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Patient preference and compliance between Hawley retainers and vacuum-formed retainers following orthodontic treatment.

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PATIENT PREFERENCE AND COMPLIANCE BETWEEN HAWLEY RETAINERS AND VACUUM-FORMED RETAINERS FOLLOWING ORTHODONTIC TREATMENT

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A Thesis Approved on May 29th, 2013

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DEDICATION

This thesis is dedicated to my wife. Thank you for your patience, understanding, and support during this long journey.

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I would like to thank my committee members, Dr. Eric Bednar, Dr. David Tasman, and Dr. Baxter Johnson for the guidance and wisdom they have provided in support of this study. As well as, Savitra Appana for her wonderful work in preparing the statistics for this study in such a timely manner. Also, thank you to my co-residents Brian Beckstrom, Carl Gioia, Senthil Arun, Andy Marshall, and Justin Jay for their help with this study.

ABSTRACT

PATIENT PREFERENCE AND COMPLIANCE BETWEEN HAWLEY RETAINERS AND VACUUM-FORMED RETAINERS FOLLOWING ORTHODONTIC TREATMENT

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May 29th, 2013

Introduction: The traditional Hawley retainer has been replaced in many orthodontic offices by vacuum-formed retainers (VFRs). There has yet to be a study that investigates preferences and reasons for noncompliance between Hawley and vacuum-formed retainers by allowing each to be worn within the same patient. ***Specific Aim***: To determine differences in compliance and reasons for noncompliance between Hawley and VFRs. *Hypothesis*: There will be increased compliance with VFRs due to better esthetics, speech, and comfort. ***Methods***: In consecutive months but in a different order, two treatment groups received a set of Hawleys and VFRs following comprehensive treatment. All patients were instructed to wear retainers full time. Patients filled out a standard questionnaire at recall appointments to gauge compliance and preferences between retainer types. ***Expected results***: There will be an increase in preference for and compliance with VFRs within each group. The patients in both groups will report greater compliance the month they were given VFRs. Following 2 months, all patients will show a preference for VFRs. Reasons for choosing VFRs over Hawleys will include esthetics, fit, speech, and comfort. ***Conclusions***: Vacuum-formed retainers when compared directly are preferred over Hawley retainers and lead to higher levels of compliance in the short-term orthodontic retention phase of treatment.

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CHAPTER I

INTRODUCTION

A. Introduction

In 1934, Oppenheim stated the phrase, “Retention is one of the most difficult problems in orthodontia; in fact, it is the problem.”[1] Three-quarters of a century later that phrase still holds true. Orthodontic literature has been reporting studies on the biological importance of holding teeth in their desired final positions following orthodontic treatment for since the 1950’s, yet at present day proper guidelines and protocols for optimal orthodontic retention is still under investigation. This is in part due to the difficulty in controlling and verifying variables such as cooperation, length of retention time, growth, and variations in appliance design.

B. Literature Review

1. Tissue Reorganization In Rotational Relapse

Reitan was the first to explain rotational relapse histologically by finding a persistence of free gingival fiber deviations as long as 232 days following de-rotation of dog teeth orthodontically. He reported that both collagenous and elastic fibers were found in the gingival fiber bundles and remodeling and reorganization occurs more slowly than in the periodontal fibers. Therefore, he

concluded that relapse of rotated teeth following retention is primarily caused by a contraction of displaced supra-alveolar structures.[2] Many orthodontic studies since then have reported similar histologic evidence showing the alterations in bone and periodontal tissues surrounding orthodontically moved teeth and that considerable time is needed for complete reorganization of those tissues to occur. Specifically, these authors believe that the transseptal and gingival fibers are chiefly responsible for balancing the muscular forces to achieve proper equilibrium and stability of orthodontically treated teeth.[3] In accordance with these findings, Reitan and others advocated either overrotation of crooked teeth or supracrestal fiber transection to ensure proper tooth alignment after retention.[2,3] Edwards et al described such a procedure for the surgical release of these fibers. His clinical results further substantiated the rationale that circumferential supracrestal fibers play a major role in the return of malalignment and rotations of treated teeth.[4]

2. Factors of Relapse

Since then orthodontists and researchers have debated whether certain modifiable treatment factors if properly addressed can minimize or even eliminate post-treatment relapse. Many authors have argued that a strong correlation between intercanine width and post-retention crowding exists.[17,18,19,20] In 1949, Strang was first to advocate maintaining initial canine width during treatment to avoid relapse and later Steadman supported the claim that intercanine width should remain unchanged for best long term stability.[17,18] In 1956, Peak reported on 43 cases with greater than 6 months post-retention finding that cases with

canine expansion during treatment became more crowded after retention.[19] Lombardi in 1979, presented 30 more cases several years after treatment corroborating Peak's findings.[20] However in 1981, Little etal refuted these previous claims with a very influential and convincing study on stability and relapse after edgewise treatment. These authors followed 65 first bicuspid extraction cases with a minimum of 10 years beyond complete removal of any retainer devices. They found no cause and effect relationship between changing inter canine width and subsequent incisors crowding postretention. Most interestingly, they also found a pattern of relapse in displaced and rotated madibular anterior teeth different from their pre-treatment positions. Regardless of the underlying mechanism, they found that without retention maintaining anterior alignment is less than 30 percent. Also, 20 percent of patients will show marked crowding many years after removal of retainers. This was the result of a decrease in arch dimensions of width and length in patients without retention, regardless if intercanine width was altered.[5] These findings also refuted Strang's argument that premolar extractions improves stability due to the distal movement of canines into greater bone width.[5,17] Little et al summed up long-term alignment as being "variable and unpredictable". Due to the lack of descriptive characteristics or measured variables such as age of initiated treatment, molar classification, sex, initial alignment, arch width, arch length, overbite, overjet, that could be linked to improved stability.[5] As a result, today most orthodontists feel long term retention is unavoidable and necessary for successful treatment results.

Profitt believes that 3 major factors affect retention; soft-tissue pressures, long-term changes in growth, and disruption and reorganization of periodontal and gingival fibers. Soft tissue pressures should be accounted for and controlled at the beginning with proper treatment planning. Long term changes in growth are mostly out of the clinician's control. The final factor is under both the practitioner's and patient's control with retention appliance.[7] Reitan's subsequent study in 1967 found that it takes 3-4 months for reorganization of periodontal fibers to remodel, 4-6 months for the gingival fibers, and close to a year for some supracrestal fibers.[6] In light of this, Proffit recommends full-time wear of retainers for 3-4 months and part-time wear for at least 12 months.[7]

3. Removable Appliance to Prevent Relapse

According to Pratt etal, the two most widely used removable retention appliances today in the US are the Hawley retainer (47%) and the vacuum-formed retainer (41%). These results confirm a shift away from the traditional Hawley retainer for both arches, toward a combination of vacuum formed retainers (VFR) and fixed lower retainers. They also reported that fifty-three percent of the orthodontists believe that patients are more compliant with vacuum-formed retainers and only 6% thought the reverse was true.[8]

4. Hawley vs. Vacuum-Formed Retainers

Clinically, Rowland etal has been one of only a few studies to argue that VFRs are more effective than the traditional Hawley retainers. While they reported a greater change in labial segments in Hawley patients versus VFR patients, it was stated by the authors "that it might be clinically significant in the

mandibular arch if located to a single tooth displacement." Therefore the authors made sure to state in the discussion that VFR shouldn't be considered more effective at maintaining tooth positions.[9] However, it did validate for many traditional orthodontist who have relied heavily on Hawley retainers for many years, that both can be equally effective retention devices in respect to preventing the return of tooth malignment if worn as instructed.

In 2010, Thickett and Power compared part time wear versus full time wear in 62 retention patients using vacuum formed retainers. Their results demonstrated no statistically significant change in incisor irregularity at the 1year post-retention time in both groups.[14] In the same year, Shawesh et al published a similar study with similar results when evaluating part time versus full time wear of Hawley retainers. Their results also showed no statistically significant changes in incisor irregularity between the time point of debonding and 1 year into retention within each group.[15] While, the specific aim of both these studies was to compare part time versus full time wear, their data lend more support to the equivalent clinical effectiveness of both these retainers in maintaining the positions of orthodontically moved teeth. Therefore in the majority of orthodontic patients it would be accurate to say patient compliance, not retainer design, becomes the most important factor in the retention stage of treatment.

5. Special Circumstances

It is believed by Profitt and published in Contemporary Orthodontics that there is a minority of patients that would benefit from a specific retainer type. These include patients with a pre-treatment openbite, deep bite, midline

diastema, mandibular incisor instability, and posterior crossbites. The degree or severity of which these conditions present before treatment vary greatly and it becomes the doctors judgment on whether or not special retention is needed. There has been little research done in this area and leaving only case reports to support these theories. Profitt believes that once open bites are closed by orthodontic treatment it is better to use a retainer that covers the occlusal surfaces of the posterior teeth. In his book he advocates substituting normal Hawleys with night time wear of appliances which have bite blocks. Therefore, given the choice between the two practitioners may choose the VFRs over the Halwey type, because of the VFR's bite block effect. Profitt also believes that once severe deep bites have been fixed by orthodontic treatment it may be beneficial to use a Hawley retainer that prevents the posterior teeth from coming together. This is done by fabricating the Hawley retainers with extra acrylic posterior to the maxillary incisors so that the lower anterior teeth prematurely contact. Closed midline diastemmas and unstable mandibular incisors may benefit from fixed retainers according to Profitt and retention upper arches which have been dramatically expanded with palatal expansion devices may benefit from stable acrylic palatal coverage of the Hawley retainers.[7] These recommendations by Profitt are not supported by clinical research. Rather, it is at the discretion of the practitioners to provide the best retention protocol for their patients.

6. Comfort and Compliance

Wong and Freer conducted survey research in 2006 that found a strong relationship between compliance with removable retainers and patient's perception on its comfort. Hichens et al discovered through a patient satisfaction questionnaire that most people preferred the vacuum-formed retainer over Hawley retainers.[10] Mollov etal reported in a survey study including mostly college students and dental students similar increase in patient satisfaction with VFR's as compared to Hawleys.[11] Niether of these studies investigated compliance levels between the two types nor reasoning for satisfaction or dissatisfaction. Kacer etal studied retention compliance from debond to 2 years post-retention and found that 60% were wearing their retainer more than 10 hours a day in the first 3 months. While compliance decreased over the 2 year time points only 19% were no longer wearing their retainers. They reported no differences in compliance between retainer type. However, in one of the four offices used in the study, patients were given both a maxillary Hawley and maxillary VFR and allowed to wear either. They found no difference in preferences with 54% wearing their Hawley and 46% wearing their VFR. This study did not specifically evaluate patient satisfaction between these two retainer types.[12]

Pratt etal reported in their survey study that patient compliance was greater in the first two years with vacuum-formed retainers, but this compliance declined more rapidly following the 2 year mark. They concluded that VFR's produced more compliance in the short term (<2yrs) but Hawley produced more

compliance in the long term (>2yrs). They also investigated reasons for noncompliance in their survey between retainer type and found little differences in concern about esthetics, comfort, and speech.[13]

C. Significance

There has yet to be a study that investigates preferences and reasons for compliance or noncompliance between Hawley and vacuum-formed retainers by allowing each retainer type to be worn within the same patient. Kacer et al reported preference statistics from one office but did not evaluate patient's reasons or satisfaction between the two; it was more of an incidental finding. Pratt etal reported reasons for non-compliance with each retainer type independently but this data holds little weight because most patients who don't wear a retainer find it cumbersome in some way or else they would be wearing it more.

D. Purpose

It is standard protocol at the University of Louisville to give all patients both types of retainers. First, a set of vacuum-formed retainers are fabricated the day of debonding and then another set of Hawley retainers are given a month after debonding. The purpose of this randomized cross-over observational study is to determine if specific differences exist and their relationship to compliance between Hawley and vacuum-formed retainers by using each retainer type within the same patient. The current retention protocol at the University of Louisville's orthodontic program will be altered only in the order patients receive these two retainers in order to eliminate the biases that currently exist with having patients

become accustomed to the VFRs before receiving the Hawleys. Also, patients enrolled in the study will have their original retainer type taken back after a month as a means to ensure patients are only wearing one or the other type of retainer during the first two months. After, two months patients will be given the opportunity to wear either retainer type as they choose.

E. Specific Aims

1) Determine differences in compliance between Hawley and VFRs

2) Determine differences in likability between Hawley and VFRs by using patients' subjective assessment of comfort, fit, speech, and looks.

3) Determine preference for Hawley and VFRs based on likability factors; comfort, fit, speech, and looks.

4) Determine if a correlation exists between likability and compliance.

5) Determine patients' oral health quality of life while wearing retainers and if differences exist between retainer types.

6) To determine if age or sex affects retainer preference and/or compliance.

F. Hypothesis:

1) Patients will be more compliant with vacuum-formed retainers than Hawley retainers.

2) Patients will like VFRs more than Hawleys.

3) Certain likability factors will be more impactful in patients' perception of likability.

4) There will be a positive correlation between retainer likability and compliance.

5) There will be a difference in patients' oral health quality of life between retainer types.

6) There will be a difference in patients' preference and compliance with retainers based on their age and sex.

CHAPTER II

METHODS AND MATERIALS

A. Sample

50 adolescent (avg. 14.4 yrs.) orthodontic patients at the University of Louisville Orthodontic Clinic were enrolled, randomized into two treatment groups, and completed the study following their comprehensive fixed treatment. Study duration lasted 10 months.

B. Inclusion/Exclusion criteria

Inclusion Criteria:

1. Patients aged 12 to 21 years
2. Both upper and lower dental arches have been orthodontically treated.
3. Full arch orthodontics were performed.

Exclusion Criteria:

1. University Dental or Dental Hygiene Students
2. Patients requiring restorative dental work immediately following orthodontic treatment.
3. Early debonding patients. Those patients who had their braces removed early due to non-compliance, finances, or military service and have signed the official University Early Debonding Consent Form.
4. Invisalign Patients

5. Surgical Patients
6. Patients who had initial treatment planned by resident doctor and/or faculty doctor to receive fixed retainers.
7. Patients who had initial treatment planned by resident doctor and/or faculty doctor to receive only a vacuum formed retainer for prevention of relapse of an open bite.
8. Patients who had initial treatment planned by resident doctor and/or faculty doctor to receive only a Hawley retainer for prevention of relapse of a deep bite or crossbite.
9. Non-English speaking patients.

C. Methods and Materials

1. Enrollment & Randomization

Potential subjects were recruited from the patients receiving orthodontic treatment at the University of Louisville Dental School. Patients were screened based on when they were scheduled for debonding and the inclusion and exclusion criteria listed above. An online random number generator was used to create a randomization list of study numbers matched to either Group A or Group B. Each potential subject who met the inclusion and exclusion criteria was assigned a study number according to the sequential order of when they received debonding approval by overseeing faculty. The day of debonding potential subjects were given assent and parental/LAR consent and officially enrolled in the study. Screen failures were those patients who finished

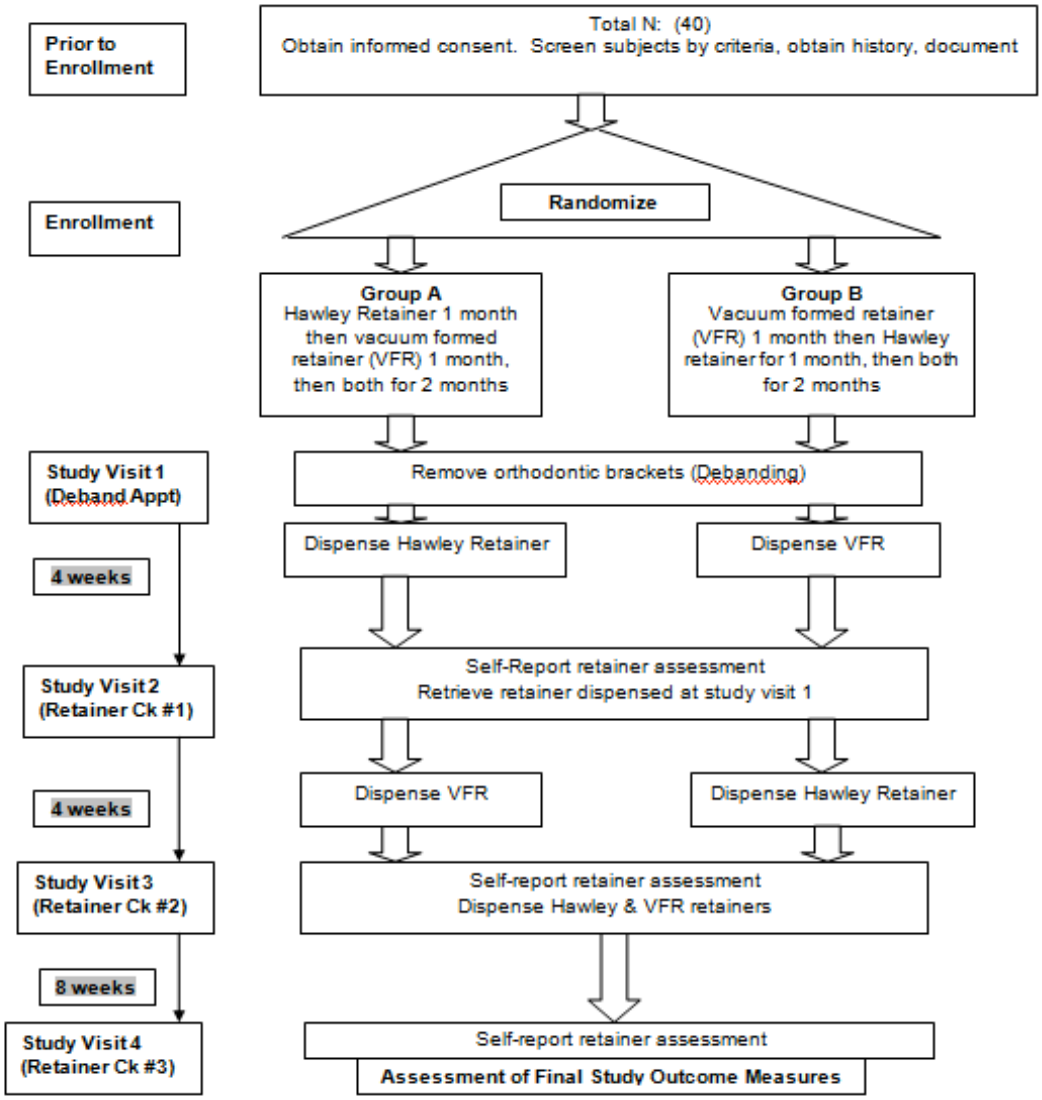
orthodontic treatment during the study window but did not qualify for the study based on our inclusion/exclusion criteria above or denied enrollment. These patients received retention treatment following the current protocol. VFRs were fabricated and given to these patients the day of debonding. At retainer check appointment #1, a month later, they received the Hawley retainers. These patients were seen 3 months later for a second retainer check appointment, instead of a month later. Patient data gathered from the screen failures remained confidential to study authors.

2. Study Groups

As the flow chart below illustrates, two study groups existed for this randomized cross-over observational study. Each study group received both Hawley and vacuum formed retainers (VFRs) following current University of Louisville Dental School protocol. For ease of documenting results for this study "VFR's" and "Essix" terminology was used interchangeably. In clinical practice the term Essix is used more commonly as it the most popular brand of material used to make VFR's. In the context of this study it was easier to track groups using the initials "HE" denoting Hawleys 1st and Essix 2nd in referring to Group A and "EH" denoting Essix 1st and Hawleys 2nd in referring to Group B. It also will become easier for the reader to draw conclusions from the results by categorizing groups using the initials "HE" and "EH" for Group A and Group B respectively.

Group A or “HE” wore Hawley retainers for 1 month, then Essix/vacuum formed retainers (VFR) for 1 month, and then the retainers of their preference for 2 months.

Group B or “EH” wore Essix/vacuum formed retainers (VFR) for 1 month, then Hawley retainers for 1month, and then the retainers of their preference for 2 months.



3. Prior to Debonding

To abide by current University Clinic protocols, all patients were approved for debonding by the faculty doctor in charge of the case prior to the patient's official inclusion into the study.

Group A or "HE": Alginate impressions for Hawley retainers were taken on subjects randomly assigned to Group A with the braces still on the teeth. These impressions were poured up in orthodontic model stone within 24 hours at the school's orthodontic clinic. Models were trimmed and sent to TP Orthodontic Lab with an appropriate lab prescription form. TP Orthodontic Lab returned complete Hawleys to the University Clinic before the patient returned to have their braces removed.

4. Study Visit #1- Debonding Appointment

This visit was a two hour scheduled visit for all patients. All subjects were debonded by resident doctor, all residual composite removed, and teeth appropriately polished. Final photos, panograph, and lateral cephalogram radiographs were taken per University Clinic protocol.

Group A or "HE": Hawley retainers returned from TP Orthodontic Labs were evaluated by resident doctor intra orally and proper adjustments were made. Resident doctors were told to achieve adequate retention and patient comfort as well as proper occlusion with retainers in place. If retainers had bite block effect, resident doctors removed lingual acrylic on upper Hawley until proper clearance was achieved.

Group B or "EH": Two sets of alginate impressions were taken with braces off. One set was poured immediately in quick set stone. The VFRs were made in the University Clinic's lab using ACE thermoplastic material from Great Lakes Orthodontics using the standard instructions provided by the clinic's Biostar machine. VFRs were cooled and trimmed accordingly. Clinically VFRs were evaluated by resident doctor intra orally and were adjusted for patient comfort. If VFR could not be fully seated over all of the teeth it was re-made during the same appointment. The second set of impressions were poured within 24 hours in orthodontic lab stone, trimmed, and sent to TP Orthodontic Lab with appropriate lab prescription.

All subjects were instructed to wear their retainers full time, only remove to eat, brush, and clean.

5. Retainer Designs

Hawley Designs- Nonextraction Cases

-Upper- Labial Bow Canine to Canine and Ball Clasps between 2nd Premolars and 1st Molars.

-Lower- Labial Bow Canine to Canine and Occlusal Rests on the 1st Molars

Hawley Designs- Extraction Cases

-Upper and Lower- Wrap-around design.

VFRs Designs- Extraction and Nonextraction Cases

-Upper- Trimmed for 1-2mm of facial gingival coverage, palatal coverage, and 2nd Molar occlusal coverage.

-Lower- Trimmed for 1-2mm of facial and lingual gingival coverage, 2nd Moral occlusal coverage.

6. Study Visit #2- 1st Retainer Check

These visits were scheduled for 30 minutes. All subjects completed the appropriate survey prior to being seen by doctor. Following, all subjects were given a new retainer type and their original retainer was taken back by resident doctor.

Group A or "HE": Alginate impressions were taken and VFRs were fabricated using the same protocol as described above for Group B subjects.

Group B or "EH": Hawley retainers returned from TP Orthodontic Labs were evaluated by resident doctor intra orally and proper adjustments were made using the same protocol as described above for Group A subjects.

All subjects were advised to wear retainers full time, only removing to eat, brush, and clean.

6. Study Visit #3- 2nd Retainer Check

Subjects in both Groups A and B completed appropriate survey prior to seeing doctor. Current retainers and previous retainers were evaluated for proper fit and adjustments were made. For Group B subjects if VFRs had unsatisfactory fit, alginate impression were taken and a new set of VFRs were fabricated that day at no cost. Subjects were given both retainer types and told to wear any retainers of their choice full time for another two months.

7. Study Visit #4- 3rd Retainer Check

Subjects in both Groups A and B completed appropriate survey prior to seeing doctor. Both types of retainers were evaluated for proper fit and adjustments were made.

It was current protocol that if a patient lost either retainer type they would be financially responsible for another. This protocol was maintained for patients included in this study. This appointment concluded subject participation in the study. Resident doctor and faculty used clinical judgment to determine if the patient should continue full time wear or switch to night time wear. Subjects were placed on 6 month retainer check recall appointment per current University Clinic protocol.

8. Retainer assessment questionnaires

There were two different retainer assessment questionnaires created for this study. Questionnaire #1 was given to all subjects at study visits #1 and #2. Questionnaire #2 was given to all subjects at study visit #3. Questionnaire #1 was used to gauge patients' compliance and complaints regarding individual retainer types. Questionnaire #2 was used to obtain information regarding patients' preference between retainer types. Both assessment questionnaires also asked patients about their oral health quality of life while wearing retainers. The questionnaire was taken from McGrath and Raman and modified to ask how "retainers" affect their oral health quality of life.[21] Also, the responses were modified so that they were ordered from bad to good instead of from good to bad to keep continuity with our designed questions. Lastly, it was altered to inquire

about an impact on school, instead of work in order to better suit our study population.

Questionnaire #1

STUDY NUMBER:___ 12.0148_____
DATE;_____4/24/12_____

(Survey for Patients at **1st & 2nd Study Visits**)
The following questionnaire is part of a research project by the University Of Louisville Department Of Orthodontics. Your **honest** responses to these following questions will provide valuable information for this study. **Only the investigator will be privileged to your identity.** Therefore, your remaining treatment here at the school will not be affected in any way by your responses to these questions.

*****Have you lost or broken any of your retainers?***(circle one) YES NO**

Answer The Following Questions By Circling A Single Number…

1) How many days a week do you think you have you been wearing your retainers?

1 2 3 4 5 6 7

2) During a normal day of wear, how many **hours** do you think you wear your retainers?

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 – 11 – 12 – 13 – 14 – 15 – 16 – 17 – 18 – 19 – 20 – 21 – 22 – 23 - 24

3) During a normal day of wear, when are you wearing your retainers?

1- Only at night 2- After school and all night 3- During School and all night

Answer the following questions by checking the appropriate box below…

The retainers I have been wearing…	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…are COMFORTABLE					
…are HARD TO TALK WITH					
…FIT WELL					
…DON'T LOOK GOOD					
I **LIKE** the retainers I have been wearing					

The next set of questions is about how your retainers may have affected <u>your quality of life</u>. Remember there is no right or wrong answer.

What **<u>effect</u>**, if any, does wearing your retainers have on your…	**Very bad**	**Bad**	**No Effect**	**Good**	**Very good**
…eating or enjoyment of food?					
…appearance?					
…speech?					
…general health?					
…ability to relax or sleep?					
…social life?					
…romantic relationships?					
…smiling or laughing?					
…confidence?					
…carefree manner (lack of worry)?					
…mood?					
…school or ability to do your usual activities					
…finances?					
…personality?					
…comfort?					
…breath odor?					

Questionnaire #2

STUDY NUMBER:___ 12.0148_____

DATE;_____4/24/12_____

(Survey for Patients at **1st & 2nd Study Visits**)

The following questionnaire is part of a research project by the University Of Louisville Department Of Orthodontics. Your **honest** responses to these following questions will provide valuable information for this study. **Only the investigator will be privileged to your identity.** Therefore, your remaining treatment here at the school will not be affected in any way by your responses to these questions.

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3) During a normal day of wear, when are you wearing your retainers?

1- Only at night 2- After school and all night 3- During School and all night

---

Check the appropriate box for each question.

Which retainer type….		**No Preference**	
….is **MORE COMFORTABLE**?			
…is **EASIER TO TALK WITH**?			
…**LOOKS BETTER**?			
…**FITS BETTER**?			
…do you **PREFER**?			

The next set of questions is about how your retainers may have affected your quality of life. Remember there is no right or wrong answer.

What **effect**, if any, does wearing your retainers have on your…	Very bad	Bad	No Effect	Good	Very good
…eating or enjoyment of food?					
…appearance?					
…speech?					
…general health?					
…ability to relax or sleep?					
…social life?					
…romantic relationships?					
…smiling or laughing?					
…confidence?					
…carefree manner (lack of worry)?					
…mood?					
…school or ability to do your usual activities					
…finances?					
…personality?					
…comfort?					
…breath odor?					

9. Confounding variables

This study analyzed age and sex as confounding variables.

D. Statistical analysis

Data analysis focused around the three primary outcomes of the study, 1) compliance, 2) quality of life, and 3) satisfaction / preference. Compliance was measured as the average number of hours / week the patient wears the retainer, obtained from multiplying question 1 and question 2 in the patient questionnaire. Quality of life measures was obtained from the 16 questions on page two of the questionnaire, measured on a likert scale from 1 (very bad) to 5 (very good). A summary measure was also obtained by summing the scores. Patient satisfaction was measured using questions 4 through 8 on the patient questionnaire. In addition to analyzing each question separately, a summative score of all 5 questions was analyzed. Lastly, patient preference was assessed using questions 4 through 8 given at the end of the third study period. Summary statistics (mean, standard deviation, median, interquartile-range (IQR)) was reported for each outcome, stratified by treatment group and time period. Visual displays (histograms, boxplots, and density estimates) was used to evaluate distributions for each outcome, and assess presence of outliers or substantial departures from normality. Quality of life scores and satisfaction measures was assessed for reliability and consistency using Cronbach's alpha, and additionally evaluated using item-response theory (IRT) models to determine whether the questions are measuring the same overall construct.

Analysis for each of the three primary outcomes (compliance, quality of life, and satisfaction) was done using a repeated measures mixed-effects (RMME) model, with the following form:

$$y_{ijk} = \mu + \alpha_j + \beta_k + u_i + \epsilon_{ij} ,$$

where y_{ijk} is the response for subject i in period $j = 1, 2$ receiving treatment $k = 1, 2$, with $u_i \sim N(0, \sigma_u^2)$ the random effect accounting for subject-level variability and $\epsilon_{ij} \sim N(0, \sigma_\epsilon^2)$ the residual error term. The terms α_j and β_k are fixed effects for time period and treatment, respectively, with $\alpha_1 = \beta_1 = 0$ for identifiability purposes. Statistically significant differences between the Hawley and VFR retainers was tested by $H_0: \beta_2 = 0$ vs. $H_1: \beta_2 \neq 0$, using either Wald or likelihood ratio tests. To test whether there is an ordering effect on treatment differences, an interaction term between time period and treatment was included in the model and tested for significance. Treatment effect was analyzed separately by order of treatment received, by testing appropriate contrasts within the interaction model. Residual plots was used to assess the normality assumption, with appropriate transformations (Box-Cox) applied if significant departures from normality are present. Though the randomization procedure should've balance the study groups with respect to confounding variables, both measured and unmeasured, were additionally evaluated the impact of important demographic variables (age, gender, gingival overgrowth) on significance and parameter estimates in the RMME model.

The RMME model automatically handled any missing values that were missing completely at random (that is, missingness is not associated with observed or unobserved covariates). Probability of missing values were checked for dependency on treatment and other demographic variables (age, gender, gingival overgrowth). If found to depend on these variables, missing values were imputed using multiple imputation to create completed data sets with missing information filled-in. Multiple (10-20) data sets were imputed and parameter estimates obtained for each one. Overall treatment effect was determined by averaging the treatment effect in each imputed data set, with standard errors determined using an imputation-corrected variance-covariance matrix.

All analysis will be performed using either SAS version 9.3, or R version 2.14.1. An $\alpha = 0.05$ will be used for statistical significance, with appropriate correction for multiple comparisons when analyzing individual questions from the quality of life and retainer satisfaction questions.

Power and Sample Size

Power and sample size calculations were based on the online calculator created by David Schoenfeld (Harvard University) for a two-sample cross-over design (URL: http://hedwig.mgh.harvard.edu/sample_size/js/js_crossover_quant.html). Power was assessed in terms of percent differences between study groups for each outcome, between the first and second study periods. For the primary outcome (patient compliance), it was expected that the overall average percentage of time that patients wear their retainers will be 50%, with the majority of values falling between 25% and 75%. Assuming a normal distribution, the

total standard deviation $\sigma_u + \sigma_\epsilon$ is then 12.5%. The table below gives the minimum detectable population difference between the two groups, as a percentage of the response value, for various sample sizes (40, 50, and 60 patients) and intra-class correlations (ICC, $\rho =$ 0.7, 0.5, and 0.3). The within-subject standard deviation σ_ϵ was calculated as the square-root of $(1-\rho)(\sigma_u^2 + \sigma_\epsilon^2)$. A two-sided α = 0.05 was used, with power of 80% and assuming a dropout rate of 25%.

		ICC		
Sample Size	Effective SS	ρ = 0.7	ρ = 0.5	ρ = 0.3
40	30	5.14	6.63	7.84
50	37.5	4.6	5.9	7
60	45	4.14	5.34	6.32

With 25% dropout and a sample size of 40, there was still 80% power to detect a 7.84% difference in responses between the two treatment groups.

CHAPTER III

RESULTS

Objective

The primary purpose of this study was to assess the differences in compliance and patient satisfaction measures between Hawley and VFR retainers based on a two-period crossover ANOVA design. Compliance was measured in terms of average number of hours per week the patient wore the retainer. Patient satisfaction was measured using patient's subjective assessment of likability factors: comfort, fit, speech, looks, and perception of likability.

Statistical Methods

This study data was analyzed using statistical methods as described in the "Statistical Analysis" section above. NOTE: For ease of interpretation and computation of the overall satisfaction score and to obtain an accurate measure of internal consistency (i.e., Cronbach's alpha), the questions based on likability factors 'speech' (Hard to Talk With) and 'looks' (Don't Look Good) were reversed to reflect a positive correlation.

Results

The randomized study groups 'Group A=HE' (read 1st Hawleys, 2nd Essix) vs. 'Group B=EH' (1st Essix, 2nd Hawleys) were balanced in terms of demographic characteristics age (14.4 vs. 14.9 years; $p = 0.172$) and sex (Males: 41.7% vs.

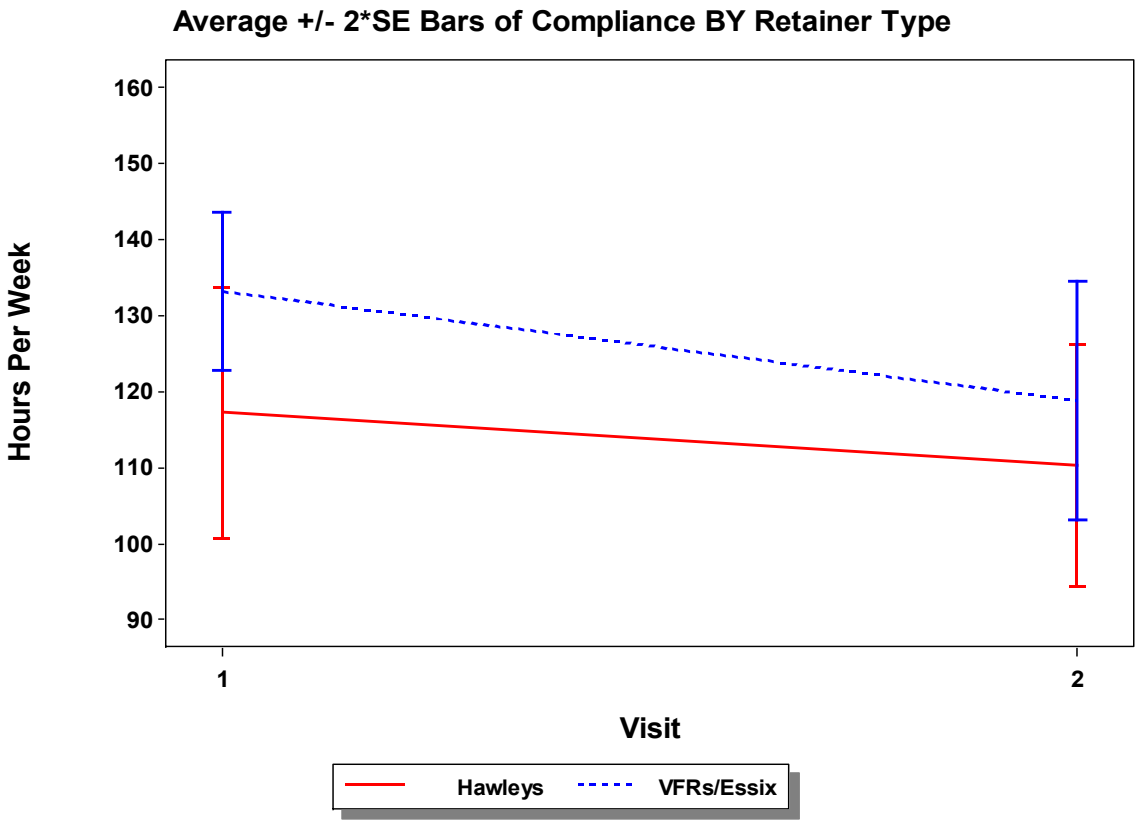
34.6%, p = 0.772) of the patient, see Appendix (Table S0). Table 1 provides the summary statistics for compliance (hours per week) and satisfaction measures stratified by retainer type (treatment) and visit (time period). In addition, graphical representations of the differences in retainer type across visits are presented below as Figures 1-7. In Figures 2-7, the downward sloping tendency of the red lines from visit 1 to visit 2 indicate that wearing a VFR retainer first appeared to have a tendency to decrease the relative satisfaction of wearing a subsequent Hawley retainer. Conversely, an upward sloping tendency of the blue lines from visit 1 to visit 2 indicate that wearing Hawley retainer first also had a tendency to increase the relative satisfaction of wearing a subsequent VFR retainer. While this was not statistically significant, the trend is nonetheless interesting to note. Based on the summary statistics and visual examination of these plots, it is clear that patients were more compliant with VFRs/Essix retainers and likability factors were also in favor of the VFRs. Table S1 in the appendix provides the summary statistics for quality of life scores stratified by retainer type and visit.

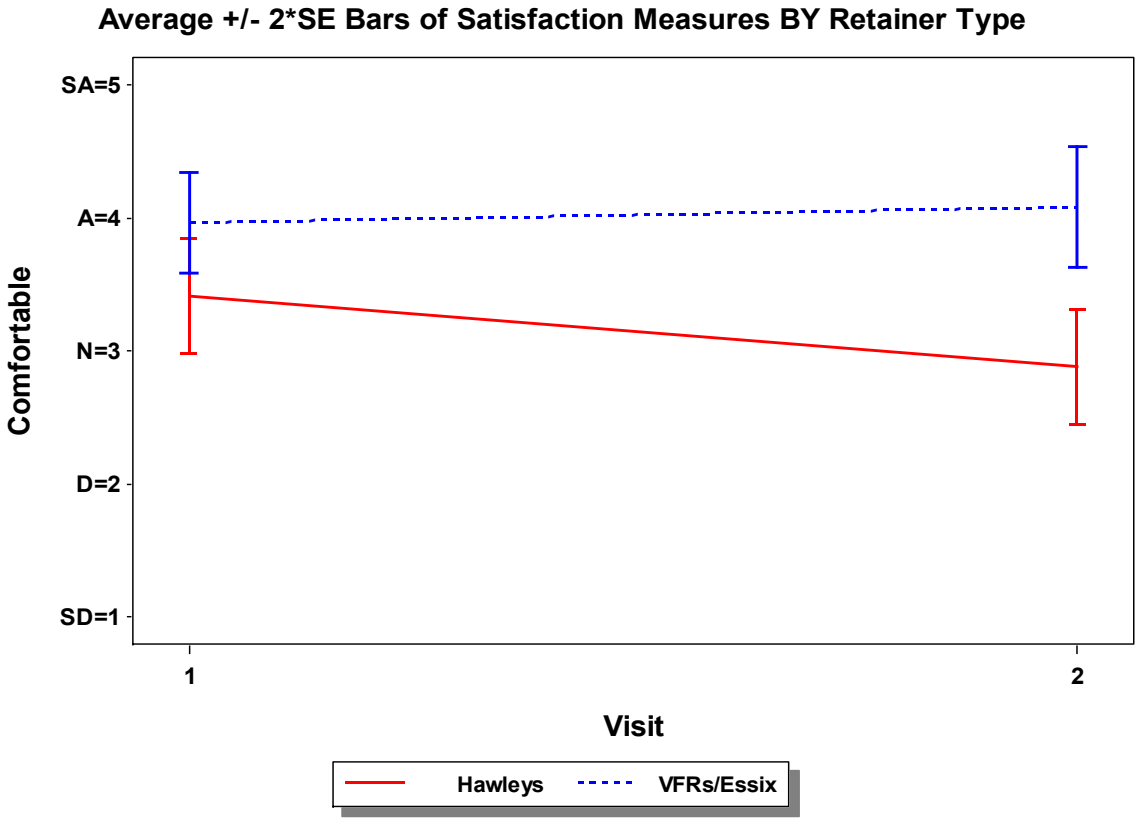
Table 1: Summary statistics of compliance and satisfaction measures by retainer type and visit.

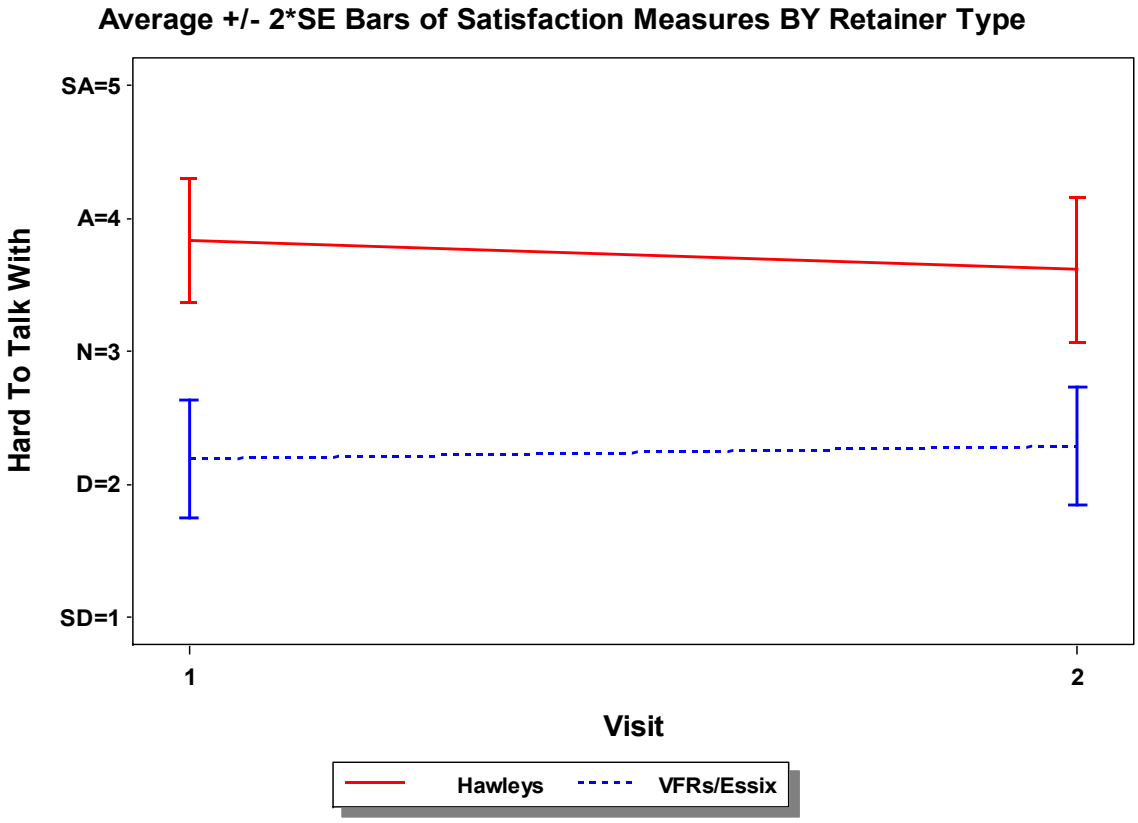
Compliance/ Satisfaction Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Minimum	Maximum
Hours Per Week	Hawleys	1	HE	24	117.21	40.47	132.5	40	168
	Hawleys	2	EH	26	110.31	40.49	119.0	8	161
	VFRs/Essix	1	EH	26	133.23	26.47	140.0	72	168
	VFRs/Essix	2	HE	24	118.79	38.38	120.0	35	161
Comfortable	Hawleys	1	HE	24	3.42	1.06	4.0	1	5
	Hawleys	2	EH	26	2.88	1.11	3.0	1	5
	VFRs/Essix	1	EH	26	3.96	0.96	4.0	1	5

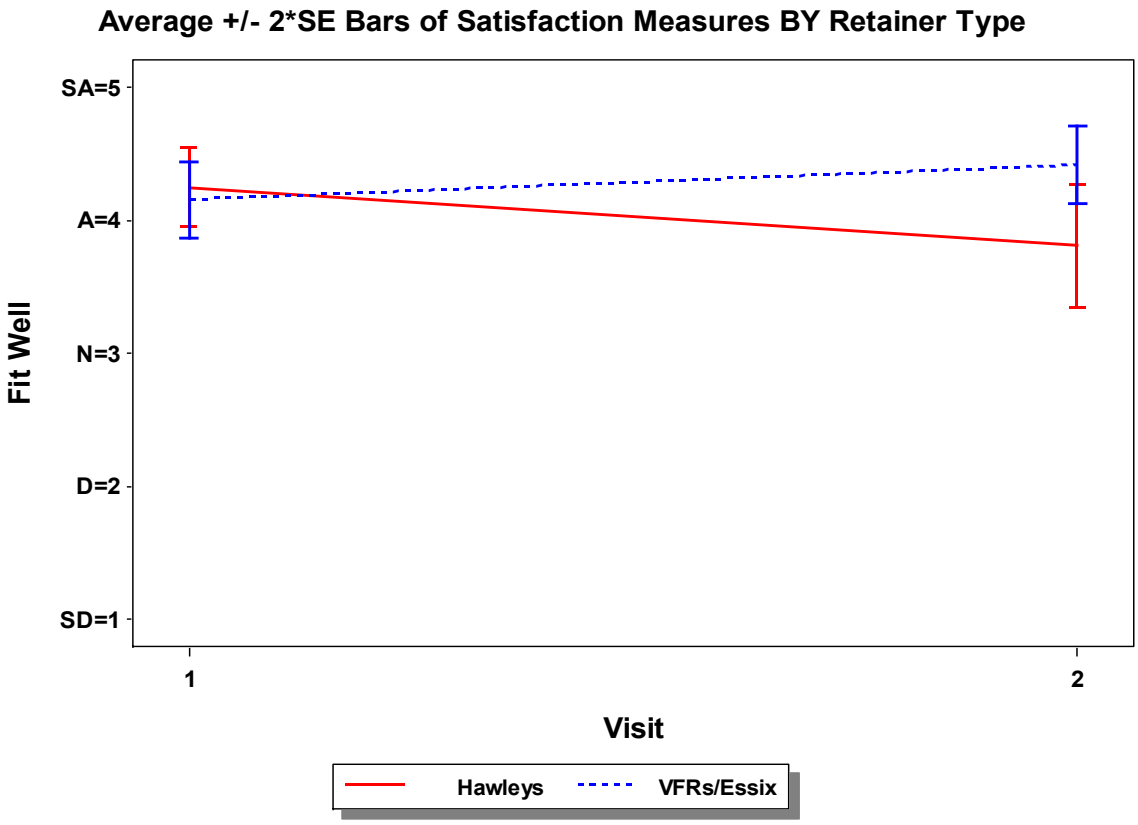
Compliance/ Satisfaction Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Minimum	Maximum
	VFRs/Essix	2	HE	24	4.08	1.10	4.5	2	5
Hard To Talk With	Hawleys	1	HE	24	3.83	1.13	4.0	1	5
	Hawleys	2	EH	26	3.62	1.39	4.0	1	5
	VFRs/Essix	1	EH	26	2.19	1.13	2.0	1	4
	VFRs/Essix	2	HE	24	2.29	1.08	2.0	1	5
Fit Well	Hawleys	1	HE	24	4.25	0.74	4.0	3	5
	Hawleys	2	EH	26	3.81	1.17	4.0	1	5
	VFRs/Essix	1	EH	26	4.15	0.73	4.0	3	5
	VFRs/Essix	2	HE	24	4.42	0.72	5.0	3	5
Don't Look Good	Hawleys	1	HE	24	3.08	1.18	3.0	1	5
	Hawleys	2	EH	26	3.04	1.31	3.0	1	5
	VFRs/Essix	1	EH	26	1.85	0.97	2.0	1	4
	VFRs/Essix	2	HE	24	1.88	1.03	2.0	1	5
Like Them	Hawleys	1	HE	24	3.33	1.01	3.0	2	5
	Hawleys	2	EH	26	2.69	1.26	3.0	1	5
	VFRs/Essix	1	EH	26	3.92	0.74	4.0	3	5
	VFRs/Essix	2	HE	24	4.17	0.96	4.5	2	5
Total Satisfaction Score	Hawleys	1	HE	24	16.08	3.16	16.5	10	22
	Hawleys	2	EH	26	14.73	3.88	15.0	6	22
	VFRs/Essix	1	EH	26	20.00	2.90	20.0	15	25
	VFRs/Essix	2	HE	24	20.50	3.84	21.0	13	25

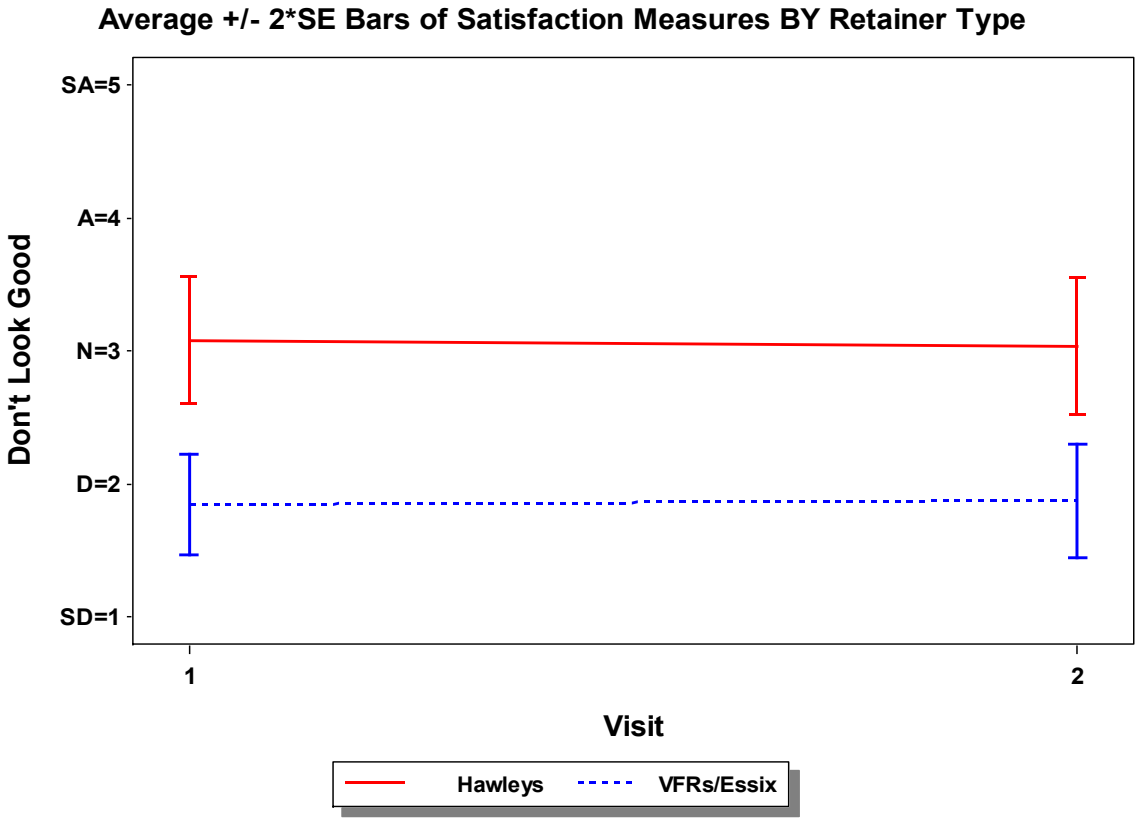
Figures 1-7: Average compliance/satisfaction measures ± 2*SE bars by retainer type and visit.

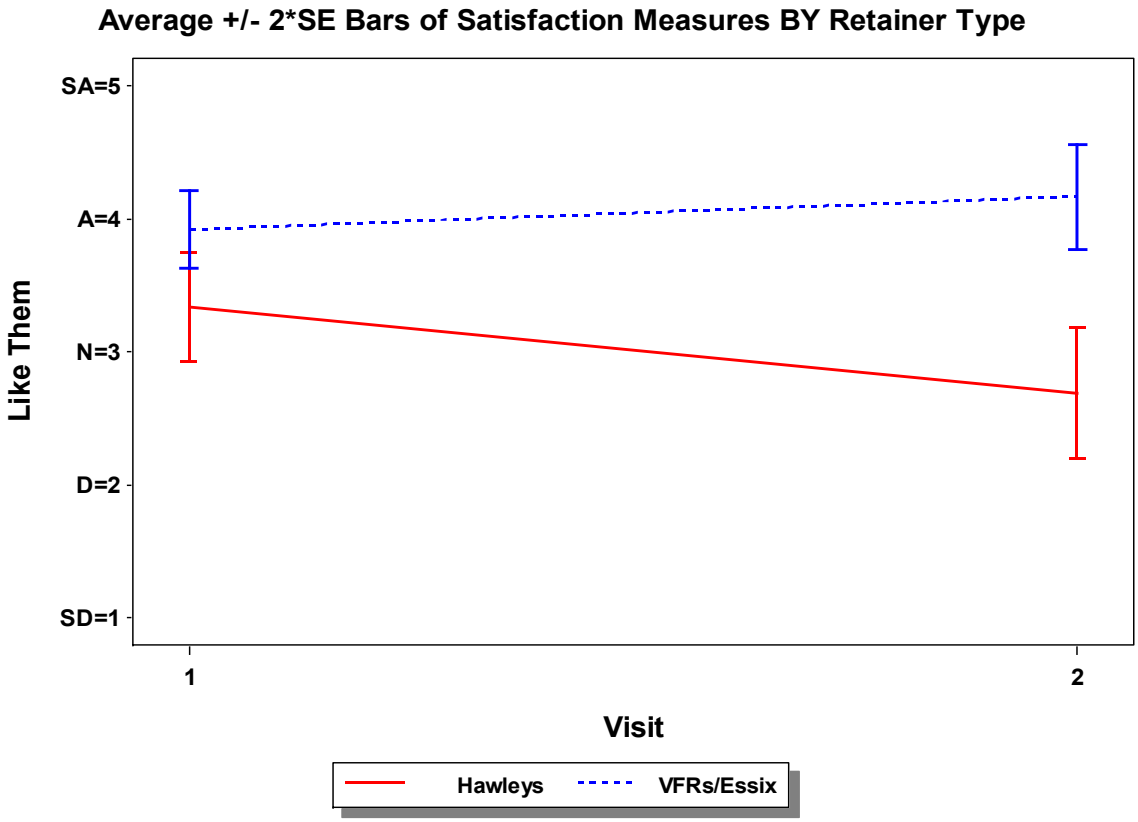

Average +/- 2*SE Bars of Compliance BY Retainer Type
Hours Per Week
160
150
140
130
120
110
100
90
1
2
Visit
Hawleys
VFRs/Essix

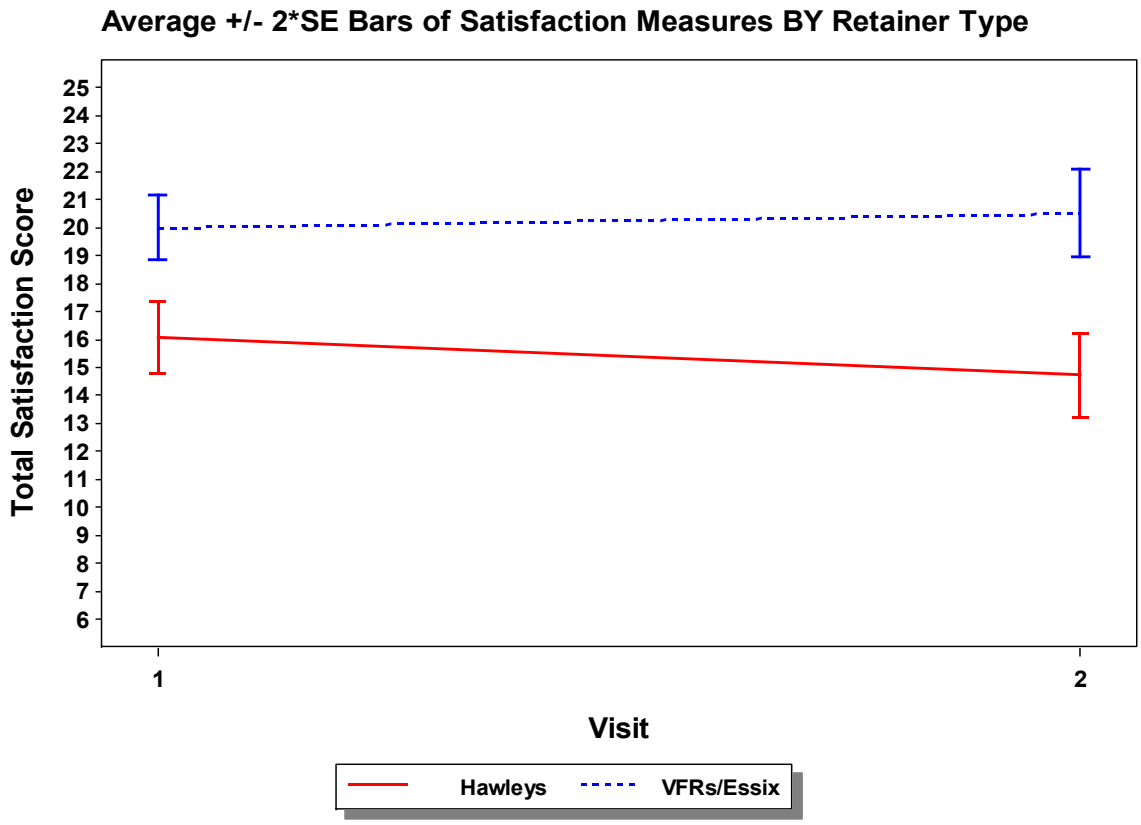

Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
Comfortable
SA=5
A=4
N=3
D=2
SD=1
1
2
Visit
Hawleys
VFRs/Essix


Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
Hard To Talk With
SA=5
A=4
N=3
D=2
SD=1
1
2
Visit
Hawleys
VFRs/Essix


Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
SA=5
A=4
N=3
D=2
SD=1
Fit Well
1
2
Visit
Hawleys
VFRs/Essix


Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
SA=5
A=4
N=3
D=2
SD=1
Don't Look Good
1
2
Visit
Hawleys
VFRs/Essix


Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
SA=5
A=4
N=3
D=2
SD=1
Like Them
1
2
Visit
Hawleys
VFRs/Essix


Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
Total Satisfaction Score
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
1
2
Visit
Hawleys
VFRs/Essix

Next, results from the repeated measures mixed-effects (RMME) model, adjusting for age and gender, are presented below for compliance and satisfaction measures.

Compliance – Hours per Week

Table 2a: Type 3 tests of fixed effects on compliance.

Effect	Num DF	Den DF	F Value	Pr > F
Visit	1	48	6.50	0.014
Treatment	1	48	8.57	0.005
Visit*Treatment	1	48	0.35	0.558
Age	1	48	2.68	0.108
Sex	1	48	3.51	0.067

From the above Table 2a it was evident that there were significant *overall* effects of visit/period (p = 0.014) and treatment (p = 0.005) on compliance; however, there was no evidence of a sequence (i.e., visit*treatment interaction) effect (p = 0.558). As shown in Table 2b below, on average, patients were *more compliant* with their retainers, wearing them for longer periods, during visit 1 as compared to visit 2 (125.3 vs. 114.6 hrs/wk, respectively). Also, patients were *less compliant* when wearing the Hawleys retainer as opposed to the VFRs/Essix retainer; they wore the Hawley retainer for shorter periods (113.8 vs. 126.1 hrs/wk).

Table 2b: Differences in least square (LS) means and 95% confidence intervals (C.I.) of compliance.

Effect	Comparison of Interest	Estimate	Standard Error	DF	t Value	Pr > |t|	95% C.I.	
Visit	Visit 1vs. 2	10.7	4.2	48	2.55	0.014	2.3	19.1
Treatment	Hawleys vs. VFRs/Essix	-12.3	4.2	48	-2.93	0.005	-20.7	-3.8

Satisfaction Measures

From Table 3a below it was clearly evident that there are only significant *overall* treatment effects ($p < 0.05$) for all the satisfaction measures; there was no evidence of visit/period or sequence effects ($p \geq 0.05$). As a result, Table 3b presents the treatment means based on the 'reduced' model with simple treatment effects and Table 3c presents the differences in treatment for each of the satisfaction measures. Treatment differences were favorable towards VFRs/Essix retainers with higher individual/combined scores for comfort, looks, perception of likability, and overall satisfaction; similarly, lower scores for speech was also in favor of VFRs/Essix retainers.

Table 3a: Type 3 tests of fixed effects on satisfaction measures.

Satisfaction Measure	Effect	Num DF	Den DF	F Value	Pr > F
Comfortable	**Visit**	1	48	1.24	0.271
	Treatment	1	48	22.43	<.001
	Visit*Treatment	1	48	1.56	0.218
	Age	1	48	0.97	0.329
	Sex	1	48	1.36	0.250
Hard to Talk With	**Visit**	1	48	0.06	0.806
	Treatment	1	48	38.06	<.001
	Visit*Treatment	1	48	0.33	0.568

Satisfaction Measure	Effect	Num DF	Den DF	F Value	Pr > F
	Age	1	48	0.34	0.564
	Sex	1	48	0.37	0.547
Fit Well	**Visit**	1	48	0.35	0.557
	Treatment	1	48	2.85	0.098
	Visit*Treatment	1	48	2.46	0.123
	Age	1	48	1.49	0.228
	Sex	1	48	0.08	0.777
Don't Look Good	**Visit**	1	48	0.00	0.972
	Treatment	1	48	27.53	<.001
	Visit*Treatment	1	48	0.02	0.888
	Age	1	48	0.01	0.906
	Sex	1	48	0.01	0.922
Like Them	**Visit**	1	48	1.03	0.316
	Treatment	1	48	27.76	<.001
	Visit*Treatment	1	48	3.58	0.064
	Age	1	48	0.25	0.617
	Sex	1	48	0.77	0.386
Overall Satisfaction	**Visit**	1	48	0.37	0.546
	Treatment	1	48	47.73	<.001
	Visit*Treatment	1	48	1.38	0.245
	Age	1	48	0.34	0.564
	Sex	1	48	0.00	0.973

Table 3b: Least square (LS) means and 95% confidence intervals (C.I.) by treatment (retainer type) for each satisfaction measure.

Satisfaction Measure	Retainer Type	Estimate	Standard Error	DF	t Value	Pr > |t|	95% C.I.	
Comfortable	Hawleys	3.14	0.15	49	20.86	<.001	2.84	3.44
	VFRs/Essix	4.02	0.15	49	26.71	<.001	3.72	4.32
Hard to Talk With	Hawleys	3.72	0.17	49	22.23	<.001	3.38	4.06
	VFRs/Essix	2.24	0.17	49	13.39	<.001	1.90	2.58
Fit Well	Hawleys	4.02	0.12	49	32.48	<.001	3.77	4.27
	VFRs/Essix	4.28	0.12	49	34.58	<.001	4.03	4.53
Don't Look Good	Hawleys	3.06	0.16	49	19.33	<.001	2.74	3.38
	VFRs/Essix	1.86	0.16	49	11.75	<.001	1.54	2.18
Like Them	Hawleys	3.00	0.15	49	20.60	<.001	2.71	3.29
	VFRs/Essix	4.04	0.15	49	27.74	<.001	3.75	4.33
Overall Satisfaction	Hawleys	15.38	0.49	49	31.30	<.001	14.39	16.37
	VFRs/Essix	20.24	0.49	49	41.19	<.001	19.25	21.23

Table 3c: Treatment differences in LS means and 95% confidence intervals (C.I.) for each satisfaction measure.

Satisfaction Measure	Comparison of Interest	Estimate	Standard Error	DF	t Value	Pr > |t|	95% C.I.	
Comfortable	Hawleys vs. VFRs/Essix	-0.88	0.18	49	-4.77	<.001	-1.25	-0.51
Hard to Talk With	Hawleys vs. VFRs/Essix	1.48	0.24	49	6.25	<.001	1.00	1.96
Fit Well	Hawleys vs. VFRs/Essix	-0.26	0.15	49	-1.73	0.091	-0.56	0.043
Don't Look Good	Hawleys vs. VFRs/Essix	1.20	0.22	49	5.36	<.001	0.75	1.65
Like Them	Hawleys vs. VFRs/Essix	-1.04	0.20	49	-5.31	<.001	-1.43	-0.65
Overall Satisfaction	Hawleys vs. VFRs/Essix	-4.86	0.69	49	-6.99	<.001	-6.26	-3.46

Lastly, spearman correlations between compliance and the five likability factors and overall satisfaction score exhibited both positive and negative correlations with all, except looks, significant at the 5% level (Table 4a). Likability factors

speech and *looks* were negatively correlated with compliance; while *comfort*, *fit*, *perception of likability* and *overall satisfaction* score were positively correlated. However, the spearman 'partial' correlations, controlling for visit and retainer type effects, became less significant after adjustment (Table 4b). Figure 8 presents a scatterplot matrix of compliance and satisfaction measures providing visual confirmation of the associations. The assessment of the reliability of the satisfaction and quality of life measures resulted in Cronbach's alphas, 0.77 and 0.94, respectively.

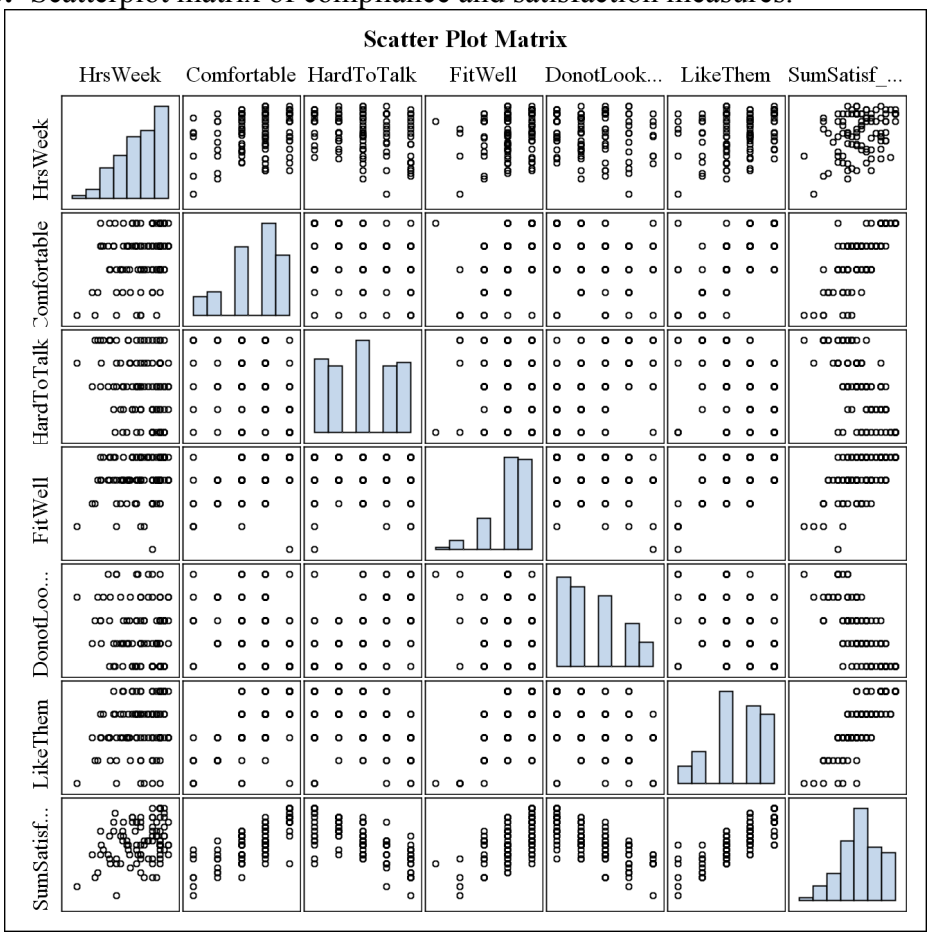
Table 4a: Spearman correlations between compliance and satisfaction measures.

Spearman Correlation Coefficients, N = 100 Prob > |r| under H0: Rho=0						
	Total Satisfaction Score	**Comfortable**	**Hard To Talk**	**Fit Well**	**Don't Look Good**	**Like Them**
Hours Per Week	0.28857 0.0036	0.22161 0.0267	-0.27992 0.0048	0.21720 0.0300	-0.13613 0.1769	0.24730 0.0131

Table 4b: Spearman 'partial' correlations between compliance and satisfaction measures, 'after adjustment' for visit and retainer type.

Spearman Correlation Coefficients, N = 100, Prob > |r| under H0: Rho=0						
	Total Satisfaction Score	**Comfortable**	**Hard To Talk**	**Fit Well**	**Don't Look Good**	**Like Them**
Hours Per Week	0.24156 0.0166	0.16657 0.1012	-0.23995 0.0173	0.20628 0.0416	-0.07240 0.4786	0.19539 0.0539

Figure 8: Scatterplot matrix of compliance and satisfaction measures.



Patient Preference

Twenty-seven patients were present at visit 3, where they were asked to evaluate the retainer of their choice. Out of 27, 18 (66.7%), 25 (92.6%), 22 (81.5%), and 12 (44.4%) chose VFRs/Essix retainer based on satisfaction measures comfort, speech, looks, and fit, respectively. 17 out of 27 patients preferred VFRs/Essix retainer. The assessment of the reliability of the patient preference measures resulted in Cronbach's alpha of 0.78.

Appendix

Table S0: Summary statistics of demographic characteristics and tests for differences in study groups.

Variable	Treatment	N	Mean	Std Dev	Std Err	Minimum	Maximum	Pr > |t|
Age	Hawleys	24	14.3750	1.2790	0.2611	12.0000	17.0000	
	VFRs/Essix	26	14.9231	1.4946	0.2931	12.0000	19.0000	
	Diff (1-2)		-0.5481	1.3955	0.3950			0.1717

Treatment(Retainer Type)	Sex		
Frequency Percent Row Pct	F	M	Total
Hawleys	14 28.00 58.33	10 20.00 41.67	24 48.00
VFRs/Essix	17 34.00 65.38	9 18.00 34.62	26 52.00
Total	31 62.00	19 38.00	50 100.00

Fisher's Exact Test	
Cell (1,1) Frequency (F)	14
Left-sided Pr <= F	0.4121
Right-sided Pr >= F	0.7894
Table Probability (P)	0.2015
Two-sided Pr <= P	0.7716

Quality of Life measures were implemented in the questionnaires for supplemental information and were not the primary aim of this study. Therefore full statistical analysis was not performed. Quality of Life measures were analyzed using mean, standard deviations, minimums and maximums. Overall, subjects reported *no effect* for almost all quality of life measures with means around 3.0. Only 2 measures appeared to have a noticeable deviation from *no effect/mean of 3.0*. *Speech* and *breath odor* measures were noticeably below 3.0 indicating *bad effect*. *Speech* mean deviations were noticeable for Hawley retainers only with means of 2.30 and 1.92 for Groups A and B respectively. *Breath odor* mean deviations were noticeable for Hawley retainers with means of 2.74 and 2.69 and for VFRs/Essix retainers with means of 2.62, and 2.75. Overall, mean *total quality of life* measures were 46.89 for Hawley retainers and 52.01 for VFRs/Essix retainers. A mean *total quality of life* score of 51 would indicate retainer has *no effect.*

Table S1: Summary statistics of quality of life (QoL) measures by retainer type and visit.

QoL Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Minimum	Maximum
Food	Hawleys	1	HE	23	3.13	0.46	3.0	2	4
	Hawleys	2	EH	26	2.81	0.75	3.0	1	4
	VFRs/Essix	1	EH	25	2.88	0.73	3.0	1	5
	VFRs/Essix	2	HE	24	3.04	0.69	3.0	1	5
Appearance	Hawleys	1	HE	23	2.96	0.64	3.0	1	4
	Hawleys	2	EH	26	2.46	0.81	2.5	1	4
	VFRs/Essix	1	EH	26	3.50	0.86	3.0	2	5
	VFRs/Essix	2	HE	24	3.50	0.98	3.0	1	5
Speech	Hawleys	1	HE	23	2.30	0.88	2.0	1	5

QoL Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Minimum	Maximum
	Hawleys	2	EH	26	1.92	0.80	2.0	1	4
	VFRs/Essix	1	EH	26	3.19	0.80	3.0	2	5
	VFRs/Essix	2	HE	24	2.92	0.88	3.0	2	5
Health	Hawleys	1	HE	23	3.26	0.54	3.0	3	5
	Hawleys	2	EH	26	3.15	0.73	3.0	1	5
	VFRs/Essix	1	EH	26	3.46	0.71	3.0	3	5
	VFRs/Essix	2	HE	24	3.29	0.69	3.0	3	5
Sleep	Hawleys	1	HE	22	3.36	0.73	3.0	2	5
	Hawleys	2	EH	26	2.88	0.71	3.0	2	5
	VFRs/Essix	1	EH	26	3.42	0.76	3.0	2	5
	VFRs/Essix	2	HE	24	3.29	0.75	3.0	2	5
Social Life	Hawleys	1	HE	23	3.09	0.60	3.0	2	4
	Hawleys	2	EH	26	2.81	0.57	3.0	1	4
	VFRs/Essix	1	EH	26	3.38	0.64	3.0	3	5
	VFRs/Essix	2	HE	24	3.38	0.71	3.0	3	5
Romance	Hawleys	1	HE	23	3.13	0.55	3.0	2	5
	Hawleys	2	EH	26	3.00	0.28	3.0	2	4
	VFRs/Essix	1	EH	26	3.35	0.69	3.0	3	5
	VFRs/Essix	2	HE	24	3.13	0.45	3.0	3	5
Smile/Laugh	Hawleys	1	HE	23	3.22	0.90	3.0	2	5
	Hawleys	2	EH	26	2.73	0.72	3.0	1	4
	VFRs/Essix	1	EH	26	3.27	0.87	3.0	2	5
	VFRs/Essix	2	HE	24	3.50	1.02	3.0	1	5
Confidence	Hawleys	1	HE	23	3.26	0.62	3.0	2	5
	Hawleys	2	EH	26	2.85	0.67	3.0	1	4
	VFRs/Essix	1	EH	26	3.46	0.76	3.0	3	5
	VFRs/Essix	2	HE	24	3.54	0.83	3.0	2	5
Lack of Worry	Hawleys	1	HE	22	3.23	0.53	3.0	3	5
	Hawleys	2	EH	26	2.81	0.80	3.0	1	5
	VFRs/Essix	1	EH	26	3.31	0.79	3.0	2	5
	VFRs/Essix	2	HE	24	3.21	0.59	3.0	2	5
Mood	Hawleys	1	HE	23	3.09	0.51	3.0	2	4
	Hawleys	2	EH	26	3.00	0.49	3.0	2	4

QoL Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Minimum	Maximum
	VFRs/Essix	1	EH	26	3.31	0.62	3.0	3	5
	VFRs/Essix	2	HE	24	3.25	0.68	3.0	2	5
School Activities	Hawleys	1	HE	23	3.26	0.69	3.0	2	5
	Hawleys	2	EH	26	2.77	0.71	3.0	1	4
	VFRs/Essix	1	EH	26	3.31	0.55	3.0	3	5
	VFRs/Essix	2	HE	24	3.17	0.70	3.0	2	5
Finances	Hawleys	1	HE	23	3.13	0.34	3.0	3	4
	Hawleys	2	EH	26	3.04	0.20	3.0	3	4
	VFRs/Essix	1	EH	26	3.15	0.37	3.0	3	4
	VFRs/Essix	2	HE	24	3.17	0.48	3.0	3	5
Personality	Hawleys	1	HE	23	3.39	0.72	3.0	3	5
	Hawleys	2	EH	26	3.00	0.57	3.0	1	4
	VFRs/Essix	1	EH	26	3.38	0.70	3.0	3	5
	VFRs/Essix	2	HE	24	3.42	0.72	3.0	3	5
Comfort	Hawleys	1	HE	23	2.91	0.60	3.0	2	4
	Hawleys	2	EH	26	2.54	0.95	3.0	1	4
	VFRs/Essix	1	EH	26	3.31	0.79	3.0	2	5
	VFRs/Essix	2	HE	24	3.38	0.97	3.0	1	5
Breath	Hawleys	1	HE	23	2.74	0.75	3.0	1	4
	Hawleys	2	EH	26	2.69	0.62	3.0	1	4
	VFRs/Essix	1	EH	26	2.62	0.85	3.0	1	4
	VFRs/Essix	2	HE	24	2.75	0.90	3.0	1	5
Total QoL Score	Hawleys	1	HE	23	49.17	5.95	47.0	42	64
	Hawleys	2	EH	26	44.46	6.49	45.0	27	61
	VFRs/Essix	1	EH	26	52.19	8.48	48.5	42	72
	VFRs/Essix	2	HE	24	51.92	9.74	48.0	40	75

CHAPTER IV

DISCUSSION

The specific aims of this study were as follows.

1) Determine differences in compliance between Hawley and VFRs

2) Determine differences in likability between Hawley and VFRs by using patients' subjective assessment of comfort, fit, speech, and looks.

3) Determine preference for Hawley and VFRs based on likability factors; comfort, fit, speech, and looks.

4) Determine if a correlation exists between likability and compliance.

5) Determine patients' oral health quality of life while wearing retainers and if differences exist between retainer types.

6) To determine if age or sex affects retainer preference and/or compliance.

1) Compliance.

As hypothesized, the self-reported retainer wear in terms of "average" hours per week was significantly higher for patients while wearing Essix/VFRs retainers than while wearing the Hawley retainers (126.1 hrs/wk vs. 113.8 hrs/wk). This was true for both groups with means of 133.24 hrs/wk and 118.79 hrs/wk for Essix//VFRs of Groups A and B respectively compared to means of

117.21 hrs/wk and 110.31 hrs/wk for Hawleys. Also as expected, retainer wear was significantly higher in the 1st month following debonding than the 2nd month (125.3 hrs/wk vs. 114.6 hrs/wk). There was no significant sequence effect observed meaning there was no significant differences in compliance based on whether a subject received a certain retainer type 1st or 2nd.

2) Likability

There were significant differences in subjects' perception of comfort, looks, speech, and likability in favor of VFRs/Essix compared to Hawleys. However subjects' were indifferent in their perception of fit between retainer types. Results indicated a significant overall satisfaction in favor of VFRs/Essix.

3) Preference based on likability factors

There were only 27 subjects who completed Questionnaire #2 on preference, however the majority of these subjects, 17, preferred VFR's/Essix retainers while only 4 subjects preferred Hawleys. Again, the VFRs/Essix retainer was favored for likability factors comfort, speech, and looks, but not fit.

4) Correlation between likability and preference

Spearman correlations between compliance and likability exhibited significant correlations, at the 5% level, for all 5 factors except looks. Likability factors of comfort, fit, and perception of likability were all positively correlated with compliance while likability factors of speech and looks were negatively correlated with compliance because of the wording used in the questionnaire ("Don't look good" and "Hard to talk with"). These findings indicate that the retainer type that

was perceived as being more comfortable, easier to talk with, better looking, and overall more likable was worn with higher levels of compliance by subjects.

5) Quality of Life

When evaluating whether subjects quality of life was affected by retainer type the results indicate minimal subjective effects in terms of eating, appearance, general health, ability to sleep, social life, romantic relationship, smiling, confidence, carefree manner, mood, school activities, finances, personality, and comfort. Subjects reported that Hawley retainers had an overall *bad effect* on their speech in comparison to VFRs/Essix retainers which had *no effect* on their speech. Subjects also reported that both Hawley and VFRs/Essix retainers had an overall *bad effect* on their breath odor. Total quality of life scores were lower for Hawleys than for VFRs/Essix indicating a perceived decrease in quality of life when wearing Hawley retainers in comparison to VFRs/Essix.

CHAPTER V

CONCLUSIONS

A. Summary:

The results of this study provided confirmation to the expected results with the exception of likability factor of *fit.* There was an increase in preference for and compliance for VFRs/Essix over Hawley retainers. Subjects in both treatment groups reported greater compliance the month they were given VFRs/Essix. Following 2 months, subjects reported preference for VFRs/Essix. Reasons for choosing VFRs/Essix over Hawleys included esthetics, speech, and comfort; but not fit. From the results obtained in this study it can be confidently concluded that vacuum-formed/Essix retainers in comparison to Hawley retainers are preferred and lead to higher levels of compliance in the short-term orthodontic retention phase of treatment .

REFERENCES

1. Oppenheim A. The crisis in orthodontia. I. Tissue changes during retention: Skogsborg's septotomy. *Int J Orthod Dent Child.* 1934;20:640.

2. Reitan K. Tissue rearrangement during retention of orthodontically rotated teeth. *Angle Orthod.* 1958; 29:105-13.

3. Horowitz SI, Hixon EH. Physiologic recovery following orthodontic treatment. *Am J Orthod.* 1969;55:1.

4. Edwards J. Surgical procedure to eliminate rotation relapse. *Am J Orthod.* 1970;57:35-45.

5. Little RM, Wallen TR, Riedel RA. Stability and relapse of mandibular anterior alignment: first premolar extraction cases treated by traditional edgewise orthodontics. *Am J Orthod.* 1981;80:349.

6. Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic treatment. *Am J Orthod.* 1967;53:721

7. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. Fourth Edition. 2007.

8. Pratt MC, Kluemper GT, Hartsfield JK, Fardo D, Nash DA. Evaluation of retention protocols among members of the American Association of Orthodontists in the United States. *Am J Orthod Dentofacial Orthop.* 2011;140:520-6)

9. Rowland H, Hichens L, Williams A, Hills D, Killingback N, Ewings P, Clark S, Ireland A, Sandy JR. The effectiveness of Hawley and vacuumformed retainers: A single-center randomized controlled trial. *Am J Orthod Dentofacial Orthop.* 2007;132:730-7.

10. Hichens L, Rowland H, Williams A, Hollinghurst S, Ewings P, Clark S, Ireland A, Sandy J. Cost-effectiveness and patient satisfaction: Hawley and vacuum-formed retainers. *European Journal of Orthodontics.* 2007;29:372-378.

11. Mollov ND, Lindauer SJ, Best AM, Shroff B, Tufekci E. Patient attitudes toward retention and perceptions of treatment success. *Angles Orthod.* 2010;80:656-661.

12. Kacer KA, Manish V, Narendran S, Hans MG. Retainer wear and compliance in the first 2 years after active orthodontic treatment. *Am J Orthod Dentofacial Orthop.* 2010;138:592-8.

13. Pratt MC, Kluemper T, Lindstrom AF. Patient compliance with orthodontic retainers in the postretention phase. *Am J Orthod Dentofacial Orthop.* 2011;140:196-201.

14. Thickett E, Power S. A randomized clinical trial of thermoplastic retainer wear. Eur J Orthod.2010;32:1-5.

15. Shawesh M, Bhatti B, Usmani T, Mandall N. Hawley retainers full- or part-time? A randomized clinical trial. Eur J Orthod. 2010;32:165-170.

16. Lobene, R.R.; Weatherford, T.; Ross, N.M.; Lamm, R.A.; Menaker, L. A modified gingival index for use in clinical trials. Clinical Preventive Dentistry, Vol. 8, No. 1 (January-February 1986), pp. 3-6, ISSN 0163-9633.

17. Strang R. The fallacy of denture expansion as a treatment procedure. *Angle Orthod.* 1949;19:12-22.

18. Steadman S. Changes of intermolar and intercuspid distances following orthodontic treatment. *Angle Orthod.* 1961;31:207-215

19. Peak J. Cuspid stability. *Am J Orthod.* 1956;42:608-614

20. Lombardi A. Mandibular incisor crowding in completed cases. *Am J Orthod.* 1974;66:411-430

21. McGrath C, Raman B. Measuring the Impact of Oral Health on Quality of Life in Britain Using OHQoL-UK(W). *J Public Health Dent.* 2003;63(2):73-77.

CURRICULUM VITAE

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EDUCATION

2011-2013 University of Louisville School of Dentistry, Louisville, KY
Certificate in Orthodontics
Masters of Science and Dentistry
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2007-2011 University of Minnesota School of Dentistry, Minneapolis, MN
Doctor of Dental Surgery

2003-2007 Saint John's University, Collegeville, MN
Bachelor of Arts
Major: Biology

1999-2003 Thomas Jefferson High School, Bloomington, MN

HONORS AND AWARDS

Dental School:

2007-2011 University of Minnesota Academic Dean's List, 8 semesters

2008-2010 Phi Kappa Phi (Honors for Top 10% of Graduate School Class)

Saint John's University:

2007 Magna Cum Laude

2003-2007 Saint John's Academic Dean's List, 6 semesters
Cumulative GPA 3.88

2003-2007 Saint John's Varsity Men's Hockey Team Member
Senior Captain; voted by team members (2006-2007)
Most Valuable Player Award; voted by coaches & team members (2007)
MIAC All-Conference; voted by the coaches of conference teams (2007)
NCAA Division III Academic All-American (2007)
MIAC Academic All-Conference (2004-2007)
MIAC Conference Champions (2004-2006)

2003-2007 Saint John's Presidential Scholarship Recipient

Thomas Jefferson High School:

2000-2003 Varsity Hockey
Senior Captain (2003)
All-Conference Award (2003)
All-State Honorable Mention (2003)

2003 Varsity Tennis

COLLEGE & GRADUATE SCHOOL EXTRACURRICULARS

2007-present Bloomington Youth Hockey Program, Volunteer positions include: coach, try-out coordinator, instructor for summer camps, player development committee

2003-2007 Saint John's University Varsity Men's Hockey

Summer 2007 Traveled Abroad in Europe (Germany, Italy, France, Ireland, and England)

2005-2007 Student Athletic Advisory Committee (Saint John's University)

2003-present Intramural sports (hockey, softball, tennis, volleyball)

PROFESSIONAL AFFLIATIONS

2011-present American Association of Orthodonitcs

2013-present Minnesota Association of Orthodontics

2013-present

2009-present American Dental Political Action Committee (ADPAC)

2007-present American Student Dental Association (ASDA)

2007-present American Dental Education Association (ADEA)

2007-present Minnesota Dental Association (MDA)

LEADERSHIP POSITIONS

2008-2011 Coach of Bloomington Jefferson PeeWee A (13&under) Youth Traveling Hockey Team

2007-2008 Coach of Bloomington Jefferson PeeWee C (13&under) Youth Traveling Hockey Team

2006-2007 Captain of Saint John's Men's Varsity Hockey Team

2002-2003 Captain of High School Varsity Hockey Team

HOBBIES/INTERESTS

Coaching, waterskiing, wakeboarding, fishing, downhill skiing, biking, tennis, golf, music, reading

VOLUNTEER EXPERIENCE

2008, 2010 Union Gospel Mission Dental Clinic, St. Paul, MN

2007-2011 Volunteer Hockey Coach in the Bloomington Jefferson Youth Traveling Hockey Program

2007-2011 Volunteer coach/skating instructor at spring, summer, & fall Bloomington Jefferson Youth Hockey Camps (age 8-15 yr. olds)

2007-2011 Member of Dental School Mentor Program, volunteer mentor to class of 2012 students

2008-2009 Volunteered on the ASDA Elementary Outreach Committee

2006-2007 Volunteer at Kennedy Elementary Kidstop Afterschool Program, St. Joseph, MN

2002-2003 Volunteer Driver for Meals on Wheels, Bloomington, MN

EMPLOYMENT

2005-2011 City of Bloomington: Supervisor of City Softball & Volleyball Leagues and Public Parks Event Picnic Coordinator, Bloomington, MN.

2003-2007 Saint John's University Art Center: Gallery Supervisor & Schedule Coordinator

2005	Landsculpt Inc., Waverly, MN.
2002-2004	D&S Sealcoating, Eden Prairie, MN.
2001-2003	Lake Coaches Hockey Camps, Bloomington, MN.