EFFECT OF EARLY TREATMENT ON STABILITY OF OCCLUSION IN PATIENTS WITH A CLASS II MALOCCLUSION

By

SARAH S. PAVLOW

A THESIS PRESENTED TO THE GRADUATE SCHOOL
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By

Sarah S. Pavlow

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Chair: Timothy T. Wheeler
Major Department: Orthodontics

The purpose of this study was to evaluate the effect of early treatment on stability of occlusion in patients with a Class II malocclusion. The PAR index was utilized in order to evaluate changes in occlusion over time between Class II patients treated in one or two phases. Dental casts were obtained from study subjects participating in a prospective, randomized controlled clinical trial. These subjects were initially divided into three early treatment groups: bionator, headgear/bite plane or observation. PAR scores were obtained on 208 patients at debond (DCF); 156 at one year (DCR1); 116 at two years (DCR2); 76 at three years (DCR3); 54 at four years (DCR4); 51 at five years (DCR5); and 51 at 6 years post-treatment (DCR6). The PAR scores were calculated and weighted for each subject at each post-treatment timepoint. Also, the differences in the PAR scores were calculated for each subject at each post-treatment timepoint from DCF. When PAR scores of all subjects utilized were compared at DCF, results showed no statistically significant differences between treatment groups. Also, there were no

significant differences in PAR scores between treatment groups at any post-treatment timepoint except DCR4. The differences from DCF in PAR scores at each timepoint were negative indicating that PAR scores had increased and overall relapse occurred. There were statistically significant differences between treatment groups in amount of PAR score increase occurring during the time between DCF-DCR1 and between DCF-DCR4. Although there were some differences in how these Class II patients relapsed at various timepoints, it is difficult to see an emerging pattern among the results. One cannot conclude that any of the early treatment modalities are superior based on post-treatment changes in PAR scores. From the present data it does not appear that early treatment has an effect on the stability of occlusion in Class II patients.

CHAPTER 1
INTRODUCTION

A major decision facing the orthodontist is when to initiate treatment in patients with a Class II malocclusion. Two-phase treatment often features a functional appliance placed during the mixed dentition, followed later by fixed appliances. Alternatively, a single phase of treatment may be initiated after eruption of the permanent teeth. Historically, it has been believed that that if treatment is started early, during the time of highest growth potential, treatment outcome can be improved.[1] Recent studies undertaken by the University of Florida, University of North Carolina and in the United Kindgdom found that patients who received Phase I early treatment had a significant reduction in the severity of Class II discrepancy as compared with controls.[2-4] However, results published following Phase II indicated that both one- and two-phase patients underwent skeletal and dental changes that left them essentially indistinguishable at the end of treatment, and thus little was to be gained from precisely timed early treatment.[5,6] If differences in treatment effects are minimal, possibly a difference in relapse potential could justify early treatment.

The use of the Peer Assessment Rating (PAR) as a way of evaluating stability and relapse in orthodontic patients has been proven to be valid and reliable by several studies.[7-11] The index was developed by Richmond et al.[12] in order to objectively quantify malocclusion and efficacy of treatment using the opinions of 74 British orthodontists in order to determine severity of malocclusion.[7] It is arguable that the British orthodontists' opinions may not reflect the views of those in other countries, particularly in the United States. Therefore, DeGuzman et al.[9] developed a study in 1995 in order to validate the PAR index by a panel of orthodontists in the United States. In both UK and US PAR index scores are assigned to various occlusal traits (upper and lower anterior segments, buccal occlusion, overjet, overbite and midline), and then they are weighted and summed to a total number. A PAR score of zero indicates good alignment and higher scores indicate increasing irregularity. Scores can be evaluated by using a Nomogram chart or more commonly as a percentage improvement from one score to another. Orthodontic treatment should result in a reduction of 70% or more in the PAR score.[8] Reported figures of 5 year post-retention reduction in PAR score range from 63.8%-69%.[13-16]

Otuyemi and Jones[17] used the PAR index in 1995 to study post-retention changes at one and ten years in 50 Class II Division I patients. Sixty percent of patients remained in the same outcome category (as immediately after treatment) at one year post-retention and 38% remained at ten years post-retention. A large study conducted by Al Yami et al.[13] also used the PAR index to evaluate changes immediately post-retention, 2 years, 5 years, and 10 years out. They found that 67.5% of the achieved orthodontic results as measured by PAR still existed 10 years post-retention, and there was a 45% reduction of PAR compared with pre-treatment. However, almost 50% of the relapse occurred in the first two years. In 2002 Linklater and Fox[18] evaluated 78 patients with all Angle classes with the PAR Index at a mean of 6.5 years post-retention. They found a 62% PAR score reduction from pre-treatment values in dual arch fixed appliance cases, and a 44.3% reduction in single arch cases. A similar study by Birkeland et al.[14] evaluated 224 patients with all Angle classes at 5 years post-retention. They saw a PAR score reduction of 63.8% from pre-treatment values at the 5 year follow up. Seventy-six percent retained good stability while 19.7% exhibited moderate to severe relapse. The long term success was best for Class II Division II and Division I (69.8% and 64.6% PAR score reduction respectively).

Post-retention instability can occur in several different ways such as changes in skeletal and inter-arch relationships, overjet, overbite, molar classification and upper and lower anterior crowding and rotations.[19] Variables that may impact relapse potential include an unfavorable skeletal pattern and/or direction of growth, inadequate growth, muscular interferences, tooth size discrepancy, occlusion, overexpansion, over-retraction, changes in the original arch form and molar and canine width, eruption of third molars, habits, periodontal condition, or endocrine dysfunction.[19-24] In addition, the patient's molar classification, skeletal pattern, length of time in retention, length of time in post-retention, or type of treatment rendered may have an effect on relapse potential.

No studies to date have asked quite the same question which the present study attempts to answer. What effect, if any, does early treatment have on relapse? A recent retrospective study conducted by McKnight et al.[25] utilized the PAR index to measure relapse in Class II patients treated in two-phases. They concluded that early treatment does not preclude the occurrence of post-treatment relapse. The present study takes this question one step further by examining if there a significant difference in relapse, as measured by the PAR index over time, between Class II patients who had early treatment and those who did not. Thus the purpose of this study was to evaluate the effect of early treatment on stability of occlusion in patients with a Class II malocclusion.

CHAPTER 2
EXPERIMENTAL DESIGN AND METHODS

The experimental design was a prospective, longitudinal, randomized controlled trial of treatment of children with a Class II malocclusion. The design of the study conducted at the University of Florida was published in detail by Keeling et al.[26] in 1995. The data used for this project was collected from subjects who were evaluated at debond data collection point (DCF) and points recorded at yearly intervals after DCF (DCR–retention)

Informed consent was obtained for all subjects, and full orthodontic records were taken on 320 patients. These records consisted of a clinical examination, medical and dental histories; maxillary and mandibular impressions, centric occlusion bite registration; lateral cephalometric, panoramic and hand-wrist radiographs; and facial and intraoral photographs.[3,27]

A stratified block randomization procedure was performed to assign a treatment protocol to each subject. Each subject had an equal chance of assignment to the bionator early treatment group, the headgear/biteplane early treatment group or the observation group. Within the early treatment groups it was also equally likely that they would be assigned to the retention or no retention group. The final number of subjects included in each study group for this investigation was bionator (n= 91), headgear/biteplane (n= 97), and observation (n= 82). Criteria used to define strata included: severity of Class II malocclusion (mild: bilateral ½ cusp, severe low: one side > ½ cusp, severe high: bilateral full cusp); the need for preparatory treatment/observation (maxillary incisor alignment to produce an overjet equal to or greater than the molar discrepancy –for treated subjects only, not observation group; posterior cross bite correction; habit cessation); mandibular plane angle-SN/GoGn (<30° = mild, 30-40° = moderate, >40° = severe); race (white and non-white); and gender in cases where Sn/GoGn > 40.[3,5, 27]

There were three overall phases to this study: Phase I (Class II early treatment/observation, retention/no retention, and follow-up); Phase II: comprehensive treatment (all subjects); and Phase III: retention (all subjects). This study will concentrate on the Phase III aspect of the study in which many subjects are in retention or perhaps post-retention.

A comparison of the PAR scores of dental casts from all data collection points that occurred at debond (DCF) and in retention (annual DCR for 6 years) allowed changes in occlusion to be determined. The investigator was blinded as to whether or not the subject received early treatment. All casts were assigned a PAR score by the same calibrated investigator (SSP). The investigator's intra-rater reliability score was R=0.93.

Data on subjects' molar classification at each individual data collection date were available to allow for correct articulation of the models. The seven components of the index included: upper contact point displacement, lower contact point displacement, left buccal occlusion, right buccal occlusion, overjet, overbite, and midline. Individual component scores were multiplied by the US weightings[9] and summed to get a final PAR score.

The Kruskal Wallis test (KW) was used to compare PAR scores between the three early treatment groups. A separate comparison of the PAR scores at DCF (debond) was done for all subjects used in the analysis at each individual timepoint, as well as a comparison of PAR scores at each post-treatment timepoint. Finally, differences in PAR scores were compared at each timepoint from DCF. KW (and Fisher Exact test for midline PAR component) was also used in order to compare early treatment groups by PAR component. The significance level was set at $p<0.05$.

CHAPTER 3
RESULTS

A total of 208 subjects participating in the study had a DCF PAR score and at least one retention PAR score. Only those subjects' PAR scores were used for the statistical analysis. This resulted in 208 subjects being evaluated at debond (DCF), 156 patients evaluated at one year (DCR1), 116 at two years (DCR2), 76 at three years (DCR3), 54 at four years (DCR4), 51 at five years (DCR5), and 51 at 6 years post-treatment (DCR6).

	Bionator	Control	Headgear	Total
DCF	67	69	72	208
DCR1	52	51	53	156
DCR2	39	39	38	116
DCR3	24	30	22	76
DCR4	17	16	21	54
DCR5	18	14	19	51
DCR6	22	15	14	51

Figure 1. Total number of dental casts scored (208 subjects with DCF and at least one DCR)

Out of the 173 subjects included in the analysis, 58 were treated with the bionator, 57 were in the control group, and 58 were treated with headgear/biteplane. According to the chi-square test, the treatment groups did not differ by gender (p=0.26), nor did they differ by initial molar class severity (p=0.93). Also, the treatment groups did not differ by race (when evaluated by the Fisher Exact test (p=0.06)). Current age in years was evaluated using both the KW test (p=0.28) and analysis of variance (ANOVA) (p=0.34). Also, length of follow-up in years was evaluated with the KW test (p=0.09) and ANOVA (p=0.1). The treatment groups did not differ significantly by current age or length of follow-up in years.

Figure 2 shows a comparison of PAR scores at DCF (debond) for all subjects used in the analysis at each individual timepoint. There were no statistically significant differences at debond between treatment groups, as measured by PAR scores, of subjects used in the analysis at each individual timepoint. All subjects evaluated at each timepoint essentially finished comprehensive treatment with no differences in PAR score between early treatment groups.

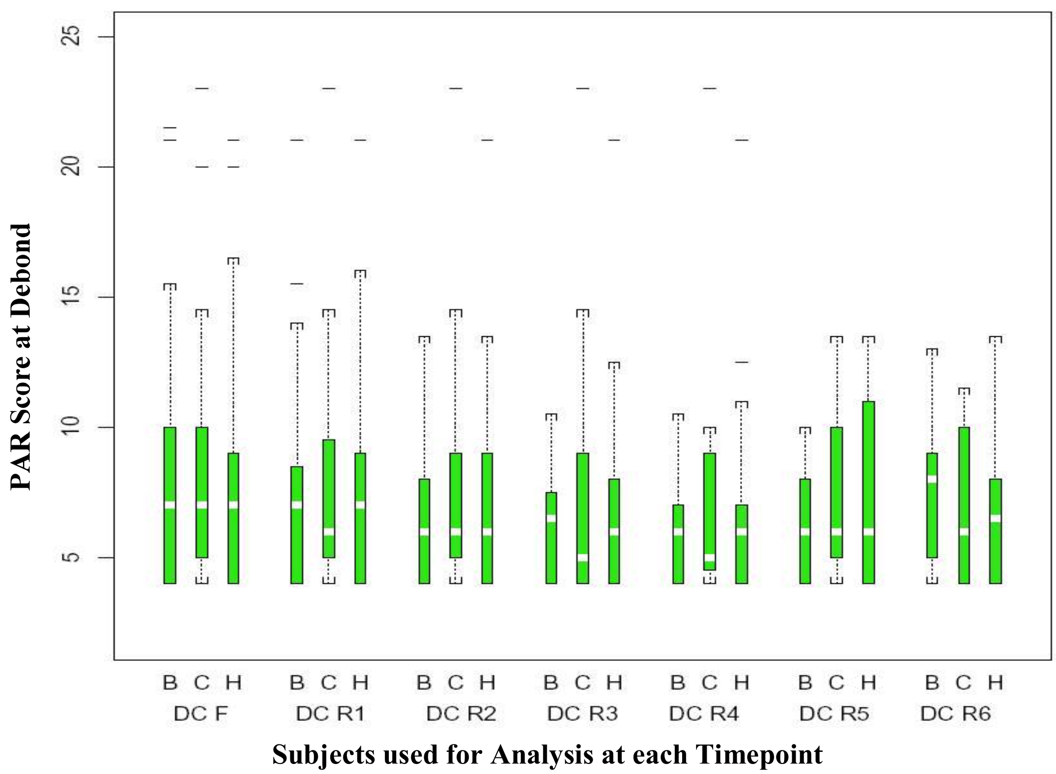

Figure 2. Comparison of PAR scores between treatment groups at debond (DCF). B=Bionator, C=Control, H=Headgear/Biteplane. Medians, inter-quartile ranges and outliers are shown. There are no significant differences between treatment groups at DCF for all subjects used in the analysis.

Figure 3 shows a comparison of PAR scores for each treatment group compared at each post-treatment time point. There was a statistically significant difference in PAR scores between treatment groups at DCR4 ($p<0.01$). No other time points showed any differences between early treatment groups.

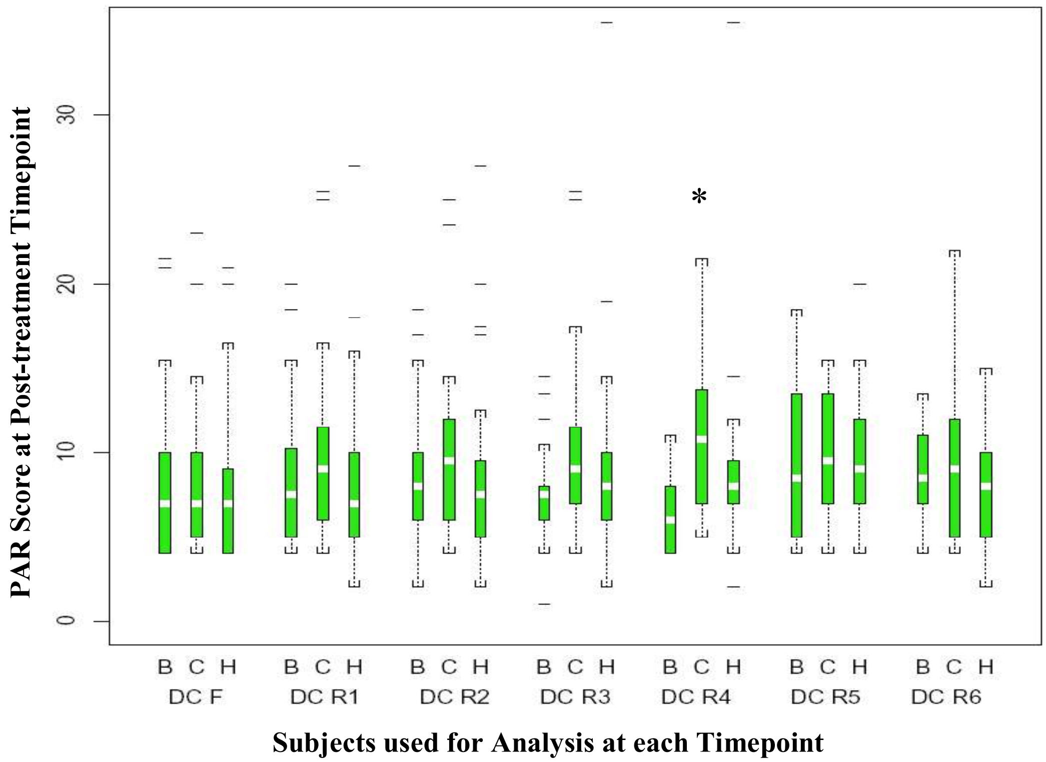

Figure 3. Comparison of PAR scores between treatment groups at each post-treatment timepoint. B=Bionator, C=Control, H=Headgear/Biteplane. Medians, inter-quartile ranges and outliers are shown. Timepoint with a significant difference between treatment groups (DCR4) is highlighted with an asterisk.

Figure 4 shows differences in PAR scores between early treatment groups compared at each post-treatment time point from DCF (DCF minus DCR). PAR scores increase as negative occlusal changes occur, therefore negative values indicate occlusal changes (relapse) were occurring whether they be significant or not. There were significant differences between treatment groups in amount of relapse occurring between DCF and DCR1 ($p<0.05$) as well as between DCF and DCR4 ($p<0.05$).

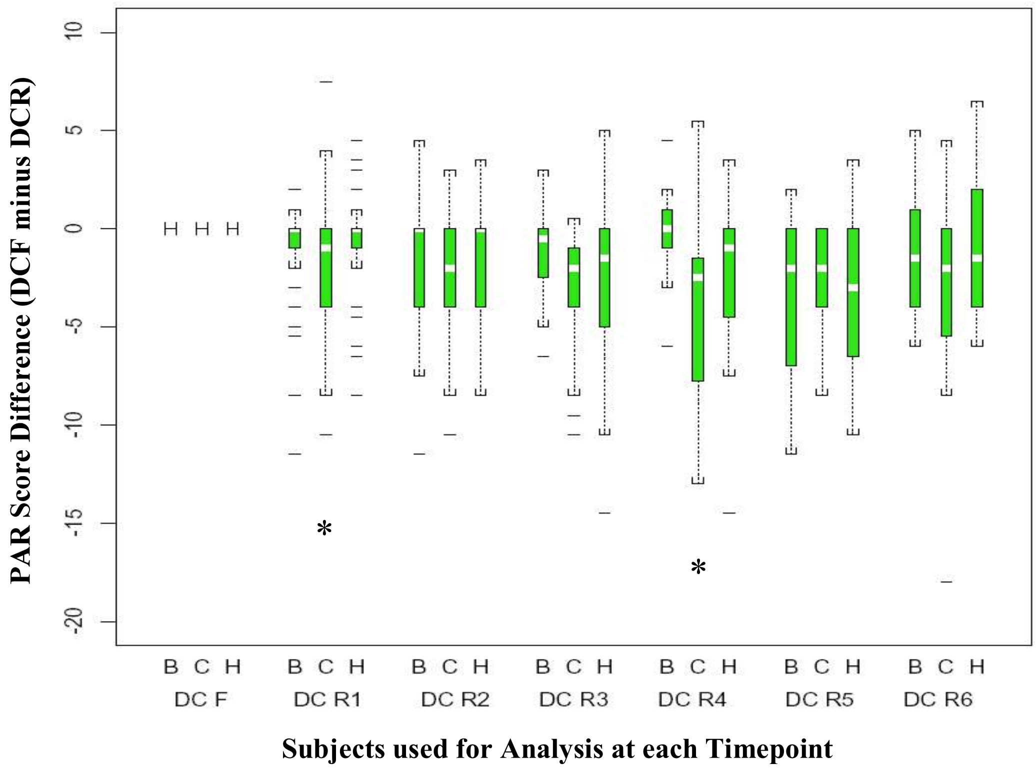

Figure 4. Comparison of differences between treatment groups in post-treatment PAR scores from DCF. B=Bionator, C=Control, H=Headgear/Biteplane. Medians, inter-quartile ranges and outliers are shown. Timepoints with significant differences between treatment groups (DCR1, DCR4) are highlighted with asterisks.

Further examination of the components of the post-treatment PAR scores for each early treatment groups was done in order to evaluate whether individual aspects of the occlusion relapsed differently among treatment groups. In the lower anterior component there was a statistically significant difference between early treatment groups at DCR1 ($p<0.05$) and DCR2 ($p<0.01$). The upper anterior component showed significant difference at DCR6 ($p<0.05$). Overjet was different at DCR2 ($p<0.05$) and DCR4 ($p<0.05$); overbite was different at DCR6 ($p< 0.05$); and buccal occlusion was different at DCF ($p<0.05$). The midline component showed no statistically significant differences between early treatment groups at any post-treatment timepoints.

CHAPTER 4
DISCUSSION

This study utilized the PAR Index in order to examine post-treatment occlusion in Class II patients treated in either one or two phases. It is important to realize that the PAR Index is strictly an occlusal index. It does not measure other factors that may have an effect on relapse such as inclination of incisors, arch width, arch form, eruption of third molars, or periodontal condition.[13] Other occlusal indices such as Little's Irregularity Index[28] assess malocclusion by evaluating only the upper and lower incisor alignment. The Index of Treatment Need (IOTN)[29] and The Dental Aesthetic Index (DAI)[30] have been developed more specifically for assessment of orthodontic treatment need.[31,32] The Index of Complexity, Outcome and Need (ICON) attempts to combine an evaluation of need and outcome.[33] However, the PAR Index has been developed and validated as an index of treatment outcomes.[31] It has been utilized in several studies[13,14,17,18, 25] in order to evaluate post-treatment and post-retention occlusion in patients with all types of malocclusion.

A total of 208 subjects participating in the study had a DCF PAR score and at least one retention PAR score. Only those subjects' PAR scores were used for the statistical analysis, thus resulting in different patients being analyzed at each post-treatment timepoint. Because of initial stratification, these 208 study subjects were relatively homogeneous in that they did not differ significantly by race, gender, initial molar class severity, current age at timepoint or length of follow-up in years.

Raw scores (unweighted) means were utilized for the analysis of the PAR components. Differences between the three early treatment groups were present, but sporadic among the PAR components. Otuyemi and Jones[17] reported on PAR score components in treated Class II Division I patients 10 years out. They found a general tendency for mean PAR scores to return to pre-treatment values, with the exception of the lower anterior segment which relapsed significantly within the first year after debond. Both the above mentioned study and Al Yami et al.[13] agreed that the lower anterior segment continued to deteriorate up to ten years post-treatment. In the present study, the lower anterior segment showed differences in PAR scores among groups during the first two years with the control group measuring more than either early treatment group. It appears that the control group relapsed more during the first two years of post-treatment. The upper anterior segment showed a difference in PAR scores at six years post-treatment of which the bionator had higher PAR scores, thus more relapse, than the other two groups. There was a difference in PAR scores between treatment groups in overjet at two and four years post-retention. At both timepoints the control group exhibited higher PAR scores and seemingly more relapse than either early treatment group. The overbite component showed a difference in PAR scores at six years post-treatment. In this case, the headgear/biteplane group exhibited more relapse. Also, there were differences in PAR scores between treatment groups in buccal occlusion immediately post-treatment and four years post-treatment. At debond the headgear/biteplane group showed smaller PAR scores than the other groups possibly meaning the occlusion treated out better in this group. At four years post-treatment, however, the control group showed the higher PAR scores, thus more relapse at that timepoint. Although many of the components of the occlusion with statistically significant differences between groups showed the control group with more relapse, the clinical significance of these sporadic differences is questionable. No definite pattern emerges in the component PAR data which would lead to the conclusion that one treatment group is superior over another.

Overall mean PAR scores as well as the PAR score components showed variablity in the data. An evaluation the PAR scores of all subjects utilized in the study at DCF (debond) (Figure 2) was deemed important because different subjects were evaluated at each post-treatment timepoint. This test was done in order to establish that all subjects evaluated at each timepoint finished comprehensive orthodontic treatment with essentially no differences in PAR scores between early treatment groups. The evaluation of PAR scores at each post-treatment timepoint (Figure 3) showed no statistically significant differences between treatment groups at any timepoints except at four years post debond. The control group exhibited somewhat higher PAR scores, thus it appears to have relapsed more than either early treatment group at this timepoint. When evaluating the differences in PAR scores at each timepoint from DCF (Figure 4), there were significant differences in PAR scores between early treatment groups from DCF-DCR1 and from DCF-DCR4. During the first year of post-treatment, the control group showed greater differences in PAR scores and appeared to have relapsed more than either early treatment group. During the time period of the first four years of post-treatment the control group had smaller differences in PAR scores and more relapse than either early treatment group. Overall at four years post-treatment the control group appeared to have relapsed slightly more than the early treatment groups, however the clinical significance of the DCR4 timepoint is questionable. Thus no pattern emerges in the PAR data which would lead to the conclusion that one treatment group is superior over another. These results are in agreement with Brazeau et al.[34] in which post-treatment sagittal changes in Class II Division I patients treated in one or two phases were evaluated cephalometrically. No consistent differences were found among early treatment groups (bionator, control, headgear/biteplane); thus they could not conclude that any of the treatment modalities were superior based on post-treatment sagittal changes.

There are some other variables, in addition to whether or not the patient received early treatment, which may have had an impact on the resulting data. These include compliance for retainer wear and differing methods of retention (particularly the presence of a fixed lower 3-3 retainer). Wood[35] questions the importance of retention in his study of relapse in treated Class II patients. He found that those patients in retention relapsed even more in post-retention than those who were not retained at all. Oteyumi and Jones[17] and Al Yami et al.[13] both found the lower anterior segment relapsed quickly and in some cases becoming worse than the pre-treatment position according to the PAR index. In the present study, the control group did relapse significantly more in the lower anterior segment during the first two years post-treatment. However, the clinical significance of this questionable, and it is difficult to make the conclusion from this data that doing early treatment will decrease lower incisor relapse.

In the present study, some of the subjects had fixed lower retainers, and it is possible that those patients who had fixed retention exhibited smaller lower anterior component PAR scores. However, the effect on the overall weighted PAR scores may be negligible due to the US weighting systems[9] which gives zero weight to the lower anterior segment. Al Yami et al.[13] found that the lower anterior component showed better alignment 5 and 10 years post-retention. This result should be interpreted cautiously because some patients are chosen to have a lower bonded 3-3 specifically because they exhibit certain characteristics. These include dental-facial-skeletal pattern, less than ideal long term prognosis, and initial crowding. Other factors such as practitioner education and experience might come into play as well.[28]

The severity of the overall dental-facial-skeletal pattern could also have an effect on the resulting data in this study. Glenn et al.[36] reported more severe Class II patients with larger ANB angles and shorter mandibular lengths tended to be associated with increased amounts of incisor irregularity, shorter arch lengths and deeper overbite at post-retention. In the present study attempts were made initially to stratify the treatment groups by severity of Angle molar classification as well as mandibular plane angle. However, those with more favorable growth potentials may have had better mandibular growth possibly resulting in maintenance of normal overjet, buccal occlusion, and absence of crowding in post-retention. Kim and Little[37] reported a more favorable vertical growth pattern contributed to the stability of overbite in Class II Division II patients. When evaluating treated Class II Division I patients in the long term, Otuyemi and Jones[17] implied that changes occurring up to one year post-retention were likely to be a combination of dental relapse as well as growth changes. However, those changes occurring between 1 and 10 years post-retention were most likely growth related.

It is debatable whether or not the presence or absence of third molars has an effect on the post-retention occlusion. According to Kahl-Nieke et al.[38] crowding in the lower arch was significantly less when the third molars were not present, as opposed to being impacted or erupted. However, no differences in incisor crowding were found by

Stemm[39] and Shanley[40] in groups with impacted, erupted, missing, or extracted third molars. Conflicting data may indicate that the third molars play a small role in post-treatment occlusal changes. In the present study, we can only speculate on the role of third molars given that the PAR index does not take into account their presence or absence.

Smaller arch dimensions that may have had more expansion during treatment may have a higher potential for relapse. Davis and BeGole[41] and Elms et al.[42] found that non-extraction cases that were expanded during treatment tended to constrict post-retention. De La Cruz et al.[43] reported that the greater the treatment change in arch shape, the greater the tendency for post-retention changes. However, even patients who do not undergo any treatment tend to have constriction of the arches over time.[44] Again, in the present study, we can only speculate on the role that arch width expansion may play because there is no measure for this in the PAR index .

This investigation had several limitations, in addition to whether or not the patient received early treatment, which may have had an effect on resulting data. First, during data collection some of the dental casts had broken teeth, obvious distortions and may have been incorrectly trimmed. Also, the molar classification used to articulate the models may not have been recorded correctly.

Second a geographic sampling bias was possible due to the recruitment of subjects exclusively from the Alachua county area. Further, study subjects who continued to return for data collection on a yearly basis tended to diminish with time, reasons for which we can only speculate. Original subjects may have moved away or had difficulty getting time off from work. Or perhaps they did not return simply because they were satisfied with their results, thus only subjects who exhibited relapse returned possibly for re-treatment.

CHAPTER 5
CONCLUSIONS

In this study, we attempted to determine if there was a significant difference in post-treatment changes in PAR scores experienced by subjects treated with either a one or two-phase protocol. Occlusal changes occurred over time regardless of type of treatment. Although there were some differences in how these Class II patients relapsed at various timepoints, it is difficult to see a definite pattern among the results. Also, when evaluating the overall data and the large variability, it is probable that some of these are spurious findings. Thus no early treatment modality pulls ahead as the winner with less relapse as measured by the PAR Index. Therefore one cannot conclude that any of the early treatment modalities are superior based on post-treatment changes in PAR scores. From the present data it does not appear that early treatment has an effect, one way or the other, on the stability of occlusion in Class II patients.

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BIOGRAPHICAL SKETCH

Sarah S. Pavlow was born in Pittsburgh, Pennsylvania, and raised in Lafayette Hill, Pennsylvania. She attended the Pennsylvania State University for her undergraduate study, receiving a Bachelor of Science degree in biology in 1997. She was then admitted to Temple University School of Dentistry for her dental education and graduated with honors in 2001, obtaining a Doctor of Dental Medicine degree. Dr. Pavlow furthered her education by entering into a dental residency at The University of Florida College of Dentistry where she subsequently earned a Master of Science degree with a certificate in the specialty of orthodontics in 2005.