Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Patient Preference and Compliance between Hawley Retainers and Vacuum-Formed Retainers following Orthodontic Treatment

Niharika Gupta[1], Abhimanyu Rohmetra[2], Ishita[3]

[1]PG student, Department of Oral and maxillofacial surgery, J.N Kapoor DAV(C) Dental College, Yamunanagar, Haryana;
[2]Department of orthodontics and dentofacial orthopaedics, Consultant Orthodontist , Jammu , J&K
[3]Institute of Dental Sciences, Sehora , Jammu , J&K

ABSTRACT:
Introduction: The traditional Hawley retainer has been replaced in many orthodontic clinics by vacuum-formed retainers (VFRs). **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. **Results**: There was an increase in preference for and compliance with VFRs within each group. The patients in both groups were reported greater compliance the month they were given VFRs. Following 2 months, all patients showed a preference for VFRs. Reasons for choosing VFRs over Hawleys included 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.
Key words: Esthetics; hawleys retainer; Vacuum-formed retainers.

Received: 14 April, 2020 Accepted: 28 April, 2020

Corresponding author: Dr. Niharika Gupta, PG student, Department of Oral and maxillofacial surgery, J.N Kapoor DAV(C) Dental College, Yamunanagar, Haryana, India

This article may be cited as: Gupta N, Rohmetra A, Ishita. Patient Preference and Compliance between Hawley Retainers and Vacuum-Formed Retainers following Orthodontic Treatment. J Adv Med Dent Scie Res 2020;8(5):119-129.

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.

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.[2,3]

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.[4,5] 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.[6]

Lombardi in 1979, presented 30 more cases several years after treatment corroborating Peak's findings.[7] 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.[8]

According to Pratt et al, the two most widely used removable retention appliances 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.[9]

Clinically, Rowland et al 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.[10]

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.[11]

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.[12]

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.[13]

Mollov et al reported in a survey study including mostly college students and dental students similar increase in patient satisfaction with VFR's as compared to Hawleys.[14] Niether of these studies investigated compliance levels between the two types nor reasoning for satisfaction or dissatisfaction.

Kacer et al 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.[15]

Pratt et al 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 non-compliance in their survey between retainer type and found little differences in concern about esthetics, comfort, and speech.[16]

METHODS AND MATERIALS

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

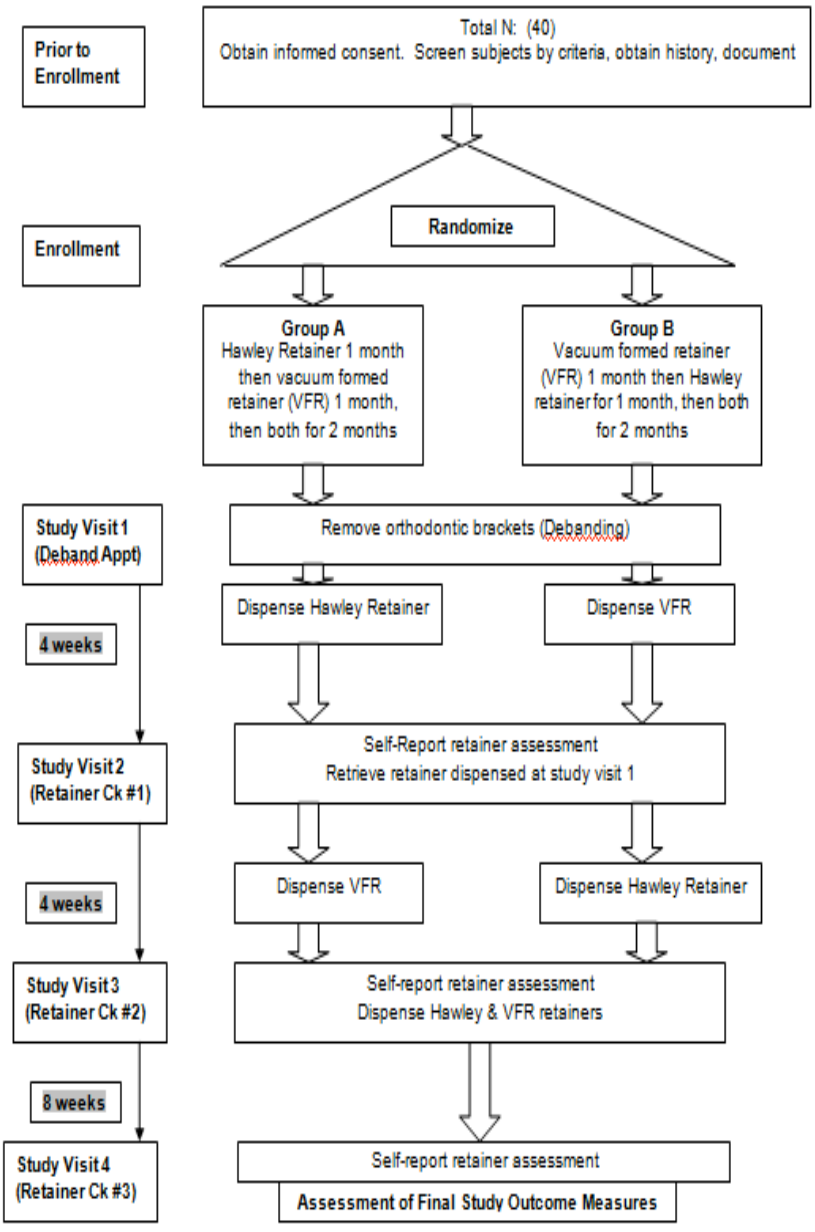
Table 1.Inclusion/Exclusion criteria

Inclusion Criteria:	Exclusion Criteria:
1. Patients aged 12 to 21 years	1. Medically compromised patients
2. Both upper and lower dental arches have been orthodontically treated.	2. Patients requiring restorative dental work immediately following orthodontic treatment.
3. Full arch orthodontics were performed.	3. Early debonding patients. Those patients who had their braces removed early due to non-compliance, finances, or any other reasons
	4. Invisalign Patients
	5. Surgical Patients

Each potential subject who met the inclusion and exclusion criteria was assigned a study number according to the sequential order of when they were debonded. 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.

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). 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 is 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 1 month, and then the retainers of their preference for 2 months.



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.[17] 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

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

The following questionnaire is part of a research. Your honest responses to these following questions will provide valuable information for this study.

Answer The Following Questions By Circling A Single Number…

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

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 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?					

Questionnaire #2
(Survey for Patients at 1st & 2nd Study Visits)
The following questionnaire is part of a research project . Your honest responses to these following questions will provide valuable information for this study.

Have you lost or broken any of your retainers?(circle one) YES NO
Answer The Following Questions By Circling A Single Number…

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

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

Check the appropriate box for each question.

Which retainer type	HAWLEYS 	No Preference	VFR 
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?					

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 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 analysing 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, box plots, and density estimates) was used to evaluate distributions for each outcome. 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.

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.

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 Table 1. Table 1b 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. In Figures 2, 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 1: Summary statistics of demographic characteristics and tests for differences in study groups.

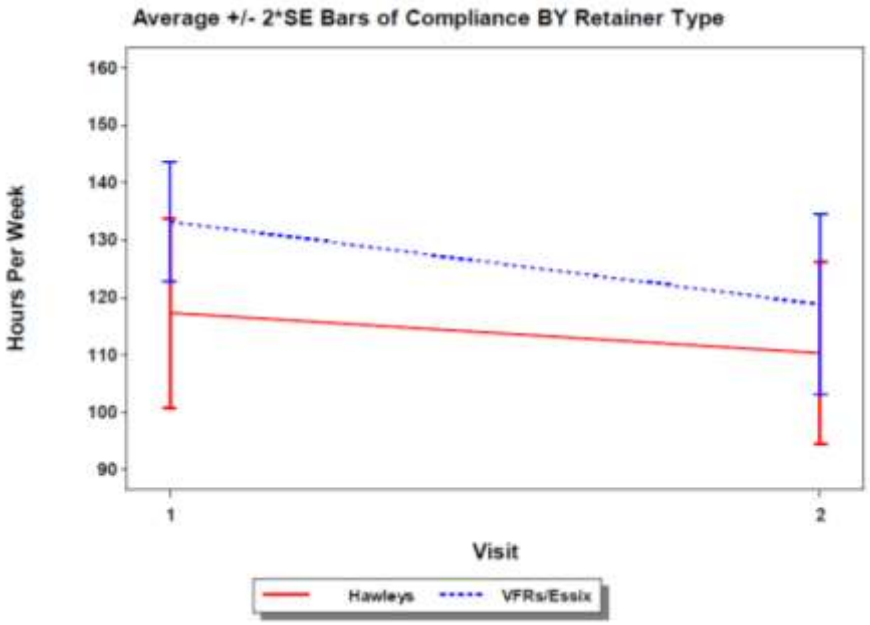
Variable	**Treatment**	**N**	**Mean**	**Std Dev**	**Std Err**	**Minimum**	**Maximum**	**Pr > |t|**
Age	**Hawleys**	24	14.3750	1.2790	0.2611	12.0000	17.0000	
	VFRs/Essix	26	14.9231	1.4946	0.2931	12.0000	19.0000	
	Diff (1-2)		-0.5481	1.3955	0.3950			0.1717

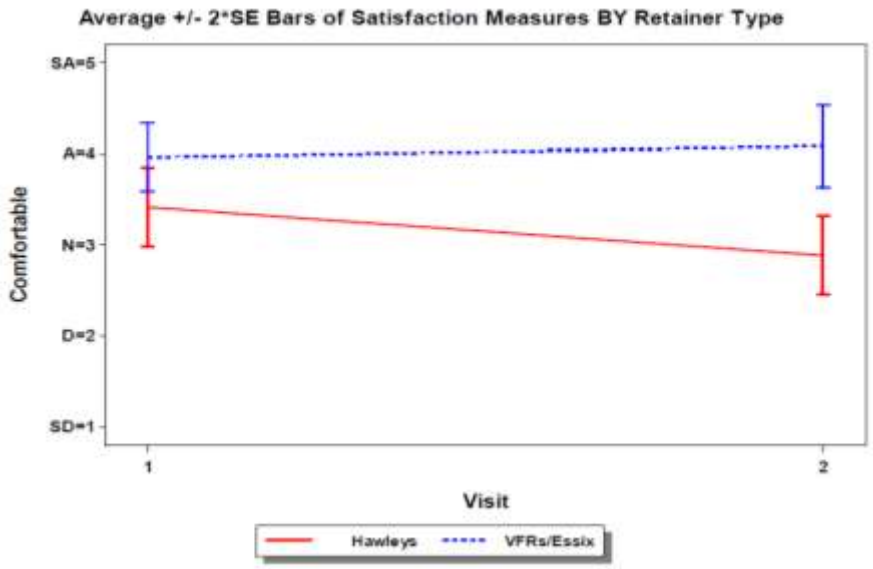
Table 1b: Summary statistics of compliance and satisfaction measures by retainer type and visit.

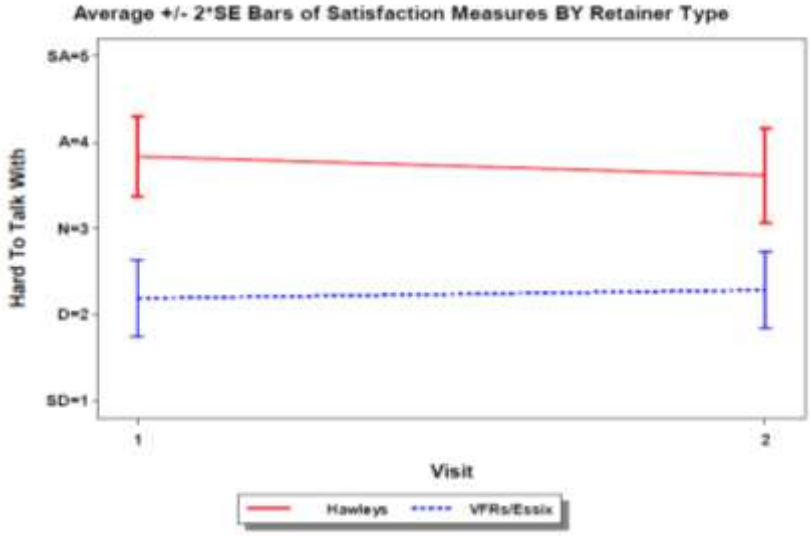
Compliance/ Satisfaction Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Minimum	Maximum
Hours Per Week	Hawleys	1	HE	24	117.21	40.47	132.5	40	168
	Hawleys	2	EH	26	110.31	40.49	119.0	8	161
	VFRs/Essix	1	EH	26	133.23	26.47	140.0	72	168
	VFRs/Essix	2	HE	24	118.79	38.38	120.0	35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

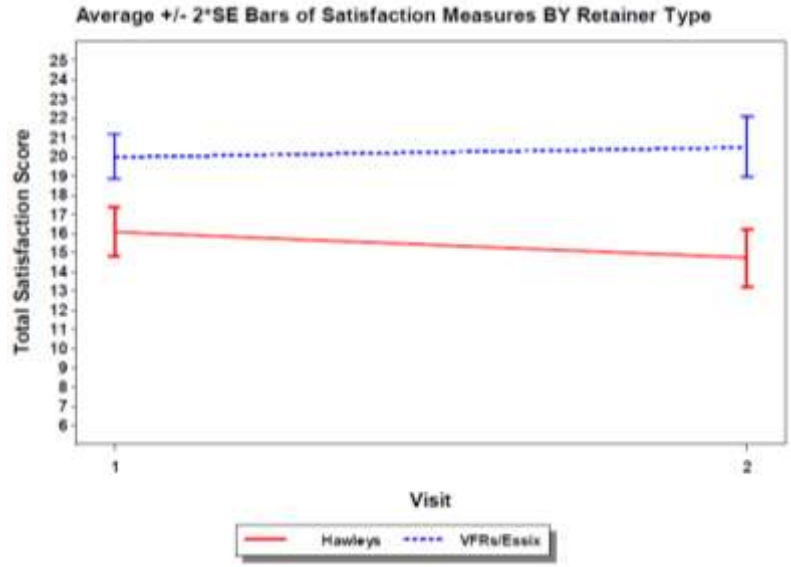
Compliance/ Satisfaction Measure	Retainer Type	Visit	Study Group (Sequence)	N	Mean	Std Dev	Median	Min.	Max.
	VFRs/Essix	2	HE	24	4.08	1.10	4.5	2	5
Hard To Talk With	Hawleys	1	HE	24	3.83	1.13	4.0	1	5
	Hawleys	2	EH	26	3.62	1.39	4.0	1	5
	VFRs/Essix	1	EH	26	2.19	1.13	2.0	1	4
	VFRs/Essix	2	HE	24	2.29	1.08	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	0	2
	Hawleys	2	EH	26	14.73	3.88	15.0	6	2
	VFRs/Essix	1	EH	26	20.00	2.90	20.0	5	2
	VFRs/Essix	2	HE	24	20.50	3.84	21.0	1	2

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




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


Average +/- 2*SE Bars of Satisfaction Measures BY Retainer Type
Total Satisfaction Score
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

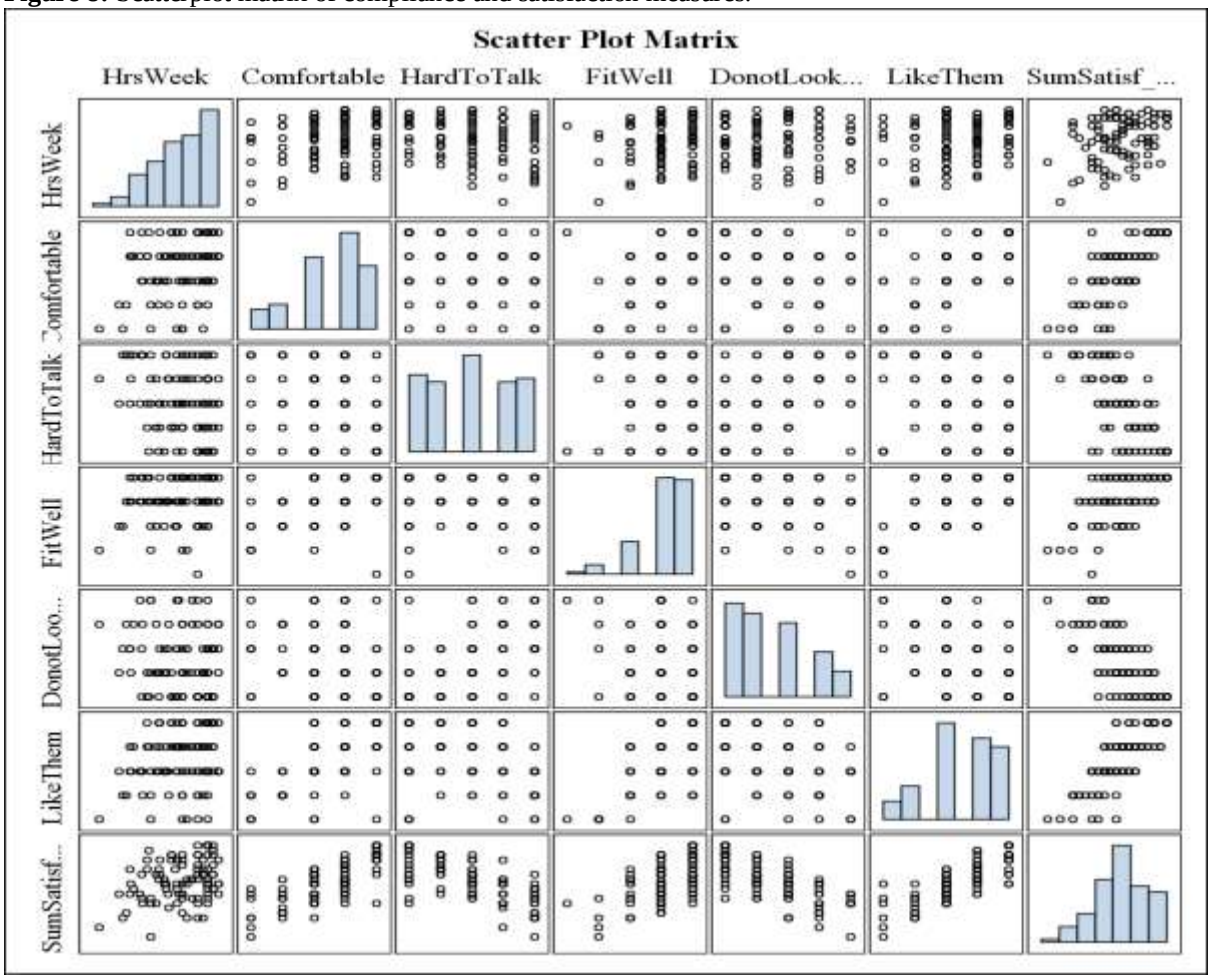
From the above Table 2a it was evident that there were significant overall effects of visit/period (p = 0.014) and treatment (p = 0.005) on compliance; however, there was no evidence of a sequence (i.e., visit*treatment interaction) effect (p = 0.558). As shown in Table 2b below, on average, patients 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

Figure 2 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.

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.

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.[14]

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[15]

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.[16]

4) 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.[17]

CONCLUSIONS

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 result 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. Strang R. The fallacy of denture expansion as a treatment procedure. Angle Orthod. 1949;19:12-22.
5. Steadman S. Changes of intermolar and intercuspid distances following orthodontic treatment. Angle Orthod. 1961;31:207-215
6. Peak J. Cuspid stability. Am J Orthod. 1956;42:608-614
7. Lombardi A. Mandibular incisor crowding in completed cases. Am J Orthod. 1974;66:411-430
8. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. Fourth Edition. 2007.
9. 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)
10. Rowland H, Hichens L, Williams A, Hills D, Killingback N, Ewings P, Clark S, Ireland A, Sandy

JR. The effectiveness of Hawley and vacuum formed retainers: A single-center randomized controlled trial. Am J Orthod Dentofacial Orthop. 2007;132:730-7.
11. Thickett E, Power S. A randomized clinical trial of thermoplastic retainer wear. Eur J Orthod.2010;32:1-5.
12. 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.
13. 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.
14. 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.
15. 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.
16. Pratt MC, Kluemper T, Lindstrom AF. Patient compliance with orthodontic retainers in the postretention phase. Am J Orthod Dentofacial Orthop. 2011;140:196-201.
17. 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