t2	Between Groups	85.166	2	42.583	6.558	.002
	Within Groups	720.728	111	6.493		
	Total	805.894	113			
L1GoMet1t2	Between Groups	427.866	2	213.933	5.365	.006
	Within Groups	4426.473	111	39.878		
	Total	4854.339	113			
L1GoMemmt1t2	Between Groups	242.942	2	121.471	6.296	.003
	Within Groups	2141.404	111	19.292		
	Total	2384.347	113			
L6GoMemmt1t2	Between Groups	43.976	2	21.988	1.652	.196
	Within Groups	1477.818	111	13.314		
	Total	1521.795	113			
OPSNt1t2	Between Groups	159.426	2	79.713	7.100	.001
	Within Groups	1246.139	111	11.226		
	Total	1405.566	113			

Multiple Comparisons
Tukey Post-hoc

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
BaSNt1t2	HERBST	FORSUS	-1.53684	1.02443	.295	-.8968	3.9704
		CONTROL	-1.27895	1.02443	.427	-1.1547	3.7126
	FORSUS	HERBST	1.53684	1.02443	.295	-3.9704	.8968
		CONTROL	.25789	1.02443	.966	-2.6915	2.1757
	CONTROL	HERBST	1.27895	1.02443	.427	-3.7126	1.1547
		FORSUS	-.25789	1.02443	.966	-2.1757	2.6915
SNAt1t2	HERBST	FORSUS	-.80000	.65315	.441	-.7516	2.3516
		CONTROL	-.40526	.65315	.809	-1.1463	1.9569
	FORSUS	HERBST	.80000	.65315	.441	-2.3516	.7516
		CONTROL	.39474	.65315	.818	-1.9463	1.1569
	CONTROL	HERBST	.40526	.65315	.809	-1.9569	1.1463
		FORSUS	-.39474	.65315	.818	-1.1569	1.9463
PtAtoNasionperpmmt1t2	HERBST	FORSUS	-.66434	.78372	.674	-1.1974	2.5261
		CONTROL	-.45325	.78372	.832	-1.4085	2.3150
	FORSUS	HERBST	.66434	.78372	.674	-2.5261	1.1974
		CONTROL	.21109	.78372	.961	-2.0729	1.6507
	CONTROL	HERBST	.45325	.78372	.832	-2.3150	1.4085
		FORSUS	-.21109	.78372	.961	-1.6507	2.0729
CoPtAmmt1t2	HERBST	FORSUS	3.49942	2.12200	.230	-8.5404	1.5415
		CONTROL	-.90407	2.12200	.905	-4.1369	5.9450
	FORSUS	HERBST	-3.49942	2.12200	.230	-1.5415	8.5404
		CONTROL	-4.40349	2.12200	.100	-.6375	9.4444
	CONTROL	HERBST	.90407	2.12200	.905	-5.9450	4.1369
		FORSUS	4.40349	2.12200	.100	-9.4444	.6375
SNBt1t2	HERBST	FORSUS	.13158	.55442	.969	-1.4486	1.1855
		CONTROL	.97632	.55442	.188	-2.2934	.3407
	FORSUS	HERBST	-.13158	.55442	.969	-1.1855	1.4486
		CONTROL	.84474	.55442	.284	-2.1618	.4723
	CONTROL	HERBST	-.97632	.55442	.188	-.3407	2.2934
		FORSUS	-.84474	.55442	.284	-.4723	2.1618
PgtoNasionperpmmt1t2	HERBST	FORSUS	-.22086	1.38387	.986	-3.0666	3.5083
		CONTROL	1.21355	1.38387	.656	-4.5010	2.0739
	FORSUS	HERBST	.22086	1.38387	.986	-3.5083	3.0666
		CONTROL	1.43441	1.38387	.556	-4.7219	1.8531
	CONTROL	HERBST	-1.21355	1.38387	.656	-2.0739	4.5010
		FORSUS	-1.43441	1.38387	.556	-1.8531	4.7219

CoGnmmt1t2	HERBST	FORSUS	5.31867	2.80238	.144	-11.9759	1.3385
		CONTROL	.13159	2.80238	.999	-6.7888	6.5256
	FORSUS	HERBST	-5.31867	2.80238	.144	-1.3385	11.9759
		CONTROL	-5.18708	2.80238	.158	-1.4701	11.8443
	CONTROL	HERBST	-.13159	2.80238	.999	-6.5256	6.7888
		FORSUS	5.18708	2.80238	.158	-11.8443	1.4701
CoGommt1t2	HERBST	FORSUS	2.78909	1.85692	.294	-7.2003	1.6221
		CONTROL	-.16327	1.85692	.996	-4.2480	4.5745
	FORSUS	HERBST	-2.78909	1.85692	.294	-1.6221	7.2003
		CONTROL	-2.95236	1.85692	.254	-1.4589	7.3636
	CONTROL	HERBST	.16327	1.85692	.996	-4.5745	4.2480
		FORSUS	2.95236	1.85692	.254	-7.3636	1.4589
ANBt1t2	HERBST	FORSUS	.92368*	.37195	.038	.0401	1.8073
		CONTROL	1.38158*	.37195	.001	.4980	2.2652
	FORSUS	HERBST	-.92368*	.37195	.038	-1.8073	-.0401
		CONTROL	-.45789	.37195	.437	-.4257	1.3415
	CONTROL	HERBST	-1.38158*	.37195	.001	-2.2652	-.4980
		FORSUS	.45789	.37195	.437	-1.3415	.4257
WITSmmt1t2	HERBST	FORSUS	-.69117	.50153	.356	-.5002	1.8826
		CONTROL	3.50418*	.50153	.000	2.3128	4.6956
	FORSUS	HERBST	.69117	.50153	.356	-1.8826	.5002
		CONTROL	2.81301*	.50153	.000	1.6216	4.0044
	CONTROL	HERBST	-3.50418*	.50153	.000	-4.6956	-2.3128
		FORSUS	-2.81301*	.50153	.000	-4.0044	-1.6216
Maxmanddiffmmt1t2	HERBST	FORSUS	1.82655	.95284	.139	-4.0901	.4370
		CONTROL	1.04541	.95284	.518	-3.3089	1.2181
	FORSUS	HERBST	-1.82655	.95284	.139	-.4370	4.0901
		CONTROL	-.78114	.95284	.692	-1.4824	3.0447
	CONTROL	HERBST	-1.04541	.95284	.518	-1.2181	3.3089
		FORSUS	.78114	.95284	.692	-3.0447	1.4824
FHtopalatalplanet1t2	HERBST	FORSUS	-.30000	.76144	.918	-1.5089	2.1089
		CONTROL	-.91842	.76144	.452	-.8904	2.7273
	FORSUS	HERBST	.30000	.76144	.918	-2.1089	1.5089
		CONTROL	-.61842	.76144	.696	-1.1904	2.4273
	CONTROL	HERBST	.91842	.76144	.452	-2.7273	.8904
		FORSUS	.61842	.76144	.696	-2.4273	1.1904
FHtomandibularplanet1t2	HERBST	FORSUS	-.30789	.80476	.923	-1.6039	2.2197

		CONTROL	-.18421	.80476	.972	-1.7275	2.0960
	FORSUS	HERBST	.30789	.80476	.923	-2.2197	1.6039
		CONTROL	.12368	.80476	.987	-2.0354	1.7881
	CONTROL	HERBST	.18421	.80476	.972	-2.0960	1.7275
		FORSUS	-.12368	.80476	.987	-1.7881	2.0354
Palattomandplanet1t2	HERBST	FORSUS	.24474	.58609	.908	-1.6370	1.1476
		CONTROL	1.02368	.58609	.193	-2.4160	.3686
	FORSUS	HERBST	-.24474	.58609	.908	-1.1476	1.6370
		CONTROL	.77895	.58609	.382	-2.1712	.6133
	CONTROL	HERBST	-1.02368	.58609	.193	-.3686	2.4160
		FORSUS	-.77895	.58609	.382	-.6133	2.1712
ArGoMet1t2	HERBST	FORSUS	.55000	.82526	.783	-2.5105	1.4105
		CONTROL	-.15526	.82526	.981	-1.8052	2.1157
	FORSUS	HERBST	-.55000	.82526	.783	-1.4105	2.5105
		CONTROL	-.70526	.82526	.670	-1.2552	2.6657
	CONTROL	HERBST	.15526	.82526	.981	-2.1157	1.8052
		FORSUS	.70526	.82526	.670	-2.6657	1.2552
CoGoMet1t2	HERBST	FORSUS	.58684	.83232	.761	-2.5641	1.3904
		CONTROL	.53158	.83232	.799	-2.5088	1.4456
	FORSUS	HERBST	-.58684	.83232	.761	-1.3904	2.5641
		CONTROL	-.05526	.83232	.998	-1.9220	2.0325
	CONTROL	HERBST	-.53158	.83232	.799	-1.4456	2.5088
		FORSUS	.05526	.83232	.998	-2.0325	1.9220
NtoANSmmt1t2	HERBST	FORSUS	2.79506	1.22803	.063	-5.7123	.1222
		CONTROL	-.75298	1.22803	.813	-2.1643	3.6702
	FORSUS	HERBST	-2.79506	1.22803	.063	-.1222	5.7123
		CONTROL	3.54804*	1.22803	.013	.6308	6.4653
	CONTROL	HERBST	.75298	1.22803	.813	-3.6702	2.1643
		FORSUS	-3.54804*	1.22803	.013	-6.4653	-.6308
ANStoMemmt1t2	HERBST	FORSUS	3.04850	1.62088	.149	-6.8990	.8020
		CONTROL	.15596	1.62088	.995	-4.0064	3.6945
	FORSUS	HERBST	-3.04850	1.62088	.149	-.8020	6.8990
		CONTROL	-2.89254	1.62088	.179	-.9579	6.7430
	CONTROL	HERBST	-.15596	1.62088	.995	-3.6945	4.0064
		FORSUS	2.89254	1.62088	.179	-6.7430	.9579
Overjetmmt1t2	HERBST	FORSUS	-1.99451*	.63717	.006	-3.5081	-.4809
		CONTROL	2.86329*	.63717	.000	1.3497	4.3769
	FORSUS	HERBST	1.99451*	.63717	.006	.4809	3.5081

		CONTROL	4.85779*	.63717	.000	3.3442	6.3714
	CONTROL	HERBST	-2.86329*	.63717	.000	-4.3769	-1.3497
		FORSUS	-4.85779*	.63717	.000	-6.3714	-3.3442
Overbitemmt1t2	HERBST	FORSUS	-.07771	.49342	.986	-1.0944	1.2498
		CONTROL	2.11762*	.49342	.000	.9455	3.2898
	FORSUS	HERBST	.07771	.49342	.986	-1.2498	1.0944
		CONTROL	2.03991*	.49342	.000	.8678	3.2120
	CONTROL	HERBST	-2.11762*	.49342	.000	-3.2898	-.9455
		FORSUS	-2.03991*	.49342	.000	-3.2120	-.8678
Interincisalanglet1t2	HERBST	FORSUS	-2.94211	2.40919	.443	-2.7811	8.6653
		CONTROL	-4.39737	2.40919	.166	-1.3258	10.1205
	FORSUS	HERBST	2.94211	2.40919	.443	-8.6653	2.7811
		CONTROL	-1.45526	2.40919	.818	-4.2679	7.1784
	CONTROL	HERBST	4.39737	2.40919	.166	-10.1205	1.3258
		FORSUS	1.45526	2.40919	.818	-7.1784	4.2679
Molarrelationshipmt1t2	HERBST	FORSUS	-.04611	.44438	.994	-1.0096	1.1018
		CONTROL	2.43197*	.44438	.000	1.3763	3.4876
	FORSUS	HERBST	.04611	.44438	.994	-1.1018	1.0096
		CONTROL	2.38586*	.44438	.000	1.3302	3.4415
	CONTROL	HERBST	-2.43197*	.44438	.000	-3.4876	-1.3763
		FORSUS	-2.38586*	.44438	.000	-3.4415	-1.3302
U1toPtAverticalmt1t2	HERBST	FORSUS	-2.68115*	.59537	.000	-4.0955	-1.2668
		CONTROL	.14134	.59537	.969	-1.5557	1.2730
	FORSUS	HERBST	2.68115*	.59537	.000	1.2668	4.0955
		CONTROL	2.53981*	.59537	.000	1.1255	3.9541
	CONTROL	HERBST	-.14134	.59537	.969	-1.2730	1.5557
		FORSUS	-2.53981*	.59537	.000	-3.9541	-1.1255
U1toFHt1t2	HERBST	FORSUS	-5.73421*	1.90999	.009	-10.2715	-1.1969
		CONTROL	2.48421	1.90999	.398	-7.0215	2.0531
	FORSUS	HERBST	5.73421*	1.90999	.009	1.1969	10.2715
		CONTROL	-3.25000	1.90999	.209	-1.2873	7.7873
	CONTROL	HERBST	-2.48421	1.90999	.398	-2.0531	7.0215
		FORSUS	3.25000	1.90999	.209	-7.7873	1.2873
U1horizontalmmt1t2	HERBST	FORSUS	4.21133	1.88623	.070	-8.6922	.2695
		CONTROL	-.64820	1.88623	.937	-3.8327	5.1291
	FORSUS	HERBST	-4.21133	1.88623	.070	-.2695	8.6922
		CONTROL	4.85953*	1.88623	.030	.3787	9.3404

	CONTROL	HERBST	.64820	1.88623	.937	-5.1291	3.8327
		FORSUS	-4.85953*	1.88623	.030	-9.3404	-.3787
U1verticalmmt1t2	HERBST	FORSUS	4.59207	1.94491	.052	-9.2123	.0282
		CONTROL	-1.21842	1.94491	.806	-3.4018	5.8387
	FORSUS	HERBST	-4.59207	1.94491	.052	-.0282	9.2123
		CONTROL	5.81049*	1.94491	.010	1.1902	10.4307
	CONTROL	HERBST	1.21842	1.94491	.806	-5.8387	3.4018
		FORSUS	-5.81049*	1.94491	.010	-10.4307	-1.1902
U6horizontalmmt1t2	HERBST	FORSUS	1.86611	1.16408	.249	-4.6315	.8992
		CONTROL	-1.36463	1.16408	.472	-1.4007	4.1300
	FORSUS	HERBST	-1.86611	1.16408	.249	-.8992	4.6315
		CONTROL	3.23074*	1.16408	.018	.4654	5.9961
	CONTROL	HERBST	1.36463	1.16408	.472	-4.1300	1.4007
		FORSUS	-3.23074*	1.16408	.018	-5.9961	-.4654
U6verticalmmt1t2	HERBST	FORSUS	-3.96396*	1.63952	.045	-7.8587	-.0692
		CONTROL	-.91138	1.63952	.844	-2.9834	4.8062
	FORSUS	HERBST	3.96396*	1.63952	.045	.0692	7.8587
		CONTROL	4.87534*	1.63952	.010	.9805	8.7701
	CONTROL	HERBST	.91138	1.63952	.844	-4.8062	2.9834
		FORSUS	-4.87534*	1.63952	.010	-8.7701	-.9805
L1toPtApogonionmt1t2	HERBST	FORSUS	.18291	.44720	.912	-1.2453	.8795
		CONTROL	-2.13224*	.44720	.000	-3.1946	-1.0699
	FORSUS	HERBST	-.18291	.44720	.912	-.8795	1.2453
		CONTROL	-1.94933*	.44720	.000	-3.0117	-.8870
	CONTROL	HERBST	2.13224*	.44720	.000	1.0699	3.1946
		FORSUS	1.94933*	.44720	.000	.8870	3.0117
L1tomandibularplant1t2	HERBST	FORSUS	-2.61579	1.44874	.172	-.8258	6.0574
		CONTROL	2.12105	1.44874	.312	-5.5626	1.3205
	FORSUS	HERBST	2.61579	1.44874	.172	-6.0574	.8258
		CONTROL	-4.73684*	1.44874	.004	-8.1784	-1.2953
	CONTROL	HERBST	-2.12105	1.44874	.312	-1.3205	5.5626
		FORSUS	4.73684*	1.44874	.004	1.2953	8.1784
L1horizontalmmt1t2	HERBST	FORSUS	3.99211	1.85871	.085	-8.4076	.4234
		CONTROL	1.82763	1.85871	.589	-6.2431	2.5879
	FORSUS	HERBST	-3.99211	1.85871	.085	-.4234	8.4076
		CONTROL	-2.16448	1.85871	.477	-2.2510	6.5800
	CONTROL	HERBST	-1.82763	1.85871	.589	-2.5879	6.2431
		FORSUS	2.16448	1.85871	.477	-6.5800	2.2510
L1verticalmmt1t2	HERBST	FORSUS	2.52002	1.80975	.348	-6.8192	1.7792

		CONTROL	1.31346	1.80975	.749	-5.6126	2.9857
	FORSUS	HERBST	-2.52002	1.80975	.348	-1.7792	6.8192
		CONTROL	-1.20656	1.80975	.783	-3.0926	5.5057
	CONTROL	HERBST	-1.31346	1.80975	.749	-2.9857	5.6126
		FORSUS	1.20656	1.80975	.783	-5.5057	3.0926
L6horizontalmmt1t2	HERBST	FORSUS	1.95073	1.23684	.260	-4.8889	.9874
		CONTROL	.64820	1.23684	.860	-3.5864	2.2900
	FORSUS	HERBST	-1.95073	1.23684	.260	-.9874	4.8889
		CONTROL	-1.30253	1.23684	.545	-1.6356	4.2407
	CONTROL	HERBST	-.64820	1.23684	.860	-2.2900	3.5864
		FORSUS	1.30253	1.23684	.545	-4.2407	1.6356
L6verticalmmt1t2	HERBST	FORSUS	3.76081	1.69064	.071	-7.7770	.2554
		CONTROL	-.73593	1.69064	.901	-3.2803	4.7522
	FORSUS	HERBST	-3.76081	1.69064	.071	-.2554	7.7770
		CONTROL	4.49673*	1.69064	.024	.4805	8.5130
	CONTROL	HERBST	.73593	1.69064	.901	-4.7522	3.2803
		FORSUS	-4.49673*	1.69064	.024	-8.5130	-.4805
U1SNt1t2	HERBST	FORSUS	-5.45263*	1.88903	.013	-9.9401	-.9651
		CONTROL	2.57105	1.88903	.365	-7.0586	1.9165
	FORSUS	HERBST	5.45263*	1.88903	.013	.9651	9.9401
		CONTROL	-2.88158	1.88903	.283	-1.6059	7.3691
	CONTROL	HERBST	-2.57105	1.88903	.365	-1.9165	7.0586
		FORSUS	2.88158	1.88903	.283	-7.3691	1.6059
U1ANSPNSmt1t2	HERBST	FORSUS	1.30701	.78714	.225	-3.1769	.5629
		CONTROL	.00487	.78714	1.000	-1.8748	1.8650
	FORSUS	HERBST	-1.30701	.78714	.225	-.5629	3.1769
		CONTROL	-1.30213	.78714	.228	-.5678	3.1720
	CONTROL	HERBST	-.00487	.78714	1.000	-1.8650	1.8748
		FORSUS	1.30213	.78714	.228	-3.1720	.5678
U6ANSPNSmt1t2	HERBST	FORSUS	1.14950	.58458	.125	-2.5382	.2392
		CONTROL	-.96499	.58458	.229	-.4237	2.3537
	FORSUS	HERBST	-1.14950	.58458	.125	-.2392	2.5382
		CONTROL	2.11449*	.58458	.001	.7258	3.5032
	CONTROL	HERBST	.96499	.58458	.229	-2.3537	.4237
		FORSUS	-2.11449*	.58458	.001	-3.5032	-.7258
L1GoMet1t2	HERBST	FORSUS	-2.61579	1.44874	.172	-.8258	6.0574
		CONTROL	2.12105	1.44874	.312	-5.5626	1.3205
	FORSUS	HERBST	2.61579	1.44874	.172	-6.0574	.8258

		CONTROL	-4.73684*	1.44874	.004	-8.1784	-1.2953
	CONTROL	HERBST	-2.12105	1.44874	.312	-1.3205	5.5626
		FORSUS	4.73684*	1.44874	.004	1.2953	8.1784
L1GoMemmt1t2	HERBST	FORSUS	1.88997	1.00765	.151	-4.2837	.5038
		CONTROL	-1.68386	1.00765	.221	-.7099	4.0776
	FORSUS	HERBST	-1.88997	1.00765	.151	-.5038	4.2837
		CONTROL	3.57383*	1.00765	.002	1.1801	5.9676
	CONTROL	HERBST	1.68386	1.00765	.221	-4.0776	.7099
		FORSUS	-3.57383*	1.00765	.002	-5.9676	-1.1801
L6GoMemmt1t2	HERBST	FORSUS	1.36894	.83709	.235	-3.3575	.6196
		CONTROL	.10966	.83709	.991	-2.0982	1.8789
	FORSUS	HERBST	-1.36894	.83709	.235	-.6196	3.3575
		CONTROL	-1.25928	.83709	.293	-.7293	3.2478
	CONTROL	HERBST	-.10966	.83709	.991	-1.8789	2.0982
		FORSUS	1.25928	.83709	.293	-3.2478	.7293
OPSNt1t2	HERBST	FORSUS	-.39211	.76868	.867	-1.4339	2.2182
		CONTROL	-2.28947*	.76868	.010	-4.1155	-.4634
	FORSUS	HERBST	.39211	.76868	.867	-2.2182	1.4339
		CONTROL	-2.68158*	.76868	.002	-4.5076	-.8555
	CONTROL	HERBST	2.28947*	.76868	.010	.4634	4.1155
		FORSUS	2.68158*	.76868	.002	.8555	4.5076