# CEPHALOMETRIC ANALYSIS OF POSTTREATMENT CHANGES IN CLASS II DIVISION 1 PATIENTS TREATED IN EITHER ONE OR TWO PHASES

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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The purpose of this investigation was to examine the posttreatment differences in sagittal skeletal, dental and soft tissue changes following one-phase (control) or two-phase (bionator or headgear) Class II treatment. Lateral cephalograms of 166 subjects (55 headgear, 58 bionator and 53 control), treated as part of a randomized controlled clinical trial, were examined for differences in post treatment change. Final cephalograms (CDF) were compared to cephalograms taken at one year (CDR1) and at least three and a half years (CDR 4-6) postorthodontic treatment. All cephalograms were traced and digitized by a single calibrated examiner. The sagittal skeletal and dental changes were examined utilizing a modified Johnston's analysis. The soft and hard tissues were evaluated by analysis of various angular and linear changes. The differences were examined using the Kruskal-Wallis statistical method with significance levels set at $p<0.05$. From DCF to DCD1, the horizontal movement of B point was significant ($p= 0.03$) with retrusive change in the headgear (HG) group ($-0.38\pm3.6$ mm) and protrusive

changes in the bionator (B) group (0.73±1.3 mm) and the control (C) group (0.76±1.3 mm). The vertical change in the position of the lower incisor was also significant (p=0.01) for this time period. There was intrusion for both HG (0.49±1.6 mm) and B (0.56±1.5 mm) and no mean change (0.0±1.3 mm) in C. The only significant soft tissue difference was seen between DCF and DCR1. The vertical change in glabella was -0.05±3.4 mm in the HG group, -1.73±1.9 mm in the B group and 0.44±3.2 in the C group with a significance of p=0.03. In the DCF to DCR 4, 5, 6 time period, SNB was significant (p=0.05) with C being smaller (0.02±1.0º) than HG (0.59±1.3º) or B (0.60±0.9º). Additionally, in this time period, the upper (p=0.04) and lower (p=0.05) incisors had significantly different amounts of vertical change. The values for the upper incisor were twice as great in B (1.83±1.5 mm) compared to HG (0.93±1.9 mm), while C (1.19±1.5 mm) was intermediate. The values for the lower incisor were HG (0.89±2.4 mm), B (1.44±1.4 mm) and C (0.02±1.0 mm). No treatment method had a consistently better response in the posttreatment period. Given that there were few differences, one cannot conclude that either treatment modality is superior based on sagittal posttreatment change.

# CHAPTER 1
# INTRODUCTION

Historically, there have been two methods for treating Class II Division 1 malocclusion. One method involves two phases of treatment. The early phase occurs in the mixed dentition and is focused on molar correction and growth modification, typically with a headgear or a functional appliance. The latter phase commences in the permanent dentition, detailing the occlusion with full fixed appliances. Normalization of the growth pattern, decreased incisor trauma, and fewer extractions are advantages assigned to this method.[1] Less damage to oral structures[2] and increased stability[3] are also possible advantages.

The alternate method of treating Class II malocclusion consists of a single phase. Treatment is initiated in the permanent dentition with full fixed appliances. Advantages for this method include shorter overall treatment time and lower financial cost to the patient.[4]

The evidence for the reported benefits of either treatment method has generally come from retrospective studies.[1-4] Only recently have these two treatment modalities been directly compared using well-controlled prospective clinical trials. Results calculated after phase one treatment indicated substantial improvement in the malocclusion.[5, 6] This could lead to the conclusion that early treatment is advantageous. Results collected later, after *all* patients had finished fixed appliances, indicated no difference between one- and two-phase treatment.[7, 8] The patients are essentially indistinguishable, and there is no apparent advantage associated with early treatment. A final aspect that has yet to be investigated is possible posttreatment differences that may exist between one- and two-phase treatment.

Changes that occur in the posttreatment period can be divided into two groups. The first type of change is growth. Growth is change in size and form that occurs as the subject proceeds to adulthood. The second type of change is relapse. Relapse is change that tends to revert structures to their pretreatment positions.

The purpose of this study is to use cephalometric analysis to compare the hard and soft tissue changes that occur posttreatment, in children treated with either a one-phase or a two-phase method.

# CHAPTER 2
# MATERIALS AND METHODS

## Sample Selection

The sample of patients used for this analysis consisted of one hundred sixty-six patients (69 females, 97 males) treated as part of a randomized controlled clinical trial. Details of patient selection and randomization have previously been reported.[6] Briefly, fourth grade children with Class II Division 1 malocclusion were randomly assigned to one of three treatment groups: 1) early treatment with headgear/biteplane followed by comprehensive treatment, 2) early treatment with a bionator followed by comprehensive treatment, or 3) comprehensive treatment preceded by no early treatment. Molar severity, mandibular plane angle, and gender were equivalent between groups prior to treatment.

For this analysis, all subjects that completed treatment were considered. Subjects that had a final cephalogram (DCF) and at least one post treatment cephalogram (DCR) available, were chosen. The post treatment radiographs were labeled with the number of years post treatment. For example, DCR3 was the radiograph take three years after treatment was completed. Attempts were made to take records every year, but all time points were not available for all patients. The preferred time points likely to show short and long term changes were DCR1 and 5. If these points were unavailable, the next closest were chosen.

**Cephalometric Tracing**

To standardize the tracings for each patient, templates were created for various structures including cranial base, maxilla, mandible, incisors and first molars (Figure 1). During the construction of the template, two films of the patient were examined side by side. The most distinct image of each structure was chosen for drawing the template. Adequate detail was included on the template, including bony trabeculae and cortical borders, to allow the template to be re-oriented correctly. A mean functional occlusal plane (MFOP), constructed by averaging the functional occlusal planes from before and after comprehensive treatment, was then added to the template.

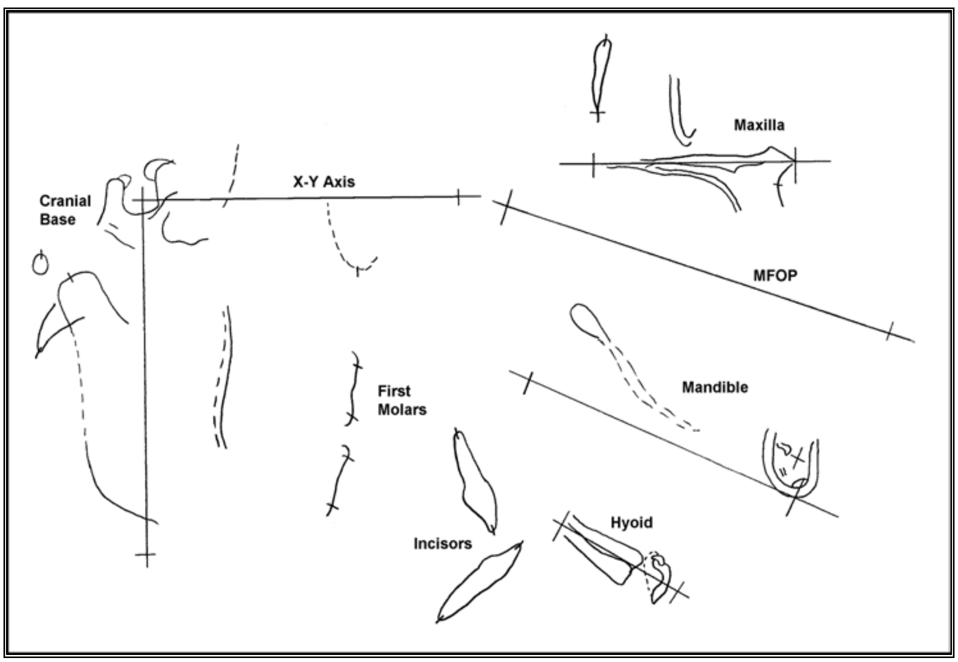


Figure 1. Custom template

The template was oriented independently for each structure by 'best-fit' visual approximation. Registration crosses were transferred to a separate sheet of acetate. Various other points, including 23 soft tissue points, were then drawn freehand. A completed cephalometric tracing can be seen in Figure 2. The X and Y coordinates for each point was then digitized using a Hipad TM 1200 series Digitizer (TM, Houston Instruments) and formatted using the software program CephMaster (Trilobyte Software, Ann Arbor, MI). All cephalograms were traced and digitized by the same calibrated examiner.

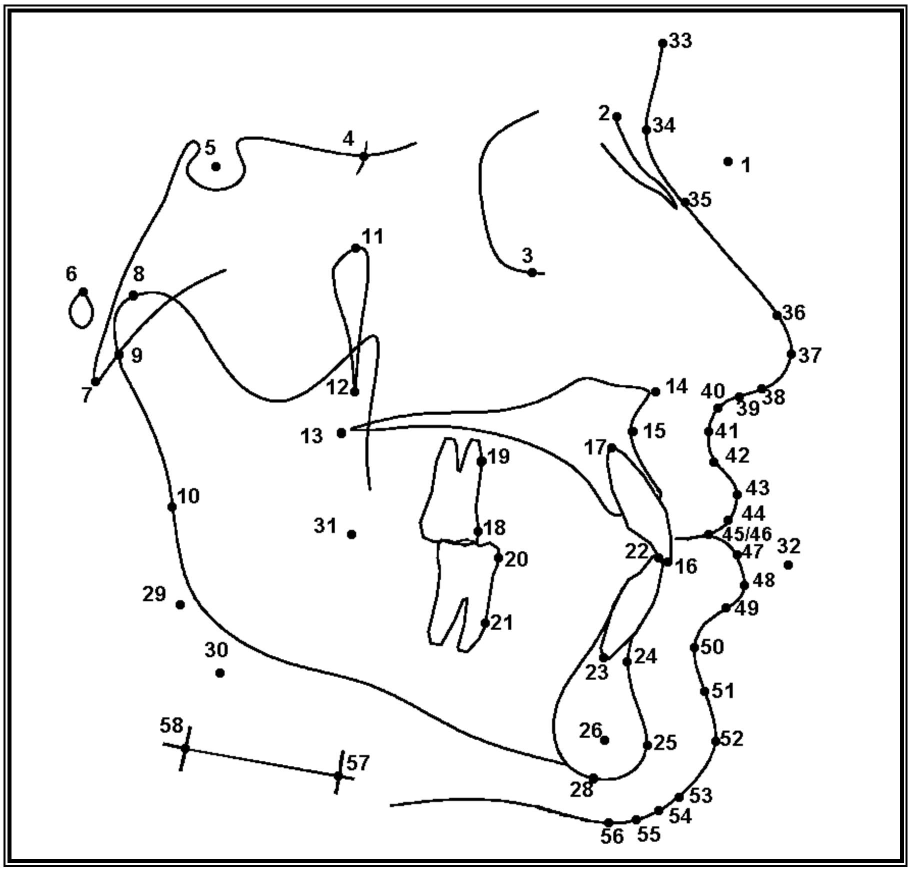


Figure 2. Cephalometric landmarks. 1, X-Axis Point. 2, Nasion. 3, Orbitale. 4, Sphenoethmoid Point. 5, Sella. 6, Porion. 7, Basion. 8, Condylion. 9, Articulare. 10, Ramus Point. 11, PTM Superior. 12, PTM Inferior. 13, Posterior Maxillary Plane. 14, Anterior Maxillary Plane. 15, A Point. 16,Upper Incisor Tip. 17,Upper Incisor Apex. 18, Upper Molar Mesial Contact. 19, Upper Molar Mesial Root. 20, Lower Molar Mesial Contact. 21, Lower Molar Mesial Root. 22, Lower Incisor Tip. 23, Lower Incisor Apex. 24, B Point. 25, Pogonion. 26, D Point. 28, Menton. 29, Posterior Mandibular Plane. 30, Y-Axis Point. 31, Posterior Mean Functional Occlusal Plane. 32, Anterior MFOP. 33-56, Soft Tissue Points. 57, Anterior Hyoid Point. 58, Posterior Hyoid Point.

**Cephalometric Analysis**

A modified Johnston analysis was used to analyze anterior-posterior (A-P) changes. The details of this method have been previously reported.[9, 10] Briefly, this method references linear A-P changes to the mean functional occlusal plane (MFOP). Four separate superimpositions were conducted between DCF and each of the DCRs for that patient. The superimpositions were always done parallel to the MFOP. Three skeletal and six dental changes were evaluated (Table 1). By convention, changes in the Johnston analysis that lead to Class I occlusion were given a positive sign. Those that detract from molar or overjet correction were given a negative sign.

Table 1. Measurements from Johnston's analysis

| Measurement | Definition |
|---|---|
| *Skeletal* | |
| Maxilla (MAX) | Maxillary displacement relative to cranial base (SE registration point) |
| Mandible (MAND) | Mandibular displacement relative to cranial base |
| Apical Base (AB) | Mandibular displacement relative to the maxilla |
| *Dental* | |
| Maxillary molar (U6) | Change in position of the upper molars |
| Maxillary Incisor (U1) | Change in position of the upper incisor |
| Mandibular Molar (L6) | Change in position of the lower molar |
| Mandibular Incisor (L1) | Change in position of the lower incisor |
| Molar Differential (U6-L6) | Total molar change |
| Overjet (U1-L1) | Total overjet change |

Various additional linear and angular measurements were calculated. These included evaluation of skeletal, dental and soft tissue structures. These measurements can be seen in Table 2. Several of the measurements use an x,y-axis constructed as part of the subject's template. This serves to quantify linear changes perpendicular to the appropriate axis.

## Statistical Analysis

For each calculated measure, the differences among groups were examined using Kruskal-Wallis and descriptive statistical methods. Significance levels were set at $p<0.05$.

Table 2. Cephalometric variables

| ***Measure*** | ***Definition*** |
|---|---|
| **Skeletal** | |
| *Angular (degrees)* | |
| S-N-A | 5-2-15 |
| S-N-B | 5-2-24 |
| FMA | 29-28 / 6-3 |
| SN-MPA | 29-28 / 5-2 |
| PP-SEN | 13-14 / 4-2 |
| PP-SN | 13-14 / 5-2 |
| MP-PP | 29-28 / 13-14 |
| Ramus-MP | 29-28 / 10-9 |
| A-N-B | 15-2-24 |
| Ba-S-N | 2-5-7 |
| *Linear (mm)* | |
| ANS | 14 / 5-30, 14 /1-5 |
| A pt | 15 / 5-30, 15 /1-5 |
| B pt | 24 / 5-30, 24 /1-5 |
| Pogonion | 25 / 5-30, 25 /1-5 |
| Hyoid | 57 / 5-30, 57 /1-5 |
| **Dental** | |
| *Angular (degrees)* | |
| U1-NA | 2-15 / 17-16 |
| U1-SN | 2-5 / 17-16 |
| L1-MPA | 23-22 / 28-29 |
| L1-NB | 23-22 / 24-2 |
| **Dental** | |
| *Linear (mm)* | |
| U1 X, Y | 16 / 5-30, 16 /1-5 |
| U6 X, Y | 18 / 5-30, 18 /1-5 |
| L1 X, Y | 22 / 5-30, 22 /1-5 |
| L6 X, Y | 20 / 5-30, 20 /1-5 |
| **Soft Tissue** | |
| *Angular (degrees)* | |
| Nasolabial | 38-40-42 |
| Facial Angle | 6-3 / 52-34 |
| Facial Convexity | 34-40-52 |
| *Linear (mm)* | |
| Nasal Projection | 37 / 33-52 |
| Glabella X, Y | 33 / 5-30, 33 /1-5 |
| Nasal Tip X, Y | 37 / 5-30, 37 /1-5 |
| ST A pt X, Y | 41 / 5-30, 41 /1-5 |
| Upper Lip X, Y | 43 / 5-30, 43 /1-5 |
| Lower Lip X, Y | 48 / 5-30, 48 /1-5 |
| ST B pt X, Y | 50 / 5-30, 50 /1-5 |
| Pogonion X, Y | 52 / 5-30, 52 /1-5 |

CHAPTER 3
RESULTS

## Sample

Distribution of gender and treatment group of the sample can be seen in Table 3. The sample was predominately Caucasian (97%) with a slightly higher proportion of non-white subjects in the bionator group (eight versus two in each of the other two groups).

Table 3. Description of sample

| | Males | | Females | | Total | |
|---|---|---|---|---|---|---|
| Group | N | % | N | % | N | % |
| Headgear | 28 | 17 | 27 | 16 | 55 | 33 |
| Bionator | 34 | 20 | 24 | 15 | 58 | 35 |
| Control | 35 | 21 | 18 | 11 | 53 | 32 |
| Total | 97 | 58 | 69 | 42 | 166 | 100 |

Data were unavailable for forty-two subjects completing the study. The missing data was due to 1) no post treatment records taken on thirty-three subjects, 2) two subjects had missing radiographs, and 3) four subjects were being retreated.

Table 4 represents the distribution of tracings per time point.

Table 4. Time point distribution

| Time Point | Radiographs |
|---|---|
| DCF | 166 |
| DCR1 | 150 |
| DCR2 | 111 |
| DCR3 | 9 |
| DCR4 | 32 |
| DCR5 | 34 |
| DCR6 | 19 |
| DCR7 | 4 |
| Total | 525 |

**Time Period DCF to DCR1**

According to the Johnston analysis, there were no significant differences in the amount of sagittal skeletal change experienced by the different treatment groups between the time points DCF and DCR1. Additionally, this analysis shows no differences in any dental measures during this time period, as seen in Figure 3.

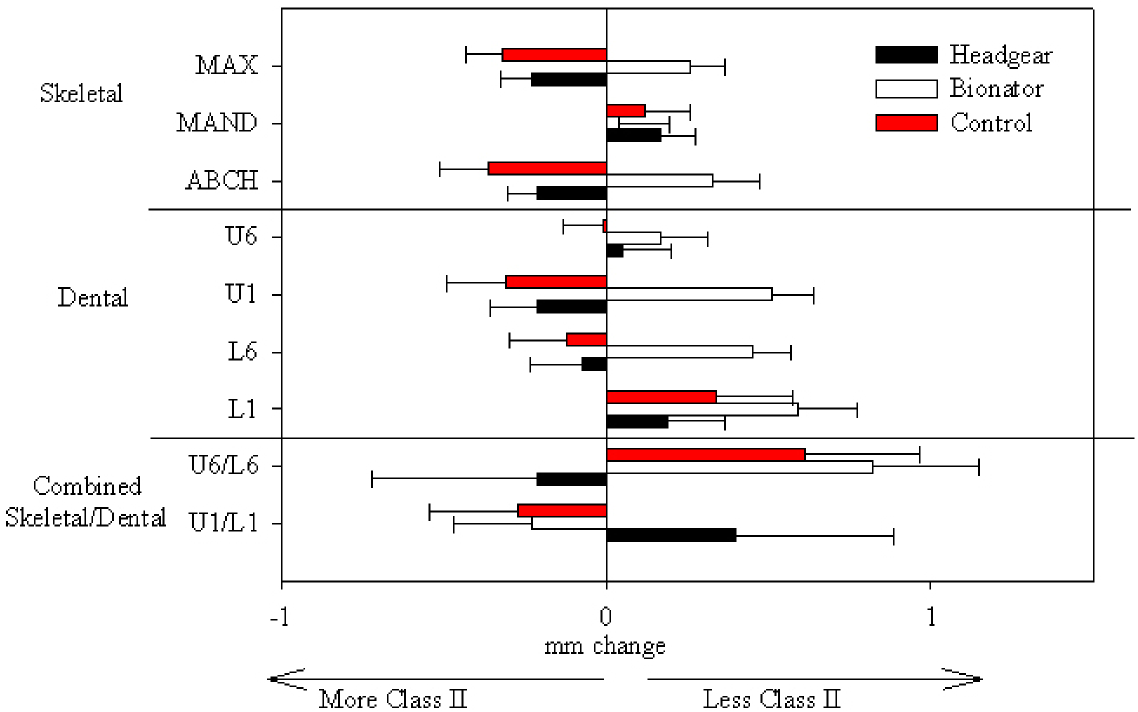


Figure 3. Johnston analysis: Comparison of mean changes DCF to DCR1

The hard tissue analysis shown in Table 5 demonstrates a couple of significant differences. The changes of the horizontal position of B point and the vertical position of the lower incisor were different between treatment groups. The headgear group experienced a negative mean change (-0.38 ±3.6 mm) in the position of B point while both the bionator and control group had positive mean changes (0.73±1.3 mm and 0.76 ±1.2 mm, respectively). The lower incisor moved forward an average of one half millimeter in the headgear and bionator groups (0.49 ±1.6 mm and 0.56±1.5 mm, respectively). In the control group there was no mean change (0.00 ±1.3 mm). The soft tissue analysis (Table 6) shows a significant difference in the change in position of glabella. In the headgear group, the vertical position changed -0.05±3.4 mm, while in the bionator group it moved more (-1.73±1.9 mm), and the control group had a positive change of 0.44±3.2 mm.

**Time Period DCF to DCR 4, 5 or 6**

To examine changes occurring an average of five years post treatment, the time periods DCR 4, 5 and 6 were combined. According to the Johnston analysis, there were no significant differences in skeletal changes or dental changes for this time period (see Figure 4).

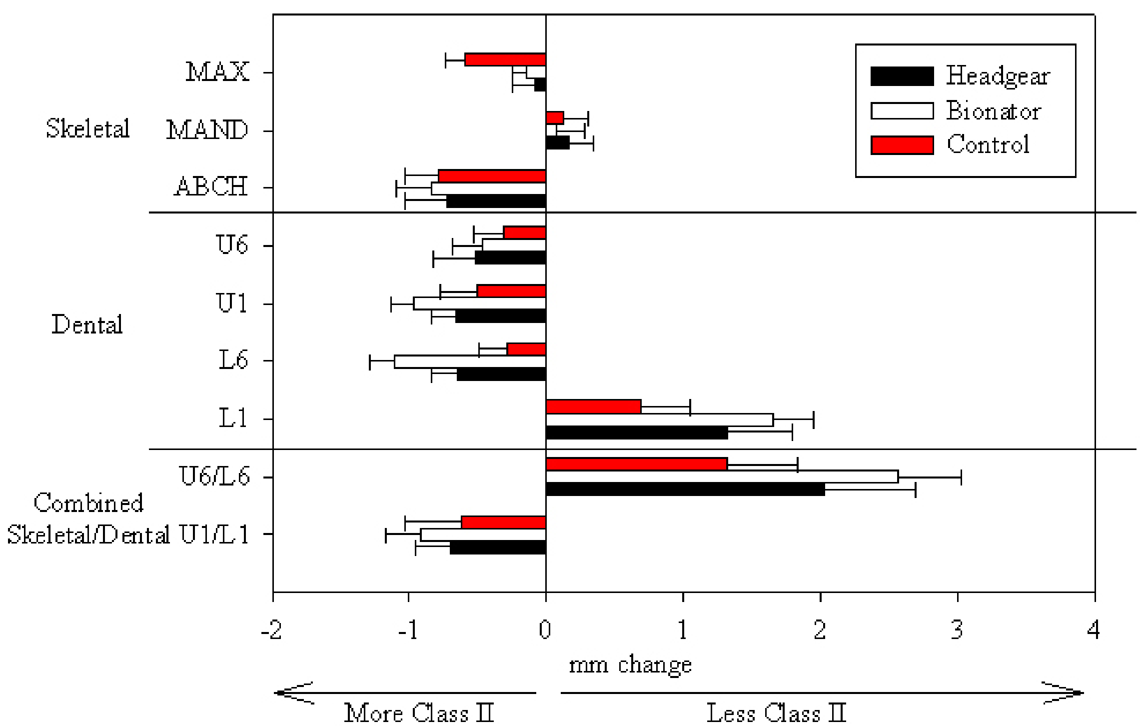


Figure 4. Johnston analysis: Comparison of mean changes DCF to DCR 4, 5 or 6

Additional cephalometric analysis indicated significant differences in only a few hard tissue measures and no differences in any soft tissue measures (see Tables 7 and 8, respectively). The hard tissue measures that exhibited differences are SNB and the vertical position of the upper and lower incisors. The control group had less change in SNB (0.02 ±1.0º) than either headgear (0.59 ±1.3º) or bionator (0.60 ±0.9º). The bionator group had considerably more vertical change in both the upper (1.83±1.5 mm) and lower (1.44±1.4 mm) incisor than the other two groups. The upper incisor changed 0.93±1.9mm in the headgear group and 1.19±1.5 mm in the control group. The lower incisor changed 0.89±2.4mm in the headgear group and 0.50±1.5 mm in the control group.

Table 5. Hard tissue: Comparison of mean changes DCF to DCR1

| Variable | Headgear N=50 Mean (SD) | Bionator N=53 Mean (SD) | Control N=47 Mean (SD) | P-values |
|---|---|---|---|---|
| **Skeletal** | | | | |
| *Angular* | | | | |
| S-N-A | 0.27 (3.1) | 0.14 (0.9) | 0.01 (1.3) | 0.72 |
| S-N-B | -0.12 (2.1) | 0.36 (0.8) | 0.07 (0.8) | 0.12 |
| FMA | -0.15 (2.7) | -0.53 (1.4) | -0.47 (1.9) | 0.88 |
| SN-MPA | -0.09 (2.3) | -0.44 (1.1) | -0.35 (1.5) | 0.53 |
| PP-SEN | -0.39 (1.3) | -0.36 (1.3) | 0.17 (1.3) | 0.07 |
| PP-SN | -0.21 (1.1) | -0.25 (1.1) | 0.06 (1.1) | 0.36 |
| MP-PP | -0.12 (2.4) | -0.19 (1.4) | -0.41 (1.6) | 0.33 |
| Ramus-MP | 0.55 (4.1) | -0.77 (2.0) | -0.44 (2.5) | 0.19 |
| A-N-B | -0.16 (1.2) | -0.22 (0.7) | -0.06 (1.1) | 0.45 |
| Ba-S-N | -0.00 (1.3) | -0.00 (1.2) | 0.09 (1.5) | 0.87 |
| *Linear* | | | | |
| ANS X | -0.40 (3.6) | 0.28 (1.2) | 0.53 (1.3) | 0.18 |
| ANS Y | 0.23 (1.4) | 0.36 (1.4) | 0.15 (1.1) | 0.69 |
| A pt X | -0.40 (3.6) | 0.33 (1.1) | 0.52 (1.3) | 0.22 |
| A pt Y | 0.25 (1.4) | 0.38 (1.3) | 0.15 (1.0) | 0.70 |
| B pt X | -0.38 (3.6) | 0.73 (1.3) | 0.76 (1.2) | **0.03*** |
| B pt Y | 0.40 (2.2) | 0.32 (1.0) | 0.11 (1.6) | 0.64 |
| Pog X | -0.17 (3.8) | 0.79 (1.5) | 0.99 (1.6) | 0.12 |
| Pog Y | 0.81 (2.1) | 0.98 (1.9) | 0.73 (1.6) | 0.71 |
| Hyoid X | -0.28 (4.5) | 0.57 (5.9) | 0.72 (4.9)[a] | 0.63 |
| Hyoid Y | 0.20 (5.8) | 1.80 (4.8) | 1.60 (4.6)[a] | 0.64 |
| **Dental** | | | | |
| *Angular* | | | | |
| U1-NA | 0.27 (3.7) | 0.43 (2.9) | 0.09 (2.9) | 0.78 |
| U1-SN | -0.01 (2.7) | 0.58 (2.6) | 0.02 (2.9) | 0.57 |
| L1-MPA | -0.15 (3.9) | -0.09 (2.8) | -0.31 (3.3) | 0.66 |
| L1-NB | -0.36 (3.8) | -0.17 (2.6) | -0.59 (2.9) | 0.50 |
| *Linear* | | | | |
| U1 X | -0.23 (3.7) | 0.75 (1.2) | 0.85 (1.3) | 0.07 |
| U1 Y | 0.70 (1.7) | 0.82 (1.3) | 0.43 (1.1) | 0.19 |
| U6 X | -0.34 (3.5) | 0.69 (1.4) | 0.64 (1.4) | 0.20 |
| U6 Y | 0.57 (1.5) | 0.84 (1.3) | 0.56 (1.2) | 0.46 |
| L1 X | -0.42 (3.6) | 0.54 (1.3) | 0.60 (1.4) | 0.17 |
| L1 Y | 0.49 (1.6) | 0.56 (1.5) | -0.00 (1.3) | **0.01*** |
| L6 X | -0.21 (3.8) | 0.64 (1.3) | 0.80 (1.2) | 0.24 |
| L6 Y | 0.78 (1.6) | 0.86 (1.4) | 0.51 (1.1) | 0.38 |

[a] N=46

* Significant at $p < 0.05$

Table 6. Soft tissue: Comparison of mean changes DCF to DCR1

| Variable | Headgear N=50 Mean (SD) | Bionator N=53 Mean (SD) | Control N=47 Mean (SD) | P-values |
|---|---|---|---|---|
| **Soft Tissue** | | | | |
| *Angular* | | | | |
| Nasolabial | -1.38 (4.8) | -0.24 (6.1) | -0.50 (5.1) | 0.52 |
| F. Angle | -0.13 (2.0)[a] | 0.43 (1.9)[b] | 0.73 (2.3)[c] | 0.84 |
| F. Convexity | 0.10 (1.4)[a] | 0.08 (1.6)[b] | 0.48 (2.4)[c] | 0.91 |
| *Linear* | | | | |
| Nasal Pro | 0.22 (0.8)[e] | 0.06 (1.1)[e] | -0.04 (1.4)[d] | 0.47 |
| Glabella X | 0.19 (1.3) | 0.56 (1.4)[g] | 0.62 (1.2) | 0.34 |
| Y | -0.05 (3.4) | -1.73 (1.9)[g] | 0.44 (3.2) | **0.03*** |
| Nasal Tip X | 0.42 (1.5)[e] | 0.92 (1.6)[f] | 0.84 (1.5)[d] | 0.22 |
| Y | 0.30 (1.7)[e] | 0.42 (1.5)[f] | 0.11 (1.5)[d] | 0.51 |
| ST A pt X | 0.06 (1.4) | 0.52 (1.3) | 0.49 (1.4) | 0.31 |
| Y | 0.29 (1.7) | 0.55 (1.5) | 0.25 (1.3) | 0.54 |
| U Lip X | 0.01 (1.7) | 0.39 (1.5)[g] | 0.49 (1.6) | 0.39 |
| Y | 0.22 (1.8) | 0.71 (1.6)[g] | 0.26 (1.3) | 0.26 |
| L Lip X | 0.20 (1.7) | 0.62 (1.5) | 1.27 (3.7) | 0.53 |
| Y | 0.48 (2.7) | 0.28 (1.6) | -0.36 (4.4) | 0.52 |
| ST B pt X | 0.01 (1.6) | 0.76 (1.7) | 1.16 (3.8) | 0.06 |
| Y | 0.24 (2.2) | 0.52 (1.7) | -0.41 (4.5) | 0.41 |
| ST Pog X | 0.30 (1.7) | 0.86 (1.8) | 1.31 (3.8) | 0.19 |
| Y | 0.64 (2.6) | 0.95 (2.2) | 0.27 (4.9) | 0.91 |

[a] N =20, [b] N=25, [c] N=26, [d] N=46, [e] N=49, [f] N=50, [g] N=52

* Significant at $p < 0.05$

Table 7. Hard tissue: Comparison of mean changes from DCF to DCR 4, 5 or 6

| Variable | | Headgear N=26 Mean (SD) | Bionator N=33 Mean (SD) | Control N=26 Mean (SD) | P-values |
|---|---|---|---|---|---|
| **Skeletal** | | | | | |
| *Angular* | | | | | |
| S-N-A | | 0.19 (1.0) | 0.14 (1.0) | -0.14 (1.7) | 0.71 |
| S-N-B | | 0.59 (1.3) | 0.60 (0.9) | 0.02 (1.0) | **0.05*** |
| FMA | | -0.40 (2.5) | -1.34 (2.1) | -0.35 (2.7) | 0.20 |
| SN-MPA | | -1.27 (2.2) | -1.15 (1.9) | -0.51 (2.0) | 0.30 |
| PP-SEN | | -0.15 (1.4) | -0.53 (1.1) | 0.01 (1.7) | 0.37 |
| PP-SN | | -0.12 (1.3) | -0.18 (1.8) | 0.06 (1.1) | 0.71 |
| MP-PP | | -1.14 (2.8) | -0.97 (1.3) | -0.57 (2.0) | 0.33 |
| Ramus-MP | | -1.37 (2.4) | -0.93 (2.0) | -0.92 (2.4) | 0.88 |
| A-N-B | | -0.40 (1.0) | -0.46 (1.0) | -0.16 (1.8) | 0.89 |
| Ba-S-N | | -0.24 (1.4) | -0.15 (1.3) | 0.03 (1.6) | 0.81 |
| *Linear* | | | | | |
| ANS | X | 0.44 (1.1) | 0.64 (1.5) | 1.06 (2.0) | 0.34 |
| | Y | 0.44 (1.9) | 0.89 (1.3) | 0.25 (1.5) | 0.22 |
| A pt | X | 0.37 (1.1) | 0.68 (1.5) | 1.03 (1.9) | 0.31 |
| | Y | 0.40 (1.8) | 0.81 (1.2) | 0.33 (1.4) | 0.35 |
| B pt | X | 1.11 (2.4) | 1.39 (2.4) | 1.43 (2.2) | 0.82 |
| | Y | 1.11 (2.5) | 1.29 (2.0) | 0.75 (2.1) | 0.62 |
| Pog | X | 1.64 (2.9) | 1.85 (2.8) | 1.71 (2.7) | 0.94 |
| | Y | 1.75 (3.0) | 2.18 (2.4) | 1.67 (2.0) | 0.46 |
| Hyoid | X | -1.50 (5.1) | -0.14 (5.3) | -3.14 (6.1)[a] | 0.07 |
| | Y | 2.06 (5.5) | 4.25 (6.5) | 1.62 (4.7)[a] | 0.43 |
| **Dental** | | | | | |
| *Angular* | | | | | |
| U1-NA | | -0.02 (3.5) | -0.13 (4.5) | -0.31 (4.7) | 0.84 |
| U1-SN | | 0.17 (3.8) | 0.01 (4.3) | -0.71 (4.5) | 0.84 |
| L1-MPA | | -0.57 (3.9) | 0.33 (3.5) | -1.25 (3.3) | 0.30 |
| L1-NB | | -1.24 (3.9) | -0.22 (3.6) | -1.74 (3.0) | 0.26 |
| *Linear* | | | | | |
| U1 | X | 1.05 (1.9) | 1.39 (1.9) | 1.51 (1.9) | 0.63 |
| | Y | 0.93 (1.9) | 1.83 (1.5) | 1.19 (1.5) | **0.04*** |
| U6 | X | 0.98 (1.9) | 1.53 (1.8) | 1.25 (2.2) | 0.59 |
| | Y | 1.24 (1.7) | 2.00 (1.7) | 1.20 (1.4) | 0.06 |
| L1 | X | 0.98 (2.1) | 1.32 (1.7) | 1.02 (1.6) | 0.61 |
| | Y | 0.89 (2.4) | 1.44 (1.4) | 0.02 (1.0) | **0.05*** |
| L6 | X | 1.12 (2.3) | 1.60 (2.1) | 1.37 (2.2) | 0.40 |
| | Y | 1.38 (2.1) | 2.01 (1.6) | 1.32 (1.2) | 0.11 |

[a] N =25

* Significant at $p < 0.05$

Table 8. Soft tissue: Comparison of mean changes from DCF to DCR 4, 5 or 6

| Variable | Headgear N=26 Mean (SD) | Bionator N=33 Mean (SD) | Control N=26 Mean (SD) | P-values |
|---|---|---|---|---|
| **Soft Tissue** | | | | |
| *Angular* | | | | |
| Nasolabial | -1.37 (7.0) | -0.86 (5.2) | -1.74 (4.8) | 0.63 |
| F. Angle | -0.56 (2.8)[a] | -0.81 (1.3)[c] | 1.42 (2.5)[b] | 0.45 |
| F. Convexity | -0.93 (3.0)[a] | 0.21 (2.6)[c] | 1.74 (5.2)[b] | 0.39 |
| *Linear* | | | | |
| Nasal Pro | 0.14 (1.3) | 0.63 (1.6)[d] | 0.04 (1.4) | 0.29 |
| Glabella X | 0.74 (1.9) | 1.21 (1.6) | 1.34 (2.1) | 0.57 |
| Y | -1.93 (3.7) | -2.49 (4.1) | 2.28 (4.3) | 0.99 |
| Nasal Tip X | 1.48 (2.5) | 2.26 (2.6)[d] | 2.12 (2.1) | 0.12 |
| Y | 0.83 (1.9) | 1.07 (1.8)[d] | 0.62 (1.9) | 0.63 |
| ST A pt X | 0.68 (2.0) | 1.25 (2.1) | 1.19 (1.9) | 0.48 |
| Y | 0.53 (1.7) | 1.38 (1.7) | 0.83 (1.7) | 0.07 |
| U Lip X | 0.54 (2.4) | 1.97 (2.2) | 1.09 (1.9) | 0.47 |
| Y | 0.87 (1.9) | 1.69 (1.7) | 1.18 (1.5) | 0.15 |
| L Lip X | 1.06 (2.3) | 1.47 (2.4) | 2.35 (5.2) | 0.80 |
| Y | 1.02 (2.8) | 1.42 (2.0) | 0.40 (5.5) | 0.33 |
| ST B pt X | 1.50 (2.5) | 1.55 (2.6) | 2.52 (5.3) | 0.83 |
| Y | 1.12 (3.0) | 2.04 (2.3) | 0.40 (5.8) | 0.25 |
| ST Pog X | 1.98 (3.0) | 1.95 (3.2) | 3.00 (5.5) | 0.80 |
| Y | 1.74 (3.3) | 3.14 (2.6) | 1.36 (6.00 | 0.16 |

[a] N=4, [b] N=9, [c] N=15, [d] N=32

## CHAPTER 4
## DISCUSSION

In this study, we attempted to determine if there was any difference in posttreatment changes experienced by subjects treated with either a one- or a two-phase protocol. Short term (one-year) and long term (five-year) time periods were investigated. Skeletal, dental and soft tissue changes were evaluated with cephalometric analysis.

Studies that look at the posttreatment period typically are retrospective,[4, 11, 12] limited to one treatment modality,[12-15] and have small sample sizes.[11, 16] Studies that do compare treatment modalities are usually limited to extraction versus non extraction[10] or only deal with short term response to treatment effects.[14, 15] The current study is unique in that it directly compares different treatment modalities, has relatively large sample sizes, and is conducted within the framework of a randomized clinical trial.

**Dental changes**. In their investigation of non-extraction headgear therapy, Elms et al.[17] found the results to be stable for the most part. Slight relapse was found in the lower incisor angulation (-0.5º) and lower molar angulation (0.6º). Vertical changes of the upper incisor (1.0mm) and lower incisor (2.0mm) were also found at approximately eight years post treatment. In the current study, vertical changes were also seen in the upper and lower incisors. There was significantly more incisor movement in the bionator group at five years. Additionally, in this study, a similar amount of relapse was found in the lower incisor angulation in the headgear group (-0.6º). However, this amount was not statistically different than the changes experienced by the other two groups at five years post treatment. This observation is supported by Shah,[18] who found that some degree of incisor relapse may be inevitable, regardless of the treatment protocol. If relapse is going to occur, it will be seen soon after treatment is finished.[19] About half of dental relapse occurs within two years post retention.[20]

**Skeletal changes**. In a retrospective analysis of 36 extraction patients, Vaden et al.[21] found that the greatest amount of dental relapse occurred in the subjects whose mandibular growth exceeded the maxillary growth. A decreasing ANB angle could indicate mandibular growth is occurring faster than maxillary growth. In the present study, there was negative change in ANB for both one and five year follow up. There were, however, no significant differences among the groups, despite a significantly smaller change in SNB for the control group at five years. Similarly, in a retrospective study comparing extraction versus nonextraction treatment, Glenn et al. found very little change in ANB posttreatment. [11]

The Glenn study also found that the mandibular plane angle has a tendency to close after treatment.[11] In the present study, the MPA decreased in all treatment groups. The change was mild in the first year, averaging less than one half degree. Over the longer time period it closed almost twice that amount. There was no significant difference among any of the groups for either time period. It has been shown that any orthopedic changes induced by early Class II therapy fade away.[7, 22]

The Johnston analysis was used to evaluate sagittal skeletal and dental changes. This analysis does not assess vertical changes that may impact growth or Class II correction. One benefit of this analysis is its focus on A-P changes without being affected by the change in size of skeletal components.[23] Consequently, it is an excellent tool to compare samples in different stages of growth. In a study evaluating patient age on stability, Harris et al.[23] determined post treatment stability did not differ with age. This study compared posttreatment changes occurring in patients treated either as an adult or as an adolescent.

**Soft tissue changes**. In a study of soft tissue changes following either non-extraction or premolar extraction treatment of class II malocclusion, Zierhut et al.[24] found no difference among the groups. This was a retrospective study, and one of the inclusion criteria was a successful treatment outcome. This may indicate that patients successfully treated, by whatever means necessary, would have equally stable results. In the present study, during full fixed appliances, treatment decisions were all aimed towards achieving acceptable orthodontic results. This may explain why this study found little differences in soft tissue change. These results, however, should be interpreted with caution due to the small sample size for some of the measurements. In particular, the small samples of any measurement that included soft tissue nasion may lack the statistical power to detect small differences in change. The nasal rod of the cephalostat often distorted this point. If it could not be traced accurately, the point was omitted. Additionally, the nasal tip occasionally extended past the edge of the radiograph and could not be registered.

**Potential problems.** One factor that was not controlled, in this study, was the personnel taking the radiographs. Subjects were referred to the Radiology Department of the University of Florida School of Dentistry. Additionally, a different cephalometric machine was used for part of the time investigated. Some assumptions made are that any differences in radiographic technique or equipment could affect all groups equally.

The type and duration of retention was a clinical decision made by the treating practitioner. The types of retention and compliance issues were not considered in this analysis. Potential effects of different retainers could cause differences in dental relapse. The compliance with retainer wear could be different among the different groups. Some children, as part of the study, were required to wear a retainer between the first and the second phase of treatment. These patients may have better (from practice) or worse (from burn out) compliance.

Twenty percent of the treatment sample was unavailable for this analysis. While this is understandable due to the duration of the study, it may also introduce some bias into the results. The subjects that failed to return for records may have had different posttreatment changes. Additionally, four patients are missing follow up records because they are being retreated.

Finally, A point was drawn as part of the maxillary template. Therefore, this landmark would not detect any local remodeling that may take place as the result of changes in incisor position. This point served as a maxillary registration point.

# CHAPTER 5
# CONCLUSIONS

1. There are no consistent differences in posttreatment sagittal change among the treatment groups.
2. One cannot conclude that either treatment modality is superior based on sagittal posttreatment change.

This study only evaluated the mean changes experienced by the groups. Future studies could identify the subject that had extreme changes and any possible relation to treatment protocol.

REFERENCES


1. Sadowsky PL. Craniofacial growth and the timing of treatment. Am J Orthod Dentofacial Orthop 1998;113:19-23.

2. Brin I, Tulloch JFC, Koroluk L, Phillips C. External apical root resorption in Class II malocclusion: A retrospective review of 1- versus 2-phase treatment. Am J Orthod Dentofacial Orthop 2003;124:151-6.

3. Dugoni SA, Lee JS, Varela J, Dugoni A. Early mixed dentition treatment: post retention evaluation of stability and relapse. Angle Orthod 1995;65:311-20.

4. Livieratos FA, Johnston LE. A comparison of one-stage and two-stage nonextraction alternatives in a matched Class II sample. Am J Orthod Dentofacial Orthop 1995;108:118-31.

5. Tulloch JFC, Phillips C, Koch G, Proffit WR. The effect of early intervention on skeletal pattern in Class II malocclusion: A randomized clinical trial. Am J Orthod Dentofacial Orthop 1997;111:391-400.

6. Keelling SD, Wheeler TT, King GJ, Garvan CW, Cohen DA, Cabassa S, McGorray SP, Taylor MG. Anteroposterior skeletal and dental changes after early Class II treatment with bionators and headgear. Am J Orthod Dentofacial Orthop 1998;113:40-50.

7. Tulloch JFC, Phillips C, Proffit WR. Benefit of early Class II treatment: Progress report of a two-phase randomized clinical trial. Am J Orthod Dentofacial Orthop 1998;113:62-72.

8. King GJ, McGorray SP, Wheeler TT, Dolce C, Taylor MG. Comparison of peer assessment ratings (PAR) from 1-phase and 2-phase treatment protocols for Class II malocclusions. Am J Orthod Dentofacial Orthop 2003;123:489-96.

9. Keeling SD, Cabassa SR, King GJ. Systematic and random errors associated with Johnston's cephalometric analysis. Br J Orthod 1993;20:101-7.

10. Paquette DE, Beattie JR, Johnston LE. A long-term comparison of nonextraction and premolar extraction edgewise therapy in "borderline" Class II patients. Am J Orthod Dentofacial Orthop 1992;102:1-14.

11. Glenn G, Sinclair PM, Alexander RG. Nonextraction orthodontic therapy: Posttreatment dental and skeletal stability. Am J Orthod Dentofacial Orthop 1987;92:321-8.

12. Yavari J, Shrout MK, Russell CM, Hass AJ, Hamilton EH. Relapse in Angle Class II Division 1 malocclusion treated by tandem mechanics without extraction of permanent teeth: A retrospective analysis. Am J Orthod Dentofacial Orthop 2000;118:34-42.

13. Ahn JG, Schneider BJ. Cephalometric appraisal of posttreatment vertical changes in adult orthodontic patients. Am J Orthod Dentofacial Orthop 2000;118::378-84.

14. Mills CM, McCulloch KJ. Posttreatment changes after successful correction of Class II malocclusions with the Twin Block appliance. Am J Orthod Dentofacial Orthop 2000;118:24-33.

15. Fotis V, Melsen B, Williams S. Posttreatment changes of skeletal morphology following treatment aimed at restriction of maxillary growth. Am J Orthod Dentofacial Orthop 1985;88:288-296.

16. Lima Filho RL, Lima AL. Long-term outcome of skeletal Class II Division 1 malocclusion treated with rapid palatal expansion and Kloehn cervical headgear. Am J Orthod Dentofacial Orthop 2003;124:216-24.

17. Elms TN, Buschang PH, Alexander RG. Long-term stability of Class II, Division 1, nonextraction cervical face-bow therapy: II. Cephalometric analysis. Am J Orthod Dentofacial Orthop 1996;109:386-92.

18. Shah AA. Postretention changes in mandibular crowding: A review of the literature. Am J Orthod Dentofacial Orthop 2003;124:298-308.

19. Harris EH, Gardner RZ, Vaden JL. A longitudinal cephalometric study of postorthodontic craniofacial changes. Am J Orthod Dentofacial Orthop 1999;115:77-82.

20. Al Yami EA, Kuijpers-Jagtman AM, Van't Hof MA. Stability of orthodontic treatment outcome: Follow-up until 10 years postretention. Am J Orthod Dentofacial Orthop 1999;115:300-4.

21. Vaden JL, Harris EF, Gardner RLZ. Relapse revisited. Am J Orthod Dentofacial Orthop 1997;111:543-53.

22. Dermaut LR, Aelbers CMF. Orthopedics in orthodontics: Fiction or reality. A review of the literature—Part II. Am J Orthod Dentofacial Orthop 1996;110:667-71.

23. Harris EF, Vaden JL, Dunn KL, Behrents RG. Effects of patient age on postorthodontic stability in Class II, Division 1 malocclusions. Am J Orthod Dentofacial Orthop 1994;105:25-34.

24. Zierhut EC, Joodeph DR, Artun J, Little RM. Long-term profile changes associated with successfully treated extraction and nonextraction Class II Division malocclusions. Angle Orthod 2000;70:208-219.

## BIOGRAPHICAL SKETCH

Lisamarie Brazeau was born in Denver, Colorado, and was raised in Thermopolis, Wyoming. She attended Creighton University, in Omaha, Nebraska for her undergraduate and dental training. She received her Doctor of Dental Surgery degree in May 2000, graduating magna cum laude. After graduation, she received an Orthodontic Research Fellowship at the University of Florida. She then continued her dental education At the University of Florida, earning a Master of Science degree with a certificate in orthodontics in May 2004. After graduation Lisamarie anticipates entering private practice in the Northwest.