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Orthodontic Retainers: A Survey of Patient Compliance and Satisfaction

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A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Orthodontics

ORTHODONTIC RETAINERS:

A Survey of Patient Satisfaction and Compliance

(Thesis format: Monograph)

By

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ABSTRACT

PURPOSE

Retention is an important aspect of orthodontics, which may influence the long-term outcome and satisfaction level of patients who undergo orthodontic treatment. The objective of this study was to identify commonly used orthodontic retainers and retention protocols, and assess patients' opinions and satisfaction levels with these regimens in relation to several pre-defined variables.

METHODS:

A 149 question survey was created with advanced skip and branching logic. The survey was administered to orthodontic patients at either the one or two year regularly scheduled retention appointment and the overall response rate was 99% (n=131). Data collection included queries on demographics, treatment satisfaction, stability and relapse, retention protocols, compliance, and satisfaction with prescribed retainers in relation to: appearance, speech, oral hygiene, retainer hygiene, the need for replacement and preferred retainers. Statistical analysis was done using Chi Square and Fishers' Exact tests to detect significant associations between variables.

RESULTS AND CONCLUSIONS:

In the population surveyed, Essix retainers in the maxilla (50%) and bonded retainers in the mandible (46%) were most frequently prescribed. Satisfaction with dental alignment post-treatment and post-retention was high (~90%). Retainers prescribed depicted no associations with relapse. Self-reported compliance with prescribed retainer wear ranged between 75-85%, regardless of the regimen or retainer types. Bonded retainers were rated as the most esthetic and Hawley retainers the least. Maxillary Hawley retainers affected speech most often and bonded retainers the least. Patients with bonded retainers found it most difficult to maintain oral hygiene and keep their retainers clean, while patients with Essix found it the easiest. Bonded and Essix retainers required replacement most frequently in the maxilla and mandible, respectively. Even though the majority of patients (77% maxilla, 86% mandible) were satisfied with their prescribed retainer, maxillary Essix and mandibular bonded retainers were preferred most often if replacement was an option.

Keywords: orthodontic*, retention*, retainer*, guideline*, principle*, satisfact*, adhere*, patient*, compliant*, Essix, Hawley, bonded and Fixed retainer.

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF SUMMARY TABLES

LIST OF APPENDICES

INTRODUCTION

Treatment success in orthodontics is determined by facial esthetics, occlusion and stability.[1] Retaining the results of orthodontically corrected malocclusions has been discussed in the literature since the beginning of the 20th century.[2,3] Dr. Case[2] stated, "if there is one part of orthodontia more than another that is absolutely indispensable to the success of this specialty and its establishment upon a firm foundation as one of the arts and sciences, it is the permanent retention of regulated teeth". Angle[2] described the problems of retention to be greater than the difficulties encountered in the orthodontic treatment of patients.

Orthodontic retention is defined as the phase of treatment that attempts to maintain teeth in their corrected positions after active orthodontic treatment.[4] This period can be divided into retention and post-retention phases. During the retention phase, the reorganization of the periodontal ligament occurs over the first three to four months. The gingival collagen network typically takes four to six months to remodel, and the elastic supracrestal fibers can remain deviated for up to 232 days.[5] The retention phase is considered to be a continuation of orthodontic treatment.[6] The post-retention phase, which begins after the retention phase has ended, lasts the rest of the patient's life. During this period teeth are subjected to neuromuscular forces, dentoalveolar development and growth.[7]

Little[8,9] found that long-term alignment is both variable and unpredictable. It has been reported that 40% to 90% of patients have unacceptable dental alignment ten years after orthodontic treatment.[6] Alterations in arch form, growth, neuromuscular influence, rebound in the collagen or elastic supra-crestal fibers, compensatory eruption of the dentition, natural mesial drift of the dentition and inadequate periods of retention have been described as potential causes of mal-alignment of orthodontically treated dentitions.[6,9]

The literature shows that there are variations in the retention protocols used following active orthodontic treatment.[7,10] In order to improve post-treatment stability, Blake et al[11] suggested six treatment principles: (1) the patient's pretreatment lower arch form should be maintained; (2) lower intercanine width should be maintained; (3) account for mandibular arch length decreases; (4) the most stable lower incisor position is the pre-treatment position; (5) fiberotomy is an effective means of reducing rotational relapse; and (6) lower incisor reproximation may aid in preventing relapse. Melrose et al[5], in their review of evidence relating to orthodontic retention and relapse, stated that stability can be achieved if forces from the periodontal and gingival tissues, orofacial soft tissues, occlusion and post-treatment facial growth achieve a form of equilibrium. Some orthodontists state that long-term retention is the only way to prevent relapse.[9] In 2009, Littlewood et al[4] conducted a systematic review and concluded that there was insufficient data on which to base our retention protocols.

Retainers used in orthodontic retention may be fixed to the dentition, such as a bonded wire, or removable, such as a Hawley or Essix appliance. A fixed retainer is often a flexible multi-stranded wire or a rigid titanium or steel wire bonded to either all or only some (i.e. cuspids) of the lower anterior teeth. Fixed retainers are occasionally used in the maxillary arch. A significant advantage of this form of retention is the lack of need for active patient compliance. Disadvantages have been reported to include potential gingival inflammation and the patient's belief that the orthodontist is responsible for breakage.[12] Recently Kaji et al[13] published that there is no difference in the status of the periodontal health between individuals with and without fixed retainers.

Removable Hawley type retainers consist of acrylic covering the soft tissue on the lingual surface of the dentition, a steel wire along the buccal surfaces of the incisors and canines and clasps to help retain the appliance. Advantages include the ability for the dentition to settle, improvement in posterior contacts and durability of the appliance. Disadvantages associated with the appliance include interference with settling where wires cross the occlusion and dependence on patient compliance.[12]

Essix retainers, also known as vacuum formed retainers, are clear thermoplastic appliances. This renders them more esthetic from a patients' perspective[14] and for this reason may be worn more than Hawley retainers.[12,15] They are extremely valuable in open bite cases where they act as posterior bite blocks.[12] However Essix retainers often discolour, tear and crack with time,[12,15] and the use of these retainers requires patient compliance. They do not allow the occlusion to settle,[11] and it has been reported that they may create oral environments more conducive to dental surface colonization with Streptococcus mutans and Lactobacillus.[16] To enhance stability of treatment and patient compliance, orthodontists often combine the use of various removable and fixed retainers.[12]

In a study of retention protocols, Wong et al[10] found that orthodontists in Australia and New Zealand tend to prescribe Essix retainers in the maxillary arch and fixed retainers in the mandibular arch. In the United Kingdom a combination of Essix and fixed retention is most commonly prescribed.[17] Fixed retention in both arches seems to be preferred in the Netherlands.[18] When orthodontists in the United States were surveyed, more than half indicated that the most commonly used retainers are maxillary Hawley and mandibular fixed retainers. However, there has been an increase in the use of Essix retainers in the past few years.[19,20]

Compliance may be affected by gender,[21] age,[7] patient satisfaction,[22] and appliance comfort and esthetics.[7] It has been suggested that involving patients in the decision-making process pertaining to retention protocols increases compliance.[22] Pratt et al[7] found that long-term patient compliance was affected by retainer type. Vacuum formed retainers were worn more frequently immediately post- debond,

but in the long term patients were more compliant with Hawley retainers. Also, a limited number of patients wore their retainers as instructed five years post debond.[7] Wong and Freer[21] reported a strong relationship between appliance comfort and compliance with use. In addition, they found that forgetfulness contributed to 50% of reported non-compliance. Generally females are more compliant with retainer wear, and compliance with retainers decreases with time.[21]

In 1999 Bennett and Tulloch[23] conducted a study to understand orthodontic treatment satisfaction from the patients' perspective. They found that patients were generally satisfied with the treatment outcomes, but overall there may be differences in patients' versus orthodontists' perceptions of the treatment process. Mollov et al,[24] found that most respondents were satisfied with tooth alignment both at the end of treatment and at the time of the study, but there was a 40% decrease in satisfaction since the end of active treatment. Also, 88% of the patients perceived orthodontic retention as their own responsibility. Patients who did not accept any responsibility towards retention were more likely to be unhappy with the stability of their dentition.

Al-Omiri[25] used 'dental impact on daily living' questionnaires to study patient satisfaction. He found that 34% of the subjects were completely satisfied with their teeth post treatment and 4% were dissatisfied. There was no association between sex, age, pretreatment extractions and patient satisfaction. On the other hand, personality, neuroticism scores and pain during treatment were correlated with degrees of patient satisfaction.[25] Another study showed a level of dissatisfaction amongst 29% of the adolescent population.[26] Levels of satisfaction can be influenced by unattainable expectations.[27]

Retention is an important aspect of orthodontic treatment and may influence the long-term outcome of the treatment and the satisfaction level of patients with orthodontic treatment. At present, a few studies pertaining to the individual factors affecting retention have been published, but there is a lack of consensus and a paucity of publications attempting to co-relate individual components. The objectives of this study examining orthodontic retention are:

1. To identify commonly used orthodontic retainers and assess patient satisfaction with these retainers in relation to the following pre-defined variables: appearance, speech, oral hygiene, retainer hygiene, need for replacement retainers and preferred retainers.

2. To determine patient compliance with various retention protocols and regimens utilized.

3. To evaluate patient satisfaction with the alignment and fit of their dentition immediately post-treatment and after a period of retention.

LITERATURE REVIEW

Resources used to conduct an extensive literature review included: PUBMED/Medline, OVID, CINAHL, EMBASE, BIOSIS and Dissertations and Theses. Search terms included: orthodontic*, retention*, retainer*, guideline*, principle*, satisfact*, adhere*, patient*, complian*, Essix, Hawley, bonded and Fixed retainer.

STABILITY OF ORTHODONTIC TREATMENT

Retention pertains to maintaining the stability of the dentition in the newly acquired position. Understanding relapse builds the basis for establishing retention protocols. Melrose and Millett,[5] in a review article, highlight knowledge pertaining to the origin of post treatment relapse and discuss factors of consideration in planning retention. Forces from the orofacial soft tissues determine the final tooth positions. The lower labial segment must be maintained within the narrow labio-lingual balance zone. The existing lower archform is the guide to soft tissue balance and overjet stability is achieved when a lip seal is possible. Stable overbite, a favorable interincisal angle, well interdigitating occlusion and finishing to gnathological principles of functional occlusion encourage stability. Typically post treatment occlusion responds to growth changes with dentoalveolar adaptation. This can manifest as lower labial segment crowding except in cases of significant mandibular forward growth. Factors contributing to lower incisor crowding after retention include mesio-distal incisor dimension, arch length deficiency, soft tissue factors, mesial drift, growth changes and residual Class II or Class III molar relationships.[28]

Little et al[8] found that no descriptive features including characteristics like length of retention or overbite/overjet were of value in predicting the long-term results. Even when initial intercanine width is maintained, arch dimensions of width and length typically decrease after retention. Success at maintaining mandibular anterior alignment is less than 30%.[29] As few as 10% of the cases that Little et al[9] analyzed showed clinically acceptable mandibular alignment twenty years post retention. Erdinc and his colleagues[30] stated that extraction of premolars does not influence incisor stability. Relapse tends to occur well beyond the period of growth cessation and the only way to ensure satisfaction and stability is to use fixed or removable retention for life.[9] Patients must always be advised of the limitations of our professional goals.

Housley[31] looked at the stability of transverse expansion in the mandibular arch and concluded that transverse expansion was more stable in the posterior region of the mandibular arch. Expansion in the anterior region showed greater evidence of relapse. Mandibular intercanine width must be maintained with fixed retainers to prevent incisor irregularity.[31] Dugoni[32] found a reduction in intercanine width post retention in patients treated during the early mixed dentition stage.

A systematic review on anterior open bite and stability of treatment demonstrated that there is no high level controlled evidence on the stability of this type of treatment. Case series with follow-ups show a small degree of relapse with both surgical and nonsurgical treatment of open bites. Stability of either modality is greater than 75%.[33]

Ormiston and colleagues did a more recent retrospective analysis of long-term stability. The study illustrated that initial severity of the malocclusion was correlated with post retention instability. Patients with more severe pretreatment index scores were less stable. Male sex and sustained longer periods of growth were both factors associated with instability. High quality treatment results deteriorated with time, while lower quality results improved.[34] In a ten year post retention study on stability of treatment PAR (Peer Assessment Rating) index scores were used and multiple post-retention scores were obtained at two, five and ten year intervals. It was found that 67% of orthodontic treatment results were retained ten years post retention. Half of total relapse appears to occur during the first two years after retention, most occlusal traits deteriorate till five years post retention and then stabilize. Lower anterior contact point displacement continues to deteriorate beyond initial PAR scores and the five year post retention period.[35]

In an article titled "*Relapse revisited – again*", Dyer et al[36] attempted to assess relapse twenty-four years post debond. Study participants were given a maxillary Hawley retainer and a mandibular Hawley or fixed retainer at debond and retention was a period of two to three years. Overjet, overbite, angles canine and molar classification and incisor irregularity were measured. They found that orthodontic treatment could yield relatively good long-term stability in tooth alignment. Mandibular incisor irregularity was generally less than 3.5mm, maxillary incisor positions remained stable over time, overjet increased 0.9mm and overbite lost was approximately 0.6mm. Overall it was noted that teeth are in a dynamic ever-changing relationship with their environment but the amount of change decreases as time lapses. A concern pertaining to the study was sample bias – participants wanted to know what could be done about their relapse and it is likely that patients who were extremely unhappy with their orthodontic experience did not participate.[36]

A literature review on changes in mandibular crowding in the post retention phase concluded that mandibular incisor relapse appeared to be minimal when palatal expansion was combined with prolonged retention.[37] The authors suggest that further randomized control trials would be needed in the area to provide concrete support for this statement.[37] In 2002, Lang et al[38] conducted a study on relapse and concluded that comprehensive long-term retention should be used when the treatment time is short and when therapy is started before the age of nine. Retention requirements may be reduced if a purely functional occlusion can be obtained with removable appliances and if treatment is conducted between the ages of nine and twelve years. The risk of relapse is the indicator for fixed retention. Therefore bonded retainers should be considered in male patients, non-extraction cases and after a marked decrease in overbite. Removable retainers were recommended if transverse stability of the posterior segments was of

concern, particularly in extraction cases, expansion cases and in females when the mandible has been treated with posterior uprighting. Retention periods should be at least two years. Their study was based on measuring mean therapeutic, post therapeutic and relapse related changes.[38] Cronau et al[39] advocated the use of a retention catalogue to convey information to patients on the causes and prevention of relapse. They indicate that routine use of the catalogue would contribute to successful retention management and offer legal protection for the orthodontist.

Littlewood's[4] systematic review on retention procedures for stabilizing tooth positions assessed randomized control trials and quasi-randomized controlled trials. A comparison between circumferential supracrestal fiberotomies (CSF) combined with removable retainer use versus only removable retainer wear portrayed statistically significant increases in stability in the maxillary and mandibular segments when CSF was used, and no adverse effects on the gingiva were noted. No differences were found between the survival rates of the different types of removable versus fixed lower retainers. Overall the studies analyzed had small sample sizes and insufficient data upon which to produce clinical practice guidelines. The review concluded that CSF may be a valuable adjunct procedure, and Hawley retainers worn full time may allow greater settling of the occlusion when compared to Essix retainers.[4] Edwards[40] stated that the CSF procedure was more successful in reducing relapse in the maxillary arch than the mandibular. Housley[31] found CSF to be more efficient in alleviating pure rotational relapse.

Patients should be advised of the fact that the retention phase is a part of overall treatment. Retention devices should be based on knowledge of individuals' anticipated magnitude and direction of growth. For example, overcorrection can be used during finishing a Class II case in some circumstances. Controlling the eruption of upper molars in retention patients with anterior open bite correction, indefinite retention in the lower labial segment, adjunctive procedures for rotated teeth, and permanent retention for periodontally aligned teeth and space closure in spaced dentition, are other means of increasing post treatment stability. Soft tissue adjunctive procedures include CSF, gingivoplasty, frenectomy and interproximal stripping.[2,12,41]

PATIENT SATISFACTION

In a systematic review on long-term stability of orthodontic treatment and patient satisfaction, Bondemark et al[42] concluded that there is insufficient scientific evidence to make any clinically relevant statement pertaining to patient satisfaction.[42] Sinha et al[43] studied perceived orthodontist behaviours that predict patient satisfaction, including but not limited to orthodontist patient relationships. Patients completed surveys that included an orthodontist behavior questionnaire, a visit satisfaction scale, orthodontist-patient relationship evaluation and a patient cooperation scale. In a sample of teenagers (mean age 14.4yrs +2.4yrs) they found that patients generally think that the doctor patient interaction should be warm. If the expectations are not met overall dissatisfaction follows. Eight behaviors were found to correlate with

satisfaction: doctor politeness, verbal communication of information, reassurance, concern, confidence, and unhurried mannerisms all affected patient satisfaction. The most important factor was politeness towards the patient – *criticism had a negative influence on patient cooperation*. Concern for wellbeing, on the other hand, had a positive influence. This study acknowledged that the results might be different for different age groups.[43] Keles et al[44] found similar results when they used a questionnaire to evaluate patient satisfaction with orthodontic treatment in a sample of patients from the Academic Centre for Dentistry, Netherlands. The most important factor contributing to patient satisfaction was the doctor-patient relationship. Gender had no significant correlation with patient satisfaction. They also found that overall patient satisfaction towards orthodontic treatment has increased over the past decade.[44]

In 2006 Al-Omiri and Alhaija[25] published a study designed to define the factors that affect patient satisfaction after orthodontic treatment. Their sample group received upper Hawley and lower bonded retainers, following fixed orthodontic treatment. Dental impact on daily living questionnaires identified that personality and satisfaction were correlated. Patients with high neurotism scores were associated with lower levels of satisfaction. Total satisfaction was associated with oral comfort, eating capacities, and pain dimensions during treatment. Interestingly they found that age, sex and pretreatment orthodontic treatment need had no relationship with patient satisfaction. However non-extraction patients were more dissatisfied with their dentition.[25]

A publication on the effects of orthodontics on the quality of life of young Brazilians found that patients who received orthodontic treatment had higher health related quality of life scores than non-treated subjects did.[45] Mollov et al[46] studied patient satisfaction at the end of active orthodontic treatment and after retention devices had been removed. They found that most patients (96%) were satisfied with the orthodontic treatment rendered both at the end of treatment and after a post retention period. 88% of the patients they surveyed also indicated that they were responsible for maintaining the alignment and fit of their teeth after treatment has been completed. They found a strong correlation between those who indicated that they were not responsible for the retention of their dentition post-treatment and those dissatisfied with treatment results. Patients with Essix retainers were more satisfied than patients with Hawley or bonded retainers.[24]

RETAINERS

The type of retainer a patient receives may affect their compliance in the use of the retainer, and directly or indirectly, affect the stability of the orthodontic results. In North America commonly used retainers include bonded, Hawley and Essix retainers. Prescription is based on clinical indications and practitioner personal preferences.[7,15]

Figure 1 Bonded Retainer

Indications for bonded retainers (Figure 1) include: severe pre-treatment lower incisor crowding or rotation, planned alteration in the lower intercanine width, advancement of the lower incisors during treatment and deep overbite correction.[47] Different types of wires and composites have been used in bonded retainers. Multistranded wires are increasing in popularity due to their ability to allow physiologic tooth movement. Flexible bonded retainers are recommended for cases that started with: a median diastema, spaced anterior teeth, tooth migration, loss of maxillary incisors followed by space closure, space reopening, rotated maxillary incisors, and palatally impacted canines.[48] Failure rates of bonded retainers range from 10-47%. The failure rate in the maxilla is twice that of the mandible.[49] Stormann and Ehmer[50] investigated canine-and-canine retainers (bonded to two teeth) as compared to different sizes of canine-to-canine (bonded to six teeth) retainers. They found that the canine-and-canine retainer displayed a lower detachment rate. The .0215 canine-to-canine retainer had the highest detachment rate. Incisors were more stable in the canine-to-canine retained dentition, and patients reported a higher rate of subjective discomfort with the canine-and-canine retainers. Plaque accumulation increased with all types of fixed retainers.[50] A study on gingival health, plaque accumulation, tooth stability and integrity of multistranded and round wire bonded lingual retainers found more plaque on the distal surfaces of the lower anterior dentition in subjects with multistanded retainers, however, these multistranded retainers were better at maintaining incisor alignment.[51]

Figure 2 Hawley Retainer

Indications for Hawley retainers (Figure 2) include: deep bite cases (anterior bite plate addition), minor movement of the anterior teeth (adjustment of the labial bow), holding transverse expansions and bite settling.[12,14,52] Hawley retainers are durable and portray relatively long survival rates.[21] Kumar et al[14] reported that patients found it easy to chew and bite with Hawley retainers in place and that stability after six months of retention was similar to Essix retainers. Kulak et al stated that these retainers interfere with speech, however, over time the tongue adapts to the new position.[53] Takeuchi et al[54] found four Lactobacillus species and one Propioni bacterium species within the acrylic used to make denture bases and Hawley retainers.

Figure 3 Essix Retainer

Essix retainers (Figure 3) are made from various types of plastic materials. Type A materials are more esthetic/clear but they tend to tear and crack. Type C materials are sturdier but their mechanical retention is not as good as Type A. Type Ace materials combine the positive qualities of the other two materials however they discolour and are not as durable as Type C.[12] Some indications for the use of Essix retainers are: to hold rotations especially in the posterior, retention in patients concerned about esthetics, open bite cases and cases requiring minor tooth movement.[12,28,55] The retainers are easy to fabricate and are fairly inexpensive. Millet et al [28] studied bonded retainers and Essix retainers in the mandibular arch and evaluated outcome measures of relapse in alignment and periodontal health of the lower incisors. Patients preferred bonded retainers and the clinicians preferred Essix retainers. Relapse was higher with Essix retainers due to the fact that they were more easily lost or broken. They also found that the group with the bonded retainers had mildly increased gingival inflammation and periodontal pockets as compared to the group with the Essix retainers. Neither group had an increased rate of decay in the lower incisor region.[28] In a randomized clinical control trial, Rowland and colleagues[52] compared Essix retainers and Hawley retainers during the first six months after debond. Essix retainers were more cost effective to produce and

patients preferred wearing them as compared to Hawley retainers. In terms of relapse prevention there was no difference between the retainers in the maxillary arch. In the mandibular arch Essix retainers appeared to be more effective in preventing relapse probably because of increased compliance in terms of use of the retainers.[52]

In 1997, Artun et al[56] compared one removable retainer and different types of bonded retainers. After following patients for three years, there was no difference in the survival rates of the various retainers. It is noted that the sample size was small and the data did not include standard deviations.

PRESCRIBED RETENTION PROTOCOLS

In 2010 Valiathan and Hughes[20] used a systematic survey instrument and a stratified random sample, to shed light on prescribed retention protocols in the United States. They found that in the maxillary arch the sequence of prescribed retainers from most to least prescribed is Hawley, Essix, bonded and spring. In the mandible the sequence was bonded, Hawley, Essix and spring. Patients given Hawley retainers were asked to wear them full-time more frequently than patients who used Essix retainers. When prescribed full-time retainer wear, patients with Hawley's were asked to wear them for a longer duration (six to nine months) than patients with Essix retainers (three months). Eighty-four percent of orthodontists who use removable retainers prescribe lifetime retainer wear. Orthodontists who have practiced less than sixteen years tended to instruct lifetime retention more often than older orthodontists. Retention appointments are scheduled at one, three, six and eleven month intervals. Patients were usually dismissed after the fifth appointment. They found different retention protocols depending on the gender of the orthodontist, number of years in practice, volume of patients in the practice and the geographic location of the practice.[20]

Gill and his colleagues[57] assessed Little's index, intercanine width, intermolar width, overjet and overbite at debond and six months after debond. They found no differences in these parameters, in groups prescribed part-time retainer wear and groups prescribed full-time retainer wear, after orthodontic therapy. Via a randomized clinical trial Thickett and Power[58] attempted to determine if thermoplastic retainers need to be worn full-time or whether part-time wear is adequate to prevent relapse. Study models were used to assess tooth movement. They found no real difference in relapse whether the Essix retainers were worn full-time or part-time. They concluded that part-time retainer wear can be advised for patients who have undergone extraction orthodontic treatment.[58]

In 2004 Wong and Freer[10] found that Australian and New Zealand orthodontists most often used the Essix appliance in the maxilla and canine to canine bonded retainers in the mandible. Multistranded wires were most often used as bonded retainers, followed by stainless steel wires. The position of the teeth prior to treatment dictated the type of retainer prescribed. Of the orthodontists surveyed, most recommended a

retention period greater than two years. There was some variation in the full-time followed by part-time retention protocols prescribed by Australian and New Zealand orthodontists. Some practitioners commonly used permanent retention, while others demonstrated minimal use of long term retention. There was no identifiable influencing factor.[10]

Keim et al[19] identified the most commonly used retainers in the US as bonded, Essix and Hawley retainers. Pratt and colleagues[19] used an electronic survey with branching logic to survey orthodontists in the United States. Their study depicted that US orthodontists primarily used Hawley and Essix retainers in the maxillary arch and bonded retainers in the mandibular arch. In general, practitioners in the US have been shifting away from the use of Hawleys and replacing them with Essix retainers. Fixed retention patterns seem to be linked to extraction patterns. Non-extraction treatments were associated with increased use of bonded retainers. If removable retainers are used they are typically prescribed for a lifetime. Fifty-six percent of orthodontists believed that patients are more compliant with Essix retainers. They also found that orthodontists tend to overestimate compliance with removable retainers at the five year post-retention mark.[19]

COMPLIANCE WITH RETAINER WEAR

In 2011 Pratt et al[15] reported on a study investigating patient compliance with short-term and long-term retention. They looked at age, length of time since debonding, sex, retainer type, retention protocols prescribed, regimens for retainer wear and reasons for non-compliance. A significant finding was that patients provided with Essix retainers were more compliant with wearing them as compared to patients given Hawley retainers, from the day that they were debonded to two years post-debond. After the two year period, compliance increased in the Hawley retainer group. Overall, it was found that long-term compliance was greater in the Hawley retainer group. Functional wear was suggested as a potential cause of the decrease in use of the Essix retainers over time. Esthetics was not related to compliance with retainer use. Females were more likely than males to wear their retainers; and younger patients demonstrated more initial compliance than older patients did; but this decreased with time. For removable appliances they recommended the initial use of Essix retainers with a transition to Hawley retainers. However, overall compliance with removable retainers was low and fixed retention was recommended when possible.[15]

In a randomized clinical control trial to assess patient compliance with retainer wear, microsensors were implanted into removable retainers. The authors found that patients who knew the researchers could track retainer use, wore the retainer for longer periods of time than patients who did not know. Patients who indicated full time retainer wear, actually wore the retainer for 4.3 hours more per day than those reporting part time usage. Patients who inaccurately reported retainer use, wore their retainers, on average, 12.4 hours less per day than those who accurately reported their retainer use.[59] Mehra et al[27] found that verbal

praise, the patient's desire for treatment and interest in their malocclusion and esthetics, enhance compliance. They noted that age and sex did not affect compliance and that patients who follow instructions tended to have high self-esteem. [27] Kaplan[60] recommended involving patients in the decision pertaining to retention. He suggested, once patients are informed of the high rate of relapse, they may be more compliant with retention protocols.

Wong et al[21] investigated the effect of appliance comfort and appearance on compliance. They found that in the maxillary arch there was a positive relationship between compliance, comfort level and the appearance of the retainers. In the mandibular arch a similar relationship was not noted and the reason was citied as an inconsistency in reporting comfort and compliance. Patients with bonded retainers tended to like the appearance of their retainers better and found them more comfortable than removable retainers. Patients in private practice were more compliant than patients at the dental school. Patients at the dental school found their removable retainers less comfortable. Wong and his colleagues[21] identified the problem with mailed surveys as the low patient response rates. Also, individuals responding to the survey may vary greatly from the individuals choosing not to, thereby limiting the generalizability of the results. Confounding factors such as patient motivation and orthodontist/patient relationships were other limitations of the study.[21]

Another study attempted to identify the number of hours per day and per week that patients wore their retainers during the first two years after active treatment. In the first three months after debond, 27% of the patients wore their retainers 16-24 hours, 36% wore them less than 10 hours per day, and 4% did not wear them at all. From 19-24 months after debond, 19% of patients did not wear their retainers at all. Compliance rates dropped from 69% in the first three months to 55% at 7-9months and 45% at 19-24 months. Only 4% of patients reported not wearing their retainers over the first three months after the brackets were removed. They found no difference in retainer wear based on age, sex or type of retainer. One third of respondents were non-compliant with wearing their retainers full time immediately after active treatment. However, 80% wore their retainer at least one night per week after two years of retention. Non-responders were not characterized in the study.[6]

METHODS AND MATERIALS

The thesis was designed as a cross-sectional study conducted via patient questionnaires. A combination of various aspects of previous studies, tested questions and response sets[7,10,14,15,20,21,46,61] and researched methodology for survey design[62] were implemented.

SURVEY INSTRUMENT

Each questionnaire consisted of 149 questions divided into three sections: a) satisfaction with orthodontic treatment and perceived occlusal stability, and retention protocols for the b) maxilla and c) mandible. The sections on the maxilla and mandible were further divided into three subsections each: Hawley, Essix and bonded retainers.

The first section contained questions on patient satisfaction with the treatment rendered and treatment stability during the retention period. The second and third sections contained questions on prescribed retainers and retention protocols, patient compliance, and patient satisfaction with particular retainers according to the following variables: esthetics, speech, hygiene and durability. The questionnaire included identifiers that allowed patients to be classified into subgroups based on demographic data such as age, gender and time since removal of orthodontic appliances. Five patients were recruited to validate the content of the questionnaire and their responses were not included in the analysis as. The response sets were used as a mini-pilot to test the questions in the survey and modify them as needed.

A sample of the paper version of the survey is available in Appendix A.

The Survey System software (Creative Research Systems, Pentaluma CA) was used to create an electronic version of the survey with advanced skip and branching logic. Photographic visual aids were used in the electronic version and patients responded to questions pertaining to the retainers they received. The survey was uploaded to an android tablet (Acer Iconia A200) and administered to patients via the tablet. The average number of questions answered by an individual with one upper and one lower retainer was 55.

All questions contained multiple-choice responses. When “other” was selected as an answer, the patient was given the opportunity to provide a typed response. Likert scales were used for satisfaction questions.

SAMPLE SIZE

Using the results obtained by Kumar and Bansal[14] as a guide, a sample size of 26 participants per group was calculated ($N = 13x[(2x0.5^2)/0.5^2$ with alpha = 0.05, power = 0.95 and standard deviation = 0.5).

This translates to a total of 150 prescribed retainers (25 respondents for each of the six groups).

RESEARCH PROTOCOL

The Health Sciences Review Board at Western University, London, Ontario approved all procedures and protocols for this study. Data was collected under Research Ethics Board approval #: 102797. Notice of HRSEB approval is available in Appendix B.

The inclusion criteria were: patients of the Graduate Orthodontic Clinic at Western University, patients who had undergone orthodontic treatment with full fixed appliances, a minimum of one year after orthodontic appliances have been removed, attendance at a one or two year retention follow-up appointment and the ability to provide consent.

Patients were recruited as they attended one year and two year regularly scheduled post-debond retention appointments. Patients were given details pertaining to the study, their participation was requested and they were advised that their responses would remain confidential and non-participation would not affect their treatment at the clinic in any manner. A copy of the informed consent form is available in Appendix C. Each patient, who provided informed consent, completed the survey using an android tablet. The data was collected over a nine month period and was stored under password protection at all times.

STATISTICAL ANALYSIS

The data was imported into SPSS Statistics 21.0.0. Frequencies, Distributions, Pearson Chi Squares and Fishers Exact tests were used to analyze the data. Responses such as *Very unhappy* & *Somewhat unhappy*, and *Very happy* & *Somewhat happy*, were collapsed into single groups of *Happy* or *Unhappy*, due to small cell sizes. When neutral responses such as *Neither happy nor unhappy* had cell size of less than 5 they were treated as missing data, as these responses did not influence the interpretation of our results. Data was analyzed independently for the maxillary and mandibular arches. Cross tabulations, Chi Square and Fisher's Exact tests were used to detect associations between the independent variables (age, gender, time since debond) and dependent variables (satisfaction with alignment and occlusion); and associations between types of retainers and prescribed protocols, and satisfaction with the retainers. Significance of all tests was set at $p<0.05$.

RESULTS

Of the 132 patients requested to fill in the survey at their retention appointment, only one patient refused participation citing a lack of time. The response rate was 99% with a sample size of 131 patients. The average time taken to respond to the survey was 10-15 minutes.

SAMPLE DEMOGRAPHICS

The sample demographics are presented in Table 1.

Table 1 Sample Demographics

		Frequency / N	Percent %
Age (yrs)	13.00-16.99	34	26
	17.00-20.99	73	55.7
	>21.00	24	18.3
Gender	Male	47	35.9
	Female	84	64.1
How long ago were your braces removed?	1yr	58	44.3
	2yrs	73	55.7
	Total	131	100

RETAINER DISTRIBUTION

The distribution of prescribed retainers is presented in Table 2. The association between retainer type and arch was statistically significant.

Table 2 Retainer Distribution

	Maxillary N(Percent)	Mandibular N(Percent)
Bonded	26 (13.8)	67 (46.2)
Essix	93 (49.5)	61 (42.1)
Hawley	69 (36.7)	17 (11.7)
Total	191 (100.0)	145 (100.0)

chi square p<0.001

All retainers prescribed per patient were also assessed. Some patients received more than one retainer during the retention period. Groups were created according to the multiple retainers they received per arch. The distribution of retainer protocols for the maxilla and mandible are presented in Figure 4 and Figure 5 respectively.

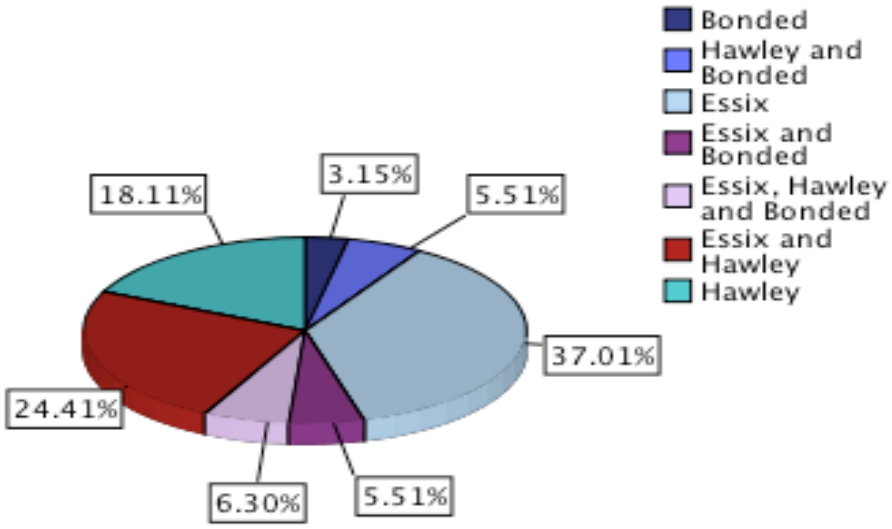


Figure 4 Combinations of Maxillary Retainers Prescribed Per Patient

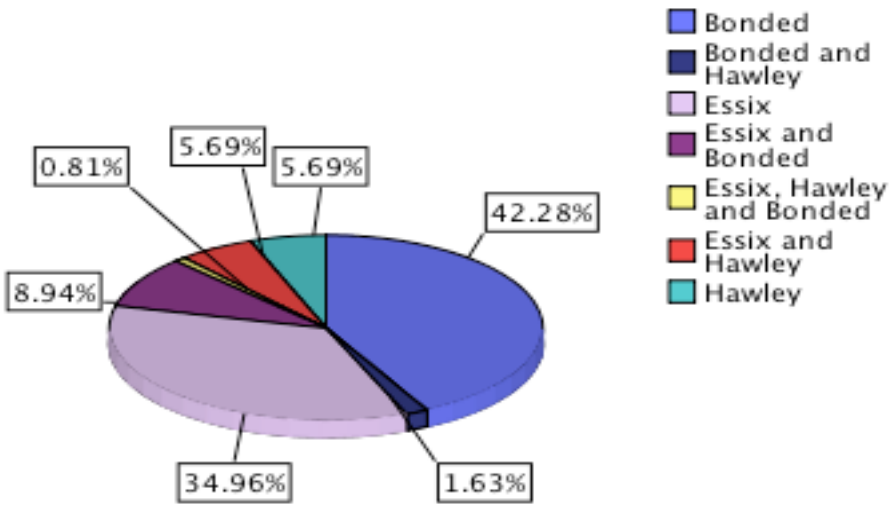


Figure 5 Combinations of Mandibular Retainers Prescribed Per Patient

Demographics

Tables 3,4,56,57 present retainers prescribed for the maxillary arch and the mandibular arch, based on age, gender and time in retention.

No statistically significant associations were noted between individual retainers or groups of retainers prescribed per patient and the sample demographics (age, gender or time since debond), with respect to the maxilla or mandible ($p>0.05$). It was noted that more females (10%) than males (0%) received all three types of maxillary retainers.

Table 3 Maxillary Retainer Prescribed By Demographics

		Maxillary Retainer Prescribed			Total
		Bonded	Essix	Hawley	
Age (yrs)	13.00- 16.99	5 (10.9%)	25 (54.3%)	16 (34.8%)	46
	17.00-20.99	16 (14.8%)	50 (46.3%)	42 (38.9%)	108
	>21.00	5 (14.7%)	18 (52.9%)	11 (32.4%)	34
			p=0.86		
Gender	Male	4 (6.9%)	33 (56.9%)	21 (36.2%)	58
	Female	22 (16.9%)	60 (46.2%)	48 (36.9%)	130
			p=0.14		
Time since debond	1yr	13(14.3%)	44(48.4%)	34(37.4%)	91
	2yrs	13(13.4%)	49(50.5%)	35(36.1%)	97
			p=0.14		
	Total	26(13.8%)	93(49.5%)	69(36.7%)	188(100.0%)

Data has been collapsed into individual retainer groups. For data pertaining to groups of maxillary retainers prescribed per patient refer to Table 56.

Table 4 Mandibular Retainer Prescribed By Demographics

		Mandibular Retainers Prescribed			Total
		Bonded	Essix	Hawley	
Age (yrs)	13.00- 16.99	19 (52.8%)	14 (38.9%)	3 (8.3%)	36
	17.00-20.99	36 (43.4%)	34 (41.0%)	13 (15.7%)	83
	>21.00	12 (46.2%)	13 (50.0%)	1 (3.8%)	26
			p=0.49		
Gender	Male	23 (44.2%)	23 (44.2%)	6 (11.5%)	52
	Female	44 (47.3%)	38 (40.9%)	11 (11.8%)	93
			p=0.9		
Time since debond	1yr	28(42.4%)	32(48.5%)	6(9.1%)	66
	2yrs	39(49.4%)	29(36.7%)	11(13.9%)	79
			p=0.3		
	Total per category	67(46.2%)	61(42.1%)	17(11.7%)	145(100.0%)

Data has been collapsed into individual retainer groups. For data pertaining to groups of mandibular retainers prescribed per patient refer to Table 57.

SATISFACTION WITH TREATMENT AND RETENTION

Tables 5-7 present patient satisfaction with treatment and retention, in the maxillary arch, mandibular arch and occlusion respectively, based on age, gender, time in retention and type of retainer prescribed. Approximately 90% of the patients were satisfied with their maxillary dentition, mandibular dentition and their occlusion at debond. Satisfaction decreased slightly to 88% at the retention appointment.

Demographics

The associations between age and satisfaction with treatment were not statistically significant at debond or retention ($p>0.05$). A statistically significant difference between males and females and the satisfaction with the alignment of their mandibular dentition and occlusion, was noted at debond ($p<0.05$). More males (98%) as compared to females (87%) were happy with their lower teeth ($p=0.05$) and their bite ($p=0.048$), at debond. This trend was also noted in the maxillary arch at debond, but it was not statistically significant. There were no significant associations between 'time in retention' and 'satisfaction with the maxillary dentition', 'mandibular dentition' or the 'occlusion' ($p>0.05$).

Retainers Prescribed

The groups of maxillary retainers prescribed per patient were significantly associated with satisfaction with the maxillary occlusion at debond only (Table 5, $p=0.03$). Patients who received only maxillary Essix or Hawley retainers were most likely to be satisfied with their maxillary occlusion at debond (96%). Receiving all three retainers was associated with reduced satisfaction (63%).

The effects of having one retainer, on the responses pertaining to the second type of retainer, were analyzed to determine the effects of this confounding factor. If patients received a maxillary or mandibular Essix only, they were most likely to be happy with their teeth at debond (95%). Receiving an Essix and another maxillary or mandibular retainer was significantly associated with a reduced degree of satisfaction at debond (78-82%) (Table 8, $p=0.04$; Table 9, $p=0.026$).

Table 5 Satisfaction With The Maxillary Dentition And Associations With The Demographics and Retainer Prescribed

		Satisfaction with the upper teeth at debond		Satisfaction with the upper teeth today	
		Unhappy	Happy	Unhappy	Happy
Age	13.00- 16.99	3(8.8%)	31(91.2%)	4(11.8%)	30(88.2%)
	17.00-20.99	9(12.5%)	63(87.5%)	8(11.0%)	65(89.0%)
	>21.00	2(8.3%)	22(91.7%)	4(18.2%)	18(81.8%)
		p=.86		p=.66	
Gender	Male	2(4.3%)	45(95.7%)	4(8.9%)	41(91.1%)
	Female	12(14.5%)	71(85.5%)	12(14.3%)	72(85.7%)
		p=.08		p=.58	
Time since debond	1yr	7(11.9%)	52(88.1%)	7(11.9%)	52(88.1%)
	2yrs	7(9.9%)	64(90.2%)	9(12.9%)	61(87.1%)
		p=.78		p=.86	
Maxillary Retainer Prescribed	Bonded	1(25.0%)	3(75.0%)	0(0,0%)	4(100.0%)
	Hawley and Bonded	2(28.6.%)	5(71.4%)	2(28.6%)	5(71.4%)
	Essix	2(4.3%)	45(95.7%)	5(10.9%)	41(89.2%)
	Essix and Bonded	1(14.3%)	6(85.7%)	1(16.7%)	5(83.3%)
	Essix, Hawley and Bonded	3(37.5%)	5(62.5%)	2(25.0%)	6(75.0%)
	Essix and Hawley	4(13.3%)	26(86.7%)	4(12.9%)	27(87.1%)
	Hawley	1(4.3%)	22(95.7%)	2(8.7%)	21(91.3%)
	No Retainer	0(0.0%)	4(100.0%)	0(0.0%)	4(100.0%)
		**p=.03		p=.6	
	Total per category	14(10.7%)	116((89.3%)	16(12.4%)	113(87.6%)

Table 6 Satisfaction With The Mandibular Dentition And Associations With The Demographics and Retainers Prescribed

		Satisfaction with the lower teeth at debond		Satisfaction with the lower teeth today	
		Unhappy	Happy	Unhappy	Happy
Age	13.00- 16.99	3(8.8%)	31(91.2%)	4(12.5%)	28(87.5%)
	17.00-20.99	7(9.9%)	64(90.1%)	7(9.9%)	64(90.1%)
	>21.00	2(8.3%)	22(91.7%)	3(13.0%)	20(87.0%)
		p=1.0		p=.79	
Gender	Male	1(2.2%)	45(97.8%)	2(4.7%)	41(95.3%)
	Female	11(13.3%)	72(86.7%)	12(14.5%)	71(88.9%)
		**p=.05		p=.14	
Time since debond	1yr	5(8.5%)	54(91.5%)	7(11.9%)	52(88.1%)
	2yrs	7(10.0%)	63(90%)	7(10.4%)	60(89.6%)
		p=1.0		p=1.0	
Mandibular Retainer Prescribed	Bonded	5(9.6%)	47(90.4%)	4(8.0%)	46(92.0%)
	Hawley and Bonded	0(0.0%)	2(100.0%)	0(0.0%)	2(100.0%)
	Essix	2(4.7%)	41(95.3%)	5(12.2%)	36(87.8%)
	Essix and Bonded	1(10.0%)	9(90.0%)	1(91.%)	10(90.9%)
	Essix, Hawley and Bonded	0(0.0%)	1(100.0%)	0(0.0%)	1(100.0%)
	Essix and Hawley	3(42.9%)	4(57.1%)	3(42.9%)	4(57.1%)
	Hawley	1(14.3%)	6(85.7%)	1(14.3%)	6(85.7%)
	No Retainer	0(0.0%)	7(100.0%)	0(0.0%)	7(100%)
		p=.12		p=.26	
	Total per category	12(9.4%)	117(90.6%)	12(11.1%)	112(88.9%)

Table 7 Satisfaction With The Occlusion And Associations With The Demographics And Retainers

		Satisfaction with the bite at debond		Satisfaction with the bite today	
		Unhappy	Happy	Unhappy	Happy
Age	13.00- 16.99	3(8.8%)	31(91.2%)	3(9.1%)	30(90.9%)
	17.00-20.99	7(10.1%)	62(89.9%)	8(11.8%)	60(88.2%)
	>21.00	2(8.7%)	21(91.3%)	4(20.0%)	16(80.0%)
		p=1.0		p=.51	
Gender	Male	1(2.3%)	42(97.7%)	3(7.3%)	38(92.7%)
	Female	11(13.3%)	72(86.7%)	12(15.0%)	68(85.0%)
		**p=.05		p=.26	
Time since debond	1yr	5(8.8%)	52(91.2%)	7(13.2%)	75(86.8%)
	2yrs	7(10.1%)	62(89.9%)	8(11.8%)	60(88.2%)
		p=.79		p=.81	
Maxillary Retainer Prescribed	Bonded	0(0.0%)	4(100%)	0(0.0%)	4(100.0%)
	Hawley and Bonded	2(28.6%)	5(71.4%)	2(33.3%)	4(66.7%)
	Essix	2(4.3%)	44(95.7%)	5(11.9%)	37(88.1%)
	Essix and Bonded	1(14.3%)	6(85.7%)	1(14.3%)	6(85.7%)
	Essix, Hawley and Bonded	2(25.0%)	6(75.0%)	2(25.0%)	6(75.0%)
	Essix and Hawley	4(13.3%)	26(86.7%)	3(10.3%)	26(89.7%)
	Hawley	1(5.0%)	19(95.0%)	2(9.5%)	19(90.5%)
	No Retainer	0(0.0%)	4(100.0%)	0(0.0%0	4(100.0%)
		P=.15		p=.56	
Mandibular Retainer Prescribed	Bonded	5(9.8%)	46(90.2%)	7(13.7%)	44(86.3%)
	Hawley and Bonded	0(0.0%)	2(100.0%)	0(0.0%)	2(100.0%)
	Essix	2(4.8%)	40(95.2%)	3(7.9%)	35(92.1%)
	Essix and Bonded	1(10.0%)	9(90.0%)	1(12.5%)	7(87.5%)
	Essix, Hawley and Bonded	0(0.0%)	1(100.0%)	0(0.0%)	1(100.0%)
	Essix and Hawley	3(42.9%)	4(57.1%)	3(42.9%)	4(57.1%)
	Hawley	1(14.3%)	6(85.7%)	1(14.3%)	6(85.7%)
	No Retainer	0(0.0%)	4(100.0%)	0(0.0%)	7(100.0%)
		p=.13		p=.32	
	Total per category	12(9.5%)	114(90.5%)	15(12.4%)	106(87.6%)

Table 8 Maxillary Essix/Exposure To Another Retainer In Addition To the Essix By Satisfaction With The Maxillary Dentition At Debond

		Happy with your upper teeth at debond		Total
		Unhappy	Happy	
	Maxillary Essix plus another retainer	8(17.8%)	37(82.2%)	45
	Essix	2(4.3%)	45(95.7%)	47
Total		10(10.9%)	82(89.1%)	92(100.0%)

fisher's exact p=0.04

Table 9 Mandibular Essix/Exposure To Another Retainer In Addition To the Essix By Satisfaction With The Mandibular Dentition At Debond

		Happy with your lower teeth at debond		Total
		Unhappy	Happy	
	Mandibular Essix plus other retainer	4(22.2%)	14(77.8%)	18
	Essix	2(4.8%)	40(95.2%)	42
Total		6(10.0%)	54(90.0%)	60(100.0%)

fisher's exact p=0.026

STABILITY AND RELAPSE

Tables 10-12 present relapse in the maxillary arch, mandibular arch and occlusion respectively, based on age, gender, time in retention and type of retainer. Of the total sample population 51% felt that their maxillary dentition had relapsed, 39% felt that they had relapse in their mandibular dentition, and 48% felt that their occlusion changed since debond. When comparing relapse in the maxillary arch to relapse in the mandibular arch 44% of the sample reported relapse in the maxillary arch but not mandibular, 19% reported the reverse. This difference was statistically significant (Table 13, $p<0.001$).

Demographics

There were no statistically significant associations between age or time in retention and relapse in the maxillary arch, mandibular arch or bite changes ($p>0.05$). There were no statistically significant associations between gender and relapse in the maxillary or mandibular arches ($p>0.05$), although more males (61%) than females (46%) reported changes in their maxillary dentition. With respect to changes in the overall "bite" since debond, 64% of the males and 40% of the females reported changes and this was a statistically significant difference (Figure 19, $p=0.03$).

Retainers Prescribed

Regardless of what retainers were prescribed per patient, relapse in the alignment of the maxillary arch, mandibular arch or occlusion/bite did not portray any statistically significant associations ($p>0.05$).

Analyzing effects of having multiple retainers on reports of relapse portrayed no statistically significant results with respect to the maxilla, mandible or occlusion ($p>0.05$). It was found that 100% of the patients with only maxillary bonded retainers reported no relapse, but 50% of those with a retainer in addition to the bonded retainer reported relapse (Table 14, $p<0.12$).

Table 10 Relapse In The Maxillary Arch By Demographics And Retainers Prescribed

		Relapse in the Maxillary Arch		
		Moved		Have not moved
Age (yrs)	13.00- 16.99	12(44.4%)		15(55.6%)
	17.00-20.99	33(52.4%)		30(47.6%)
	>21.00	13(55.5%)		10(43.5%)
			p<0.67	
Gender	Male	25(61.0%)		16(39.0%)
	Female	33(45.8%)		39(54.2%)
			p<.12	
Time since debond	1yr	24(47.1%)		27(52.9%)
	2yrs	34(54.8%)		28(45.2%)
			p<0.41	
Maxillary Retainer Prescribed	Bonded	0(0.0%)		4(100.0%)
	Hawley and Bonded	2(28.6%)		5(71.4%)
	Essix	21(48.8%)		22(51.2%)
	Essix and Bonded	3(50.0%)		3(50.0%)
	Essix, Hawley and Bonded	5(62.5%)		3(37.5%)
	Essix and Hawley	13(59.1%)		9(40.9%)
	Hawley	12(60.0%)		8(40.0%)
	No retainer	2(66.7%)		1(33.3%)
			p<0.32	
	Total per category	58(51.3%)		55(48.6%)

Table 11 Relapse In The Mandibular Arch By Demographics And Retainers Prescribed

		Relapse in the Mandibular Arch	
		Moved	Have not moved
Age (yrs)	13.00- 16.99	13(46.4%)	15(53.6%)
	17.00-20.99	24(38.8%)	38(61.3%)
	>21.00	6(28.6%)	15(71.4%)
		p<0.44	
Gender	Male	15(38.5%)	24(61.5%)
	Female	28(38.9%)	44(61.1%)
		p<0.96	
Time since debond	1yr	17(34.7%)	32(65.3%)
	2yrs	26(41.9%)	36(58.1%)
		p<0.44	
Mandibular Retainer Prescribed	Bonded	13 (29.5%)	31(70.5%)
	Hawley and Bonded	0(0.0%)	1(100.0%)
	Essix	18(47.4%)	20(52.6%)
	Essix and Bonded	4(44.4%)	5(55.6%)
	Essix, Hawley and Bonded	0(0.0%)	1(100.0%)
	Essix and Hawley	3(50.0%)	3(50.0%)
	Hawley	1(20.0%)	4(80.0%)
	No retainer	4(100.0%)	0(0.0%)
		p<0.54	
	Total per category	43(38.7%)	68(61.3%)

Table 12 Relapse In The Occlusion By Demographics and Retainers Prescribed

		Relapse in the occlusion	
		Bite changed	Bite has not changed
Age (yrs)	13.00- 16.99	14(53.8%)	12(46.2%)
	17.00-20.99	23(42.6%)	31(57.4%)
	>21.00	10(55.6%)	8(44.4%)
		p<0.50	
Gender	Male	21(63.6%)	12(36.4%)
	Female	26(40.0%)	39(60.0%)
		**p<0.03	
Time since debond	1yr	20(48.8%)	21(51.2%)
	2yrs	27(47.4%)	30(52.6%)
		p<0.89	
Maxillary Retainer Prescribed	Bonded	2(50.0%)	2(50.0%)
	Hawley and Bonded	3(50.0%)	3(50.0%)
	Essix	21(55.3%)	17(44.7%)
	Essix and Bonded	3(50.0%)	3(50.0%)
	Essix, Hawley and Bonded	2(33.3%)	4(66.7%)
	Essix and Hawley	8(40.0%)	12(60.0%)
	Hawley	8(53.3%)	7(46.7%)
	No retainer	0(0.0%)	3(100.0%)
		p<0.93	
Mandibular Retainer Prescribed	Bonded	22(53.7%)	19(46.3%)
	Hawley and Bonded	2(100%)	0(0.0%)
	Essix	13(44.8%)	16(55.2%)
	Essix and Bonded	4(40.0%)	6(60.0%)
	Essix, Hawley and Bonded	1(100.0%)	0(0.0%)
	Essix and Hawley	1(20.0%)	4(80.0%)
	Hawley	2(40.0%)	3(60.0%)
	No retainer	2(40.0%)	3(60.0%)
		p<0.4	
	Total per category	47(48.0%)	51(52.0%)

Table 13 Relapse In The Maxillary Arch Versus Relapse In The Mandibular Arch

		Lower teeth have moved since debond		Total
		Moved	Have not moved	
Upper teeth have moved since debond	Moved	31(56.4%)	24(43.6%)	55
	Have not moved	10(19.2%)	42(80.8%)	52
Total		41(38.3%)	66(61.7%)	107(100%)

chi square $p<0.001$

Table 14 Relapse in the Maxillary Arch By Patients who Received Only A Bonded Retainer And Those Who Received A Bonded Retainer In Addition To Another Retainer

	Upper teeth have moved since debond		Total
	Moved	Have not moved	
Bonded	0(0.0%)	4(100.0%)	4
Mx Bonded plus another retainer	10(47.6%)	11(52.4%)	21
Total	10(40.0%)	15(60.0%)	25(100.0%)

fisher's exact $p=0.12$

RETENTION PROTOCOLS

Tables 15-22 present full-time, part-time and current retention protocols, based on types of removable retainers prescribed for the maxillary and mandibular arches respectively.

Maxillary Removable Retainers

There were no statistically significant associations between full-time, part-time or current retainer wear and the type of maxillary retainer prescribed ($p>0.05$). In the sample population 72% of the patients given removable maxillary retainers were advised to wear them on a full-time basis for a prescribed period. In addition 73% were advised to continue on with a part-time regimen. At the retention appointment, 68% of the patients still wore their retainers.

Table 15 Maxillary Retainer Instructions For Use

	Were you instructed to wear your UR FT		Were you instructed to wear your UR ON		Do you currently wear your UR	
	yes	no	yes	no	yes	no
Essix	68(73.1%)	25(26.9)	69(75.0%)	23(25.0%)	58(63.0%)	34(37.0%)
Hawley	47(70.1%)	20(29.9%)	47(69.1%)	21(30.9%)	50(75.8%)	16(24.2%)
Total	115(71.9%)	45(28.1%)	116(72.5%)	44(27.5%)	108(68.4%)	108(31.6%)
	p=0.68		p=0.41		p=0.09	

There was a significant association between the full-time retention protocol and the type of maxillary retainer prescribed ($p=0.05$). One month to six months of Essix wear and three months to one year of Hawley use were the most common full-time retention regimens. Six months to one year of removable retainer wear was the most common part-time retention regimen ($p=0.16$). Of the patients who still wear their removable maxillary retainer, 67% reported wearing it every night ($p=0.44$). Whether patients were debonded one or two years ago did not affect their current retention regimens (Table 58, $p=0.81$).

Table 16 Maxillary Removable Retainer Full-Time Regimen

	How long did you wear your upper retainer full-time					Total
	<=1month	3months	6months	1yr	other	
Essix	14(26.4%)	12(22.6%)	19(35.8%)	4(7.5%)	4(7.5%)	53
Hawley	2(7.1%)	8(28.6%)	8(28.6%)	8(28.6%)	2(7.1%)	28
Total	16(19.8%)	20(24.7%)	27(33.3%)	12(14.8%)	6(7.4%)	81(100%)

fisher's exact p=0.05

Table 17 Maxillary Removable Retainer Part-Time Regimen

	How long did you wear your upper retainer part-time						Total
	<=1month	3months	6months	1yr	2yrs	other	
Essix	8(11.8%)	5(7.4%)	9(13.2%)	27(39.7%)	8(11.8%)	11(16.2%)	68
Hawley	2(5.0%)	6(15.0%)	12(30.0%)	11(27.5%)	5(12.5%)	4(10.0%)	40
Total	10(9.3%)	11(10.2%)	21(19.4%)	38(35.2%)	13(12.0%)	15(13.9%)	108(100.0%)

fisher's exact p=0.16

Table 18 Current Maxillary Removable Retainer Regimen

	How often do you wear your upper retainer at present					Total
	Every night	Every 2 days	Once a week	Once a month	other	
Essix	44(66.7%)	14(21.2%)	4(6.1%)	1(1.5%)	3(4.5%)	66
Hawley	27(67.5%)	5(12.5%)	6(15.0%)	1(2.5%)	1(2.5%)	40
Total	71(67.0%)	19(17.9%)	10(9.4%)	2(1.9%)	4(3.8%)	106(100.0%)

fisher's exact p=0.44

Mandibular Removable Retainers

There were no statistically significant associations between full-time, part-time or current retainer wear and the type of mandibular retainer prescribed ($p>0.05$). In the sample population, 74% percent of surveyed patients reported that they were instructed to wear their removable retainer full time. Approximately 82% of all patients with removable mandibular retainers were eventually advised to wear their mandibular retainer overnight, regardless of the type of retainer. At the retention appointment, 68% of the patients still wore their retainers.

Table 19 Mandibular Retainer Instructions For Use

	Were you instructed to wear your LR FT		Wear you instructed to wear your LR ON		Do you currently wear your LR	
	yes	no	yes	no	yes	no
Essix	44(72.1%)	17(27.9%)	50(82.0%)	11(18.0%)	41(67.2%)	20(32.8%)
Hawley	12(80.0%)	3(20.0%)	12(80.0%)	3(20.0%)	11(73.3%)	4(26.7%)
Total	56(73.7%)	20(26.3%)	62(81.6%)	14(18.4%)	52(68.4%)	24(31.6%)
	p=0.39		p=0.55		p=0.76	

There were no statistically significant associations between full-time, part-time and current retention protocols and the type of mandibular retainer prescribed ($p>0.05$). Three to six months of full-time use and one year of overnight lower removable retainer wear were the most commonly prescribed retention regimens. In the specific comments section 15% of the surveyed patient population, who wore their retainers overnight, stated that they were advised to wear their retainers for a lifetime on a part-time basis. Of the patients who still wore their removable mandibular retainers, 65% in the mandibular Essix group, and 91% in the mandibular Hawley group reported that they wore them *every night* ($p=0.72$).

Table 20 Mandibular Retainer Full Time Regimen

	How long did you wear your lower retainer full-time						Total
	2wks	1month	3months	6months	1yr	other	
Essix	1(3.3%)	6(20.0%)	6(20.0%)	10(33.3%)	3(10.0%)	4(13.3%)	30
Hawley	0(0.0%)	0(0.0%)	3(42.9%)	2(28.6%)	2(28.6%)	0(0.0%)	7
Total	1(2.6%)	6(18.4%)	9(23.7%)	12(31.6%)	5(13.2%)	4(10.5%)	37(100.0%)

fisher's exact $p=0.42$

Table 21 Mandibular Retainers Part Time Regimens

	How long did you wear your lower retainer ON								Total
	1wk	2wks	1month	3months	6months	1yr	2yrs	other	
Essix	1(2.2%)	1(2.2%)	2(4.3%)	5(10.9%)	9 (19.6%)	16(34.8%)	6(13.0%)	6(13.0%)	46
Haw-ley	0(0.0%)	0(0.0%)	0(0.0%)	1(8.3%)	2(16.7%)	6(50.0%)	1(8.3%)	2(16.7%)	12
Total	1(1.7%)	1(1.7%)	2(3.4%)	6(10.3%)	11(19.0%)	22(37.9%)	7(12.1%)	8(13.8%)	58(100%)

fisher's exact $p=0.99$

Table 22 Current Mandibular Retainer Retention Regimen

	How often do you wear your lower retainer at present					Total
	Every night	Every two days	Once a wk	Once every few months	Other	
Essix	26(65.0%)	9(22.5%)	2(5.0%)	1(2.5%)	2(5.0%)	40
Hawley	10(90.9%)	1(9.1%)	0(0.0%)	0(0.0%)	0(0.0%)	11
Total	36(70.6%)	10(19.6%)	2(3.9%)	1(2.0%)	2(3.9%)	51(100.0%)

fisher's exact $p=0.72$

COMPLIANCE

Tables 23-26 present patient compliance with full-time and part-time maxillary and mandibular removable retainer wear, based on age, gender, time in retention and type of retainer prescribed. Compliance with full-time retainer use ranged from 75% in the maxilla to 84% in the mandible. Compliance with part-time use ranged from 82% in the maxilla to 83% in the mandible.

Demographics

The association between age and compliance with full-time removable maxillary retainer wear was statistically significant (p=0.01). The data portrayed that 65% of patients aged 13-16.9, 84% aged 17-20.9 and 61% aged greater than 21 reported compliance with full time maxillary retainer wear. A similar pattern was found with full-time mandibular retainer wear, but it was not statistically significant (p=0.24). Compliance with part-time maxillary and mandibular retainer use decreased with age from 88% to 78%, but again this was not statistically significant (p>0.05). Gender and compliance did not portray a statistically significant association (p>0.05). Compliance with maxillary and mandibular retainer wear did not vary significantly when compared with years in retention (Figure 20-21, p>0.05).

Retainers Prescribed

The association between retainers prescribed and compliance was not statistically significant (p>0.05).

Table 23 Compliance With Retainer Use By Age In Years

	Were you compliant with wearing your upper retainer full-time (p=0.01)		Were you compliant with wearing your upper retainer part-time (p=0.55)	
	No	Yes	No	Yes
13.00-16.99	14(35.0%)	26(65.0%)	5(12.5%)	35(87.5%)
17.00-20.99	15(16.3%)	77(83.7%)	17(18.7%)	74(81.3%)
>21.00	11(39.3%)	17(60.7%)	6(22.2%)	21(77.8%)
Total	40(25.0%)	120(75.0%)	28(17.7%)	130(82.3%)
	Were you compliant with wearing your lower retainer full-time (p=0.24)		Were you compliant with wearing your lower retainer part-time (p=0.83)	
	No	Yes	No	Yes
13.00-16.99	3(18.8%)	13(81.3%)	2(12.5%)	14(87.5%)
17.00-20.99	5(10.9%)	41(89.1%)	8(17.4%)	38(82.6%)
>21.00	4(28.6%)	10(71.4%)	3(21.4%)	11(78.6%)
Total	12(15.8%)	64(84.2%)	13(17.1%)	63(82.9%)

Table 24 Compliance With Retainer Use By Gender

	Were you compliant with wearing your upper retainer full-time (p=0.56)		Were you compliant with wearing your upper retainer part-time (p=0.11)	
	No	Yes	No	Yes
Male	12(22.2%)	42(77.8%)	13(24.5%)	40(75.5%)
Female	28(26.4%)	78(73.6%)	15(14.3%)	90(85.7%)
Total	40(25.0%)	120(75.0%)	28(17.7%)	130(82.3%)
	Were you compliant with wearing your lower retainer full-time (p=0.25)		Were you compliant with wearing your lower retainer part-time (p=0.20)	
	No	Yes	No	Yes
Male	3(10.3%)	26(89.7%)	7(24.1%)	22(75.9%)
Female	9(19.1%)	38(80.9%)	6(12.8%)	41(87.2%)
Total	12(15.8%)	64(84.2%)	13(17.1%)	63(82.9%)

Table 25 Compliance With Retainer Use By Time Since Debond

	Were you compliant with wearing your upper retainer full-time (p=0.52)		Were you compliant with wearing your upper retainer part-time (p=0.33)	
	No	Yes	No	Yes
1yr	21(27.3%)	56(72.7%)	16(20.8%)	61(79.2%)
2yrs	19(22.9%)	64(77.1%)	12(14.8%)	69(85.2%)
Total	40(25.0%)	120(75.0%)	28(17.7%)	130(82.3%)
	Were you compliant with wearing your lower retainer full-time (p=0.84)		Were you compliant with wearing your lower retainer part-time (p=0.61)	
	No	Yes	No	Yes
1yr	6(16.7%)	30(83.3%)	7(19.4%)	29(80.6%)
2yrs	6(15.0%)	34(85.0%)	6(15.0%)	34(85.0%)
Total	12(15.8%)	64(84.2%)	13(17.1%)	63(82.9%)

Table 26 Compliance With Retainer Use

	Were you compliant with full-time use of your upper retainer (p=0.41)		Were you compliant with part-time use of your upper retainer (p=0.16)	
	No	Yes	No	Yes
Essix	21(22.6%)	72(77.4%)	13(14.1%)	79(85.9%)
Hawley	19(28.4%)	48(71.6%)	15(22.7%)	51(77.3%)
Total	40(25.0%)	120(75.0%)	28(17.7%)	130(82.3%)
	Were you compliant with wearing your lower retainer full-time (p=0.26)		Were you compliant with wearing your lower retainer part-time (p=0.5)	
	No	Yes	No	Yes
Essix	11(18.0%)	50(82.0%)	11(18.0%)	50(82.0%)
Hawley	1(6.7%)	14(93.3%)	2(13.3%)	13(86.7%)
Total	12(15.8%)	64(84.2%)	13(17.1%)	63(82.9%)

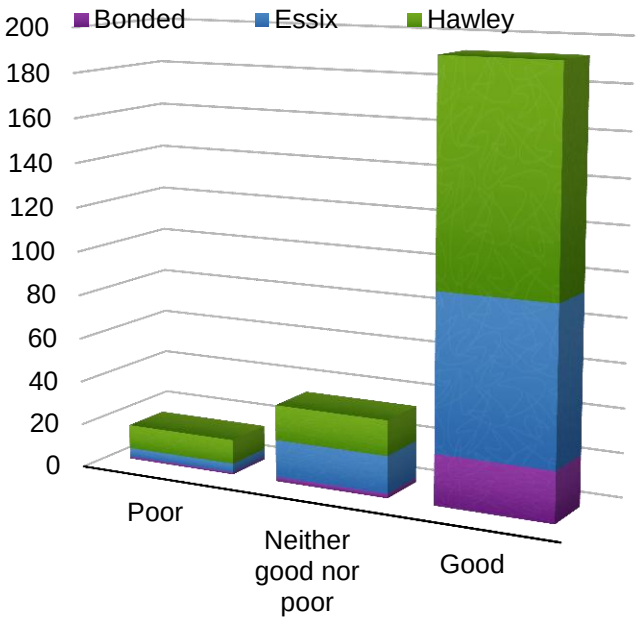
SATISFACTION WITH RETAINERS

APPEARANCE

Tables 27-29 present patient satisfaction with the appearance of their retainer, for the maxillary and mandibular arch respectively, based on age, gender, time in retention and type of retainer prescribed. The appearance of the retainer was rated as "good" by 72% of the sample with respect to the maxillary arch and 75% of the sample with respect to the mandibular arch.

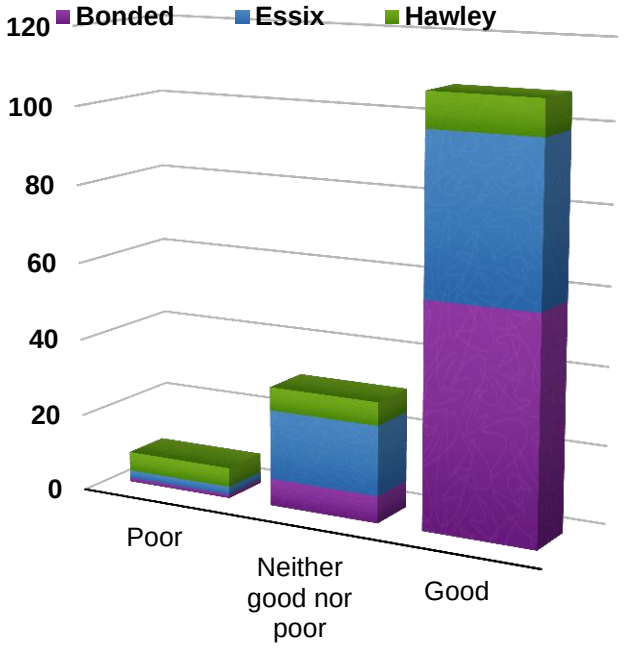
Demographics

The associations between the demographics (age, gender or time in retention) and retainer appearance were not statistically significant in either arch ($p>0.05$).



p=.01

Figure 6 Appearance Of The Maxillary Retainer



p=.003

Figure 7 Appearance Of The Mandibular Retainer

Retainers Prescribed

The associations between retainer types and retainer esthetics were statistically significant in both the maxilla (Figure 6, $p=0.01$) and mandible (Figure 7, $p<0.001$). Bonded retainers were rated as "good" with respect to esthetics most frequently (89% in the maxilla, 88% in the mandible), while Hawley retainers received a rating of "good" the least frequently (59% in the maxilla, 53% in the mandible). Having additional maxillary or mandibular retainers did not significantly influence the patient's perception of the appearance of the individual retainers (Tables 59-61, $p>0.05$). However, seventy-six percent of patients with only a mandibular Essix rated the appearance of the Essix as good. This number reduced to 47% when the patient had an additional retainer.

Table 27 Appearance Of The Maxillary Retainer By Demographics

		Rate the appearance of your upper retainer			Total
		Poor	Neither poor nor good	Good	
Age	13.00-16.99	1(2.2%)	5(11.1%)	39(86.7%)	45
	17.00-20.99	11(10.4%)	23(21.7%)	72(67.9%)	106
	>21.00	4(12.1%)	7(21.2%)	22(66.7%)	33
			p=0.14		
Gender	Male	6(10.3%)	15(25.9%)	37(63.8%)	58
	Female	10(7.9%)	20(15.9%)	96(76.2%)	126
			p=0.2		
Time in Retention	1 year	8(8.8%)	15(16.5%)	68(74.7%)	91
	2 years	8(8.6%)	20(21.5%)	65(69.9%)	93
			p=0.7		
	Total	16(8.7%)	35(19.0%)	133(72.3%)	184(100.0%)

Table 28 Appearance Of The Mandibular Retainer By Demographics

		Rate the appearance of your lower retainer			Total
		Poor	Neither poor nor good	Good	
Age	13.00-16.99	0(0.0%)	3(8.3%)	33(91.7%)	36
	17.00-20.99	4(4.9%)	21(25.6%)	57(69.5%)	82
	>21.00	1(3.8%)	7(26.9%)	18(69.2%)	26
			p=0.08		
Gender	Male	2(3.8%)	14(26.9%)	36(69.2%)	52
	Female	3(3.3%)	17(18.5%)	72(78.3%)	92
			p=0.45		
Time in Retention	1 year	2(3.0%)	15(22.7%)	49(74.2%)	66
	2 years	3(3.8%)	16(20.5%)	59(75.6%)	78
			p=0.95		
	Total	5(3.5%)	31(21.5%)	108(75.0%)	144(100.0%)

Table 29 Appearance Of Your Retainer

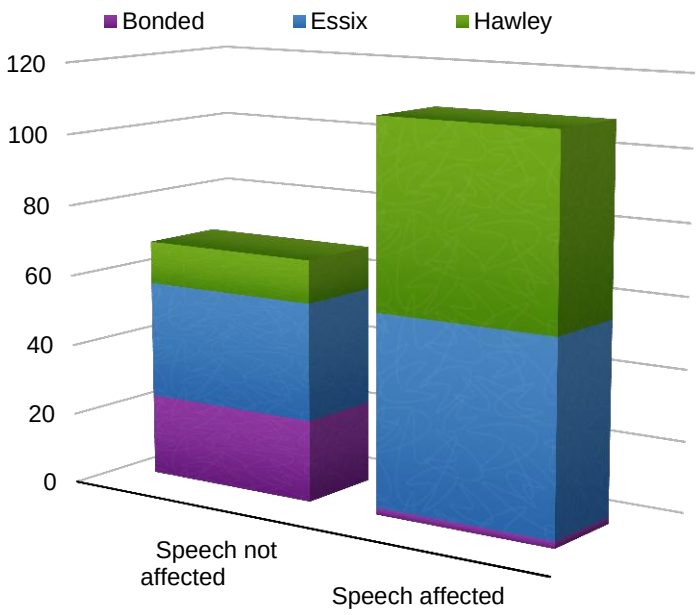
		Rate the appearance of your retainer			Total
		Poor	Neither poor nor good	Good	
Maxillary Retainer	Bonded	1(3.8%)	2(7.7%)	23(88.5%)	26
	Essix	4(4.3%)	17(18.5%)	71(77.2%)	92
	Hawley	11(16.7%)	16(24.2%)	39(59.1%)	66
Total		16(8.7%)	35(19.0%)	133(72.3%)	184(100.0%)
			p=0.01		
Mandibular Retainer	Bonded	1(1.5%)	7(10.6%)	58(87.9%)	66
	Essix	2(3.3%)	18(29.5%)	41(67.2%)	61
	Hawley	2(11.8%)	6(35.3%)	9(52.9%)	17
Total		5(3.5%)	31(21.5%)	108(75.0%)	144(100%)
			p<0.001		

SPEECH

Tables 30-32 present maxillary and mandibular retainer effects on speech, based on age, gender, time in retention and type of retainer prescribed. In general, 62% of the surveyed population reported that their maxillary retainer affected their speech and 35% reported that their mandibular retainer affected their speech.

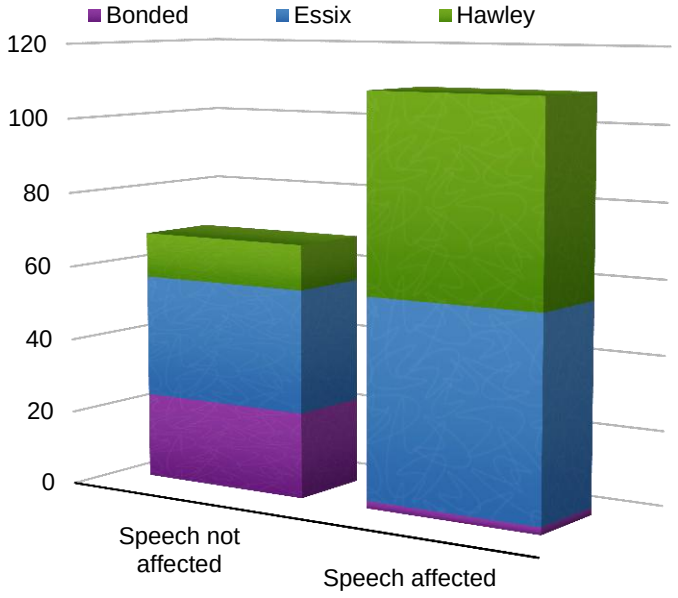
Demographics

The associations between removable retainer effects on speech and demographics (age, gender, time in retention) were not statistically significant (p>0.05).



P<0.001

Figure 8 Maxillary Retainer Affected Speech



P<0.001

Figure 9 Mandibular Retainer Affected Speech

Retainers Prescribed

The associations between retainer types and retainer effects on speech were statistically significant (Figures 8-9, p<0,001). Hawley retainers affected speech the most (82%) in the maxilla, followed by Essix (62%) and bonded (8%) retainers. In the mandibular arch approximately 60% of patients reported that both Essix and Hawley retainers affected their speech. Only 6% of patients in the mandibular bonded retainer group felt that their retainer affected their speech. The influences of being exposed to additional retainers were investigated (Tables 62-64). There was no significant influence on patients' responses with

respect to whether they thought their retainer (bonded, Essix or Hawley) affected their speech, and their exposure to another type of retainer ($p>0.05$).

Table 30 Effects Of The Maxillary Retainer On Speech By Demographics

		Does your upper retainer affect your speech		Total
		Did not affect my speech	Affected my speech	
Age (yrs)	13.00-16.99	17(43.6%)	22(56.4%)	39
	17.00-20.99	37(35.2%)	68(64.8%)	105
	>21.00	14(42.4%)	19(57.6%)	33
		p=0.57		
Gender	Male	22(40.0%)	33(60.0%)	55
	Female	46(37.7%)	76(62.3%)	122
		p=0.77		
Time in Retention	1 year	36(41.4%)	51(58.6%)	87
	2 years	32(35.6%)	58(64.4%)	90
		p=0.43		
	Total	68(38.4%)	109(61.6%)	177(100.0%)

Table 31 Effects Of The Mandibular Retainer On Speech By Demographics

		Does your lower retainer affect your speech		Total
		Did not affect my speech	Affected my speech	
Age (yrs)	13.00-16.99	24(70.6%)	10(29.4%)	34
	17.00-20.99	52(65.0%)	28(35.0%)	80
	>21.00	15(57.7%)	11(42.3%)	26
		p=0.58		
Gender	Male	35(70.0%)	15(30.0%)	50
	Female	56(62.2%)	34(37.8%)	90
		p=0.36		
Time in Retention	1 year	40(63.5%)	23(36.5%)	63
	2 years	51(66.2%)	26(33.8%)	77
		p=0.74		
	Total	91(65.0%)	49(35.0%)	140(100.0%)

Table 32 Retainer Affects On Speech

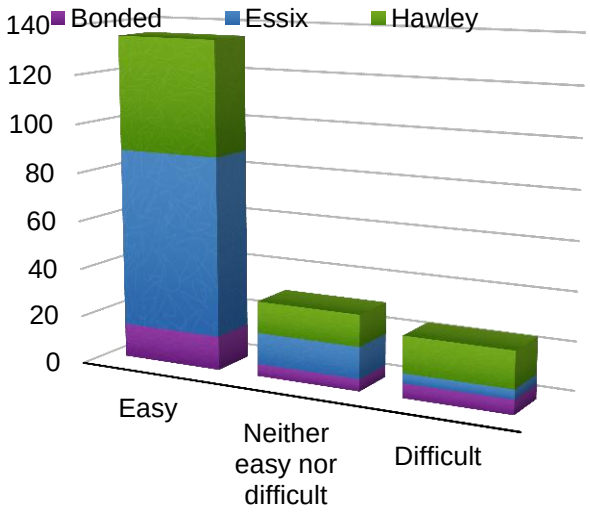
		Does your retainer affect your speech		Total
		Did not affect my speech	Affected my speech	
Maxillary Retainer	Bonded	23(92.0%)	2(8.0%)	25
	Essix	33(37.9%)	54(62.1%)	87
	Hawley	12(18.5%)	53(81.5%)	65
Total		68(38.4%)	109(61.6%)	177(100%)
		p<0.001		
Mandibular Retainer	Bonded	60(93.8%)	4(6.3%)	64
	Essix	23(39.7%)	35(60.3%)	58
	Hawley	7(41.2%)	10(58.8%)	17
Total		90(64.7%)	49(35.3%)	139 (100%)
		p<0.001		

ORAL HYGIENE

Tables 33-35 present the ease with which patients were able to maintain their oral hygiene, based on age, gender, time in retention and type of retainer prescribed. Of the patients surveyed, 8% found it difficult to maintain oral hygiene with the prescribed maxillary retainer and 20% found it difficult to maintain oral hygiene with the prescribed mandibular retainer.

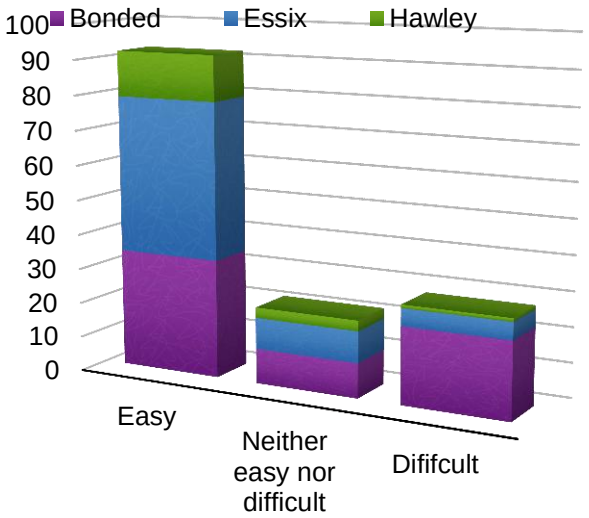
Demographics

No statistical significance was portrayed in the association between age and ability to maintain oral hygiene ($p>0.05$). Gender was significantly related to ability to maintain oral hygiene with respect to the maxillary arch only ($p<0.001$) as 11% of females versus 2% of males found it difficult to maintain oral hygiene with the prescribed maxillary retainer. The association between time in retention and the ability to maintain oral hygiene was statistically significant for the mandibular arch only ($p=0.04$) where patients debonded two years ago found it more difficult to keep their teeth clean (27%) with the mandibular retainer they were prescribed, than patients debonded one year ago (11%).



p=0.03

Figure 10 Ease of Maintaining Oral Hygiene With The Prescribed Maxillary Retainer



p=0.04

Figure 11 Ease Of Maintaining Oral Hygiene With The Prescribed Mandibular Retainer

Retainers Prescribed

The association between retainers prescribed and the ability to maintain oral hygiene was statistically significant for both the maxillary (Figure 10, $p=0.03$) and mandibular (Figure 11, $p=0.04$) arches. In the

maxilla, bonded retainers were, by far, the most difficult to keep clean (24%) followed by Hawley (8%) and Essix (4%) retainers. Similarly, bonded retainers were the most difficult to keep clean (33%) in the mandible, followed by Essix (9%) and Hawley (6%) retainers. Exposure to another mandibular retainer did not significantly influence the patients rating of 'ease of oral hygiene maintenance' pertaining to a particular retainer (Tables 36, 65).

Table 33 Ease Of Maintaining Oral Hygiene With The Prescribed Maxillary Retainer By Demographics

		How easy was if to keep your teeth clean with the upper retainer you were given			Total
		Easy	Neither easy nor difficult	Difficult	
Age (yrs)	13.00-16.99	35(79.5%)	7(15.9%)	2(4.5%)	44
	17.00-20.99	79(75.2%)	17(16.2%)	9(8.6%)	105
	>21.00	21(65.6%)	7(21.9%)	4(12.5%)	32
			p=0.6		
Gender	Male	41(71.9%)	15(26.3%)	1(1.8%)	57
	Female	94(75.8%)	16(12.9%)	14(11.3%)	124
			p<.001		
Time in Retention	1 year	72(80.9%)	12(13.5%)	5(5.6%)	89
	2 years	63(68.5%)	19(20.7%)	10(10.9%)	92
			p=0.3		
	Total	135(74.6%)	31(17.1%)	15(8.3%)	181(100.0%)

Table 34 Ease Of Maintaining Oral Hygiene With The Prescribed Mandibular Retainer By Demographics

		How easy was if to keep your teeth clean with the lower retainer you were given			Total
		Easy	Neither easy nor difficult	Difficult	
Age (yrs)	13.00-16.99	24(70.6%)	6(17.6%)	4(11.8%)	34
	17.00-20.99	55(67.1%)	9(11.0%)	18(22.0%)	82
	>21.00	13(50.0%)	7(26.9%)	6(23.1%)	26
			p=0.19		
Gender	Male	28(53.8%)	12(23.1%)	12(23.1%)	52
	Female	64(71.1%)	10(11.1%)	16(17.8%)	90
			p=0.08		
Time in Retention	1 year	48(75.0%)	9(14.1%)	7(10.9%)	64
	2 years	44(56.4%)	13(16.7%)	21(26.9%)	78
			p=0.04		
	Total	92(64.8%)	22(15.5%)	28(19.7%)	142(100.0%)

Table 35 Ease Of Maintaining Oral Hygiene With The Prescribed Retainer

		How easy was it to maintain oral hygiene			Total
		Easy	Neither easy nor difficult	Difficult	
Maxillary Retainer	Bonded	14(56.0%)	5(20.0%)	6(24.0%)	25
	Essix	74(81.3%)	13(14.3%)	4(4.4%)	91
	Hawley	47(72.3%)	13(20.0%)	5(7.7%)	65
Total		135(74.6%)	31(17.1%)	15(8.3%)	
			p=0.03		
Mandibular Retainer	Bonded	34(51.5%)	10(15.2%)	22(33.3%)	66
	Essix	45(76.3%)	9(15.3%)	5(8.5%)	59
	Hawley	13(76.5%)	3(17.6%)	1(5.9%)	17
Total		92(64.8%)	22(15.5%)	28(19.7%)	142(100.0%)
			p=0.04		

Table 36 Ease of Maintaining Oral Hygiene With The Prescribed Maxillary Retainer

	How easy was if to keep your teeth clean with the UR you were given			Total
	Easy	Neither easy nor difficult	Difficult	
Bonded	3(75.0%)	0(0.0%)	1(25.0%)	4
Mx Bonded plus another retainer	11(52.4%)	5(23.8%)	5(23.8%)	21
Total	14(56.0%)	5(20.0%)	6(24.0%)	25(100.0%)

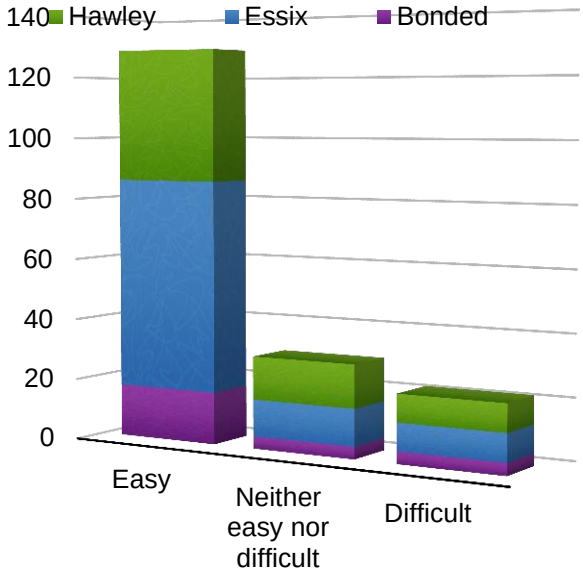
p=0.78

RETAINER HYGIENE

Tables 37-39 present the patients' ability to keep their maxillary and mandibular retainer clean, based on age, gender, time in retention and type of retainer prescribed. Overall, 12% of patients with a maxillary retainer found it difficult to keep it clean, while 17% of patients with a mandibular retainer had difficulty keeping it clean.

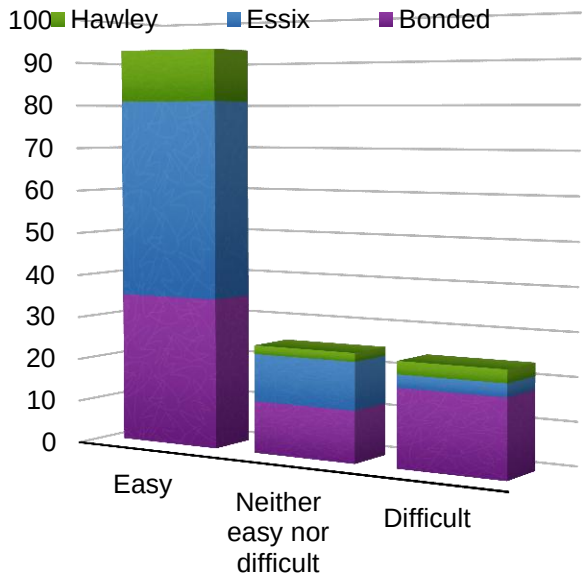
Demographics

The associations between the demographics (age, gender, time in retention) and ease of maintaining hygiene of the prescribed retainer were not statistically significant ($p>0.05$).



p=0.53

Figure 12 Ease Of Maintaining Hygiene Of The Maxillary Retainer



p=0.02

Figure 13 Ease Of Maintaining Hygiene Of The Mandibular Retainer

Retainers Prescribed

The association between the ease of maintaining hygiene of the retainer and the type of retainer was significant for the mandibular retainers only (Figure 13, p=0.02). Mandibular Essix retainers were the easiest to keep clean (5% difficulty) and bonded the most difficult (28% difficulty). A similar trend was noted in the maxillary arch as well (Figure 12). The influence of exposure to another retainer on the perceptions of keeping a particular retainer clean was statistically significant for mandibular Hawley retainers only (Table 40, p=0.02). It was found that 60% of patients with only mandibular Hawleys felt that

it was difficult to keep their Hawley clean, but when the patient was exposed to another type of retainer in addition to the Hawley, 100% felt that is was easy to keep the mandibular Hawley clean.

Table 37 Ease Of Maintaining Hygiene Of The Maxillary Retainer By Demographics

			Ease of maintaining the hygiene of the upper retainer			Total
			Easy	Neither easy nor difficult	Difficult	
Age (yrs)	13.00-16.99		29(65.9%)	8(18.2%)	7(15.9%)	44
	17.00-20.99		77(73.3%)	16(15.2%)	12(11.4%)	105
	>21.00		23(71.9%)	6(18.8%)	3(9.4%)	32
				p=0.8		
Gender	Male		39(68.4%)	12(21.1%)	6(10.5%)	57
	Female		90(72.6%)	18(14.5%)	16(12.9%)	124
				p=0.5		
Time in Retention	1 year		69(76.7%)	9(10.0%)	12(13.3%)	90
	2 years		60(65.9%)	21(23.1%)	10(11.0%)	91
				p=0.06		
		Total	129(71.3%)	30(16.6%)	22(12.2%)	181(100.0%)

Table 38 Ease Of Maintaining Hygiene Of The Mandibular Retainer By Demographics

			Ease of maintaining the hygiene of the lower retainer			Total
			Easy	Neither easy nor difficult	Difficult	
Age (yrs)	13.00-16.99		22(64.7%)	9(26.5%)	3(8.8%)	34
	17.00-20.99		57(69.5%)	12(14.6%)	13(15.9%)	82
	>21.00		14(53.8%)	4(15.4%)	8(30.8%)	26
				p=0.15		
Gender	Male		31(59.6%)	11(21.2%)	10(19.2%)	52
	Female		62(68.9%)	14(15.6%)	14(15.6%)	90
				p=0.53		
Time in Retention	1 year		44(68.8%)	10(15.6%)	10(15.6%)	64
	2 years		49(62.8%)	15(19.2%)	14(17.9%)	78
				p=0.76		
		Total	93(65.5%)	25(17.6%)	24(16.9%)	142(100.0%)

Table 39 Ease Of Maintaining Hygiene Of The Prescribed Retainer

		Ease of maintaining hygiene of the retainer			Total
		Easy	Neither easy nor difficult	Difficult	
Maxillary Retainer	Bonded	17(68.0%)	4(16.0%)	4(16.0%)	25
	Essix	69(76.7%)	12(13.3%)	9(10.0%)	90
	Hawley	43(65.2%)	14(21.2%)	9(13.6%)	66
Total		129(71.3%)	30(16.6%)	22(12.2%)	181(100.0%)
			p=0.53		
Mandibular Retainer	Bonded	35(53.8%)	12(18.5%)	18(27.7%)	65
	Essix	46(76.7%)	11(18.3%)	3(5.0%)	60
	Hawley	12(70.6%)	2(11.8%)	3(17.6%)	17
Total		93(65.5%)	25(17.6%)	24(16.9%)	142(100.0%)
			p=0.02		

Table 40 Ease Of Maintaining The Mandibular Hawley Retainer And Influence Of Exposure To Another Retainer

	How easy was it to keep your LR clean		Total
	Easy	Difficult	
Lower Hawley plus another retainer	10(100.0%)	0(0.0%)	10
Lower Hawley	2(40.0%)	3(60.0%)	5
Total	12(80.0%)	3(20.0%)	15(100.0%)

fisher's exact p=0.02

REPLACEMENT RETAINERS

Tables 41-43 present retainer replacement, based on age, gender, time in retention and type of retainer prescribed. Of the sample population, 31% had their maxillary retainer replaced and 18% had their mandibular retainer replaced.

Demographics

Age and need for replacement retainers were not statistically significant associations (p>0.05). Associations between gender and retainer replacement were statistically significant in both arches (p=0.01 maxilla, p=0.05 mandible). More females (37% maxilla, 23% mandible) had to have their upper and lower retainers replaced than males did (17% maxilla, 10% mandible). The association between time since debond and retainer replacement was statistically significant for the maxillary arch only (p=0.007). It was found that 41% of patients debonded two years ago and 22% of patients debonded a year ago had to have their maxillary retainers replaced.

Retainers Prescribed

The associations between retainer replacement and type of retainer were statistically significant for both the maxilla (p=0.03) and mandible (p=0.02). Half (50%) of the patients with maxillary bonded and one-third (33%) with Essix had to have their retainers replaced. Hawley retainers were the most durable maxillary retainer with only about one-fifth (21%) requiring replacement. In the lower arch, only 9% of the bonded retainers required replacement, making them the most durable mandibular retainer. Mandibular Essix and Hawley retainers required replacement in 28% and 18% respectively of patients prescribed those retainers.

Table 41 Replacement of Maxillary Retainers By Demographics

		Did you have to have your upper retainer replaced		Total
		Yes	No	
Age (yrs)	13.00-16.99	11(23.9%)	35(76.1%)	46
	17.00-20.99	32(34.0%)	62(66.0%)	94
	>21.00	8(30.8%)	18(69.2%)	26
		p=0.48		
Gender	Male	9(17.3%)	43(82.7%)	52
	Female	42(36.8%)	72(63.2%)	114
		p=0.01		
Time in Retention	1 year	20(22.0%)	71(78.0%)	91
	2 years	31(41.3%)	44(58.7%)	75
		p=0.007		
	Total	51(30.7%)	115(69.3%)	166(100.0%)

Table 42 Replacement of Mandibular Retainers By Demographics

			Did you have to have your lower retainer replaced		Total
			Yes	No	
Age (yrs)	13.00-16.99		9(25.0%)	27(75.0%)	36
	17.00-20.99		14(16.9%)	69(83.1%)	83
	>21.00		3(12.0%)	22(88.0%)	25
			p=.045		
Gender	Male		5(9.6%)	47(90.4%)	52
	Female		21(22.8%)	71(77.2%)	92
			p=0.05		
Time in Retention	1 year		12(18.2%)	54(81.8%)	66
	2 years		14(17.9%)	64(82.1%)	78
			p=0.97		
		Total	26(18.1%)	118(81.9%)	144(100.0%)

Table 43 Retainer Replacement By Type Of Retainer Prescribed

		Did you have to have your retainer replaced		Total
		Yes	No	
Maxillary Retainer	Bonded	11(50.0%)	11(50.0%)	22
	Essix	27(32.9%)	55(67.1%)	82
	Hawley	13(21.0%)	49(79.0%)	62
Total		51(30.7%)	115(69.3%)	166(100.0%)
		p=0.03		
Mandibular Retainer	Bonded	6(9.1%)	60(90.9%)	66
	Essix	17(27.9%)	44(72.1%)	61
	Hawley	3(17.6%)	14(82.4%)	17
Total		26(18.1%)	118(81.9%)	144(100.0%)
		p=0.02		

REASONS FOR REPLACEMENT

Tables 44-46 present the reasons for retainer replacement. The most common reason for replacement of either a maxillary or mandibular removable retainer was losing it at 39%.

Demographics

Reasons for replacement were not statistically significantly associated with age or gender (Figure 22, $p>0.05$). However, reasons for replacing the mandibular removable retainers were significantly associated with time in retention (Figure 23, $p=0.05$). During the first year of retention mandibular removable retainers were most often replaced because of tooth relapse (56%) or because they were lost (33%), and during the second year it was because they were lost (44%) or broken (33%).

Retainers Prescribed

Overall, both Essix (39% maxilla, 40% mandible) and Hawley (42% maxilla, 33% mandible) retainers were most often replaced because they were lost. There was no statistical difference in reasons for replacement between retainers (Table 46, $p=0.48$).

Table 44 Reasons For Replacing The Maxillary Removable Retainer By Demographics

		Why was your upper Essix or Hawley replaced					Total
		It did not fit right from the day I got it	It broke	I lost it	My teeth moved so it no longer fit	Other	
Age (yrs)	13.00-16.99	0(0.0%)	1(11.1%)	5(55.6%)	2(22.2%)	1(11.1%)	9
	17.00-20.99	0(0.0%)	8(33.3%)	9(37.5%)	4(16.7%)	3(12.5%)	24
	>21.00	1(20.0%)	0(0.0%)	1(20.0%)	3(60.0%)	0(0.0%)	5
				p=0.71			
Gender	Male	0(0.0%)	4(44.4%)	3(33.3%)	1(11.1%)	1(11.1%)	9
	Female	1(3.4%)	5(17.2%)	12(41.4%)	8(27.6%)	3(10.3%)	29
				p=0.58			
Time since debond	1yr	1(6.2%)	3(18.8%)	7(43.8%)	3(18.8%)	2(12.4%)	16
	2yrs	0(0.0%)	6(27.3%)	8(36.3%)	6(27.3%)	2(9.1%)	22
				p=0.71			
Total		1(2.6%)	9(23.7%)	15(39.5%)	9(23.7%)	4(10.5%)	38(100.0%)

Table 45 Reasons For Replacing The Mandibular Removable Retainer By Demographics

		Why was your lower Essix or Hawley replaced					Total
		It did not fit right from the day I got it	It broke	I lost it	My teeth moved so it no longer fit	Other	
Age (yrs)	13.00-16.99	0(0.0%)	2(33.3%)	2(33.3%)	2(33.3%)	0(0.0%)	6
	17.00-20.99	1(11.1%)	2(22.2%)	4(44.4%)	1(11.1%)	1(11.1%)	9
	>21.00	0(0.0%)	0(0.0%)	1(33.3%)	2(66.7%)	0(0.0%)	3
				p=0.82			
Gender	Male	0(0.0%)	1(25.0%)	2(50.0%)	1(25.0%)	0	4
	Female	1(7.1%)	3(21.4%)	5(35.7%)	4(25.0%)	1(7.1%)	14
				p=1.0			
Time since debond	1yr	0(0.0%)	1(11.1%)	3(33.3%)	5(55.6%)	0(0.0%)	9
	2yrs	1(11.1%)	3(33.3%)	4(44.4%)	0(0.0%)	1(11.1%)	9
				p=0.05			
Total		1(5.6%)	4(22.2%)	7(38.9%)	5(27.8%)	1(5.6%)	18(100.0%)

Table 46 Reasons For Replacement Of The Removable Retainer

		Why was your Essix or Hawley replaced					Total
		It did not fit right from the day I got it	It broke	I lost it	My teeth moved so it no longer fit	Other	
What type of maxillary retainer was given at debond	Essix	0(0.0%)	6(23.1%)	10(38.5%)	6(23.1%)	4(15.4%)	26
	Hawley	1(8.3%)	3(25.0%)	5(41.7%)	3(25.0%)	0(0.0%)	12
Total		1(2.6%)	9(23.7%)	15(39.5%)	9(23.7%)	4(10.5%)	38(100.0%)
				p=0.48			
What type of mandibular retainer was given at debond	Essix	1(6.7%)	4(26.7%)	6(40.0%)	4(26.7%)	0(0.0%)	15
	Hawley	0(0.0%)	0(0.0%)	1(33.3%)	1(33.3%)	1(33.3%)	3
Total		1(5.6%)	4(22.2%)	7(38.9%)	5(27.8%)	1(5.6%)	18(100.0%)
				p=0.4			

PREFERRED RETAINERS

Tables 47-49 present patients' preference for retainers based on age, gender, time in retention and type of retainer prescribed. Of the sample population, 23% would have preferred a maxillary retainer other than the one they received and 15% would have preferred a different mandibular retainer.

Demographics

Age and gender were not significantly associated with a preference for a different retainer ($p>0.05$). Time in retention was significantly associated with a preference for a different retainer for the maxillary arch only ($p=0.047$). As time in retention increased, a greater number of patients indicated that they would have preferred a different type of maxillary retainer (29% vs 17%). A similar result was observed in the mandible (19% vs 9%), but it was not statistically significant.

Retainers Prescribed

Retainers prescribed were not statistically significantly associated with a preference for a different retainer ($p>0.05$). However, patients with maxillary or mandibular Hawleys were most likely to indicate that they would have preferred another type of retainer and patients with bonded maxillary or mandibular retainers were the least likely.

Table 47 Preference For A Different Maxillary Retainer By Demographics

		Would you have preferred a different upper retainer		Total
		Yes	No	
Age (yrs)	13.00-16.99	10(22.2%)	35(77.8%)	45
	17.00-20.99	27(25.0%)	81(75.0%)	108
	>21.00	6(17.6%)	28(82.4%)	34
		p=.67		
Gender	Male	10(17.2%)	48(82.8%)	58
	Female	33(25.6%)	96(74.4%)	129
		p=.21		
Time in Retention	1 year	15(16.7%)	75(83.3%)	90
	2 years	28(28.9%)	69(71.1%)	97
		p=.047		
	Total	43(23.0%)	144(77.0%)	187(100.0%)

Table 48 Preference For A Different Mandibular Retainer By Demographics

			Would you have preferred a different upper retainer		Total
			Yes	No	
Age	13.00-16.99		5(13.9%)	31(86.1%)	36
	17.00-20.99		13(15.7%)	70(84.3%)	83
	>21.00		3(11.5%)	23(88.5%)	26
			p=0.95		
Gender	Male		8(15.4%)	44(84.6%)	52
	Female		13(14.0%)	80(86.0%)	93
			p=0.82		
Time in Retention	1 year		6(9.1%)	60(90.9%)	66
	2 years		15(19.0%)	64(81.0%)	79
			p=0.92		
		Total	21(14.5%)	124(85.5%)	145(100.0%)

Table 49 Preference For A Different Retainer

		Preference For A Different Retainer		Total
		Yes	No	
Maxillary Retainer	Bonded	3(11.5%)	23(88.5%)	26
	Essix	21(22.6%)	72(77.4%)	93
	Hawley	19(27.9%)	49(72.1%)	68
Total		43(77.0%)	144(23.0%)	187(100.0%)
		p=0.24		
Mandibular Retainer	Bonded	8(11.9%)	59(88.1%)	67
	Essix	9(14.8%)	52(85.2%)	61
	Hawley	4(23.5%)	13(76.5%)	17
Total		21(14.5%)	124(85.5%)	145(100.0%)
		p=0.45		

TYPE OF PREFERRED RETAINER

Tables 50-53 present the type of retainer preferred based on age, gender, time in retention and type of retainer prescribed. Of those who would have preferred a different retainer, 35% reported they would have preferred an Essix retainer in the maxillary arch and 42% would have preferred a bonded retainer in the mandibular arch.

Demographics

Age and preference for a particular type of retainer portrayed statistically significant associations in the maxilla ($p<0.001$). Younger patients (13-17) were most likely to prefer maxillary bonded or Hawley retainers. Older patients (17-21 or >21 years old) preferred maxillary Essix retainers most often. Gender or Time in Retention and preference for a different type of retainer were not statistically significantly associated ($p>0.05$).

Retainers Prescribed

Retainers prescribed and preference for different types of retainers portrayed statistically significant associations (Table 53). Patients with maxillary retainers who would have preferred a different type of retainer responded as follows: Bonded group most often preferred Essix, Essix group Hawley, and the Hawley group Essix retainers ($p<0.001$). Patients with mandibular retainers who would have preferred a different type of retainer responded as follows: Bonded group preferred Essix most often, Essix and Hawley groups preferred bonded retainers most often (Table 53, $p=0.01$). If the patient was given a maxillary Essix and another type of maxillary retainer, the most commonly preferred retainer was then a Hawley (Table 51, $p=0.048$). This association was statistically significant.

Table 50 Preferred Maxillary Retainer By Demographics

		What type of upper would you have preferred				
		Bonded	Essix	Hawley	N	Total
Age	13.00-16.99	4(40.0%)	0(0.0%)	3(30.0%)	3(30.0%)	10
	17.00-20.99	8(29.6%)	11(40.7%)	7(25.9%)	1(3.7%)	27
	>21.00	1(16.7%)	4(66.7%)	1(16.7%)	0(0.0%)	6
			p<0.001			
Gender	Male	2(20.0%)	5(50.0%)	3(30.0%)	0(0.0%)	10
	Female	11(33.3%)	10(30.3%)	8(24.2%)	4(12.1%)	33
			p=0.6			
Time In Retention	1yr	3(20.0%)	5(33.3%)	6(40.0%)	1(6.7%)	15
	2yrs	10(35.7%)	10(35.7%)	5(17.9%)	3(10.7%)	28
			p=0.5			
	Total	13(30.2%)	15(34.9%)	11(25.6%)	4(9.3%)	43(100.0%)

Table 51 What Maxillary Retainer Was Preferred By Exposure To An Essix Versus An Essix And Another Retainer

	What type of UR would you have preferred			Total
	Bonded	Hawley	N	
Maxillary Essix plus another retainer	2(16.7%)	8(66.7%)	2(16.7%)	12
Maxillary Essix	5(50.0%)	3(30.0%)	2(20.0%)	10
Total	7(30.4%)	11(47.8%)	4(17.4%)	23(100.0%)

fisher's exact p=0.048

Table 52 Preferred Mandibular Retainer By Demographics

			What type of lower would you have preferred				
			Bonded	Essix	Hawley	N	Total
Age	13.00-16.99		1(25.0%)	1(25.0%)	1(25.0%)	1(25.0%)	4
	17.00-20.99		7(53.8%)	3(23.1%)	3(23.1%)	0(0.0%)	13
	>21.00		0(0.0%)	1(50.0%)	1(50.0%)	0(0.0%)	2
				p=0.19			
Gender	Male		2(28.5%)	3(43.0%)	2(28.5%)	0(0.0%)	7
	Female		6(50.0%)	2(16.7%)	3(25.0%)	1(8.3%)	12
				p=0.84			
Time In Retention	1yr		1(25.0%)	2(50.0%)	1(25.0%)	0(0.0%)	4
	2yrs		7(46.7%)	3(20.0%)	4(26.7%)	1(6.7%)	15
				p=0.16			
		Total	8(42.1%)	5(26.3%)	5(26.3%)	1(5.2%)	19(100.0%)

Table 53 Preferred Retainer Based On Prescribed Retainer

		Preferred Retainer				
		Bonded	Essix	Hawley	N	Total
Prescribed Maxillary Retainer	Bonded	0(0.0%)	2(100%)	0(0.0%)	0(0.0%)	2
	Essix	7(31.8%)	0(0.0%)	11(50.0%)	4(18.2%)	22
	Hawley	6(31.6%)	13(68.4%)	0(0.0%)	0(0.0%)	19
Total		13(30.2%)	15(34.9%)	11(25.6%)	4(9.3%)	43(100%)
			p<0.001			
Prescribed Mandibular Retainer	Bonded	0(0.0%)	4(50.0%)	2(25.0%)	1(12.5%)	7
	Essix	5(62.5%)	0(0.0%)	3(37.5%)	0(0.0%)	8
	Hawley	3(75.0%)	1(25.0%)	0(0.0%)	0(0.0%)	4
Total		8(42.1%)	5(26.3%)	5(26.3%)	1(5.2%)	19(100.0%)
			p=0.01			

DISCUSSION

Orthodontists strive to balance patients' concerns, occlusion, facial esthetics and ultimately maintaining the results achieved during treatment. Attaining these goals is dependent not only on the practitioners' skills but also on their knowledge of patient preferences and the patient's willingness to comply with prescribed protocols. Stability of treatment can be affected by time, duration and types of retention appliances.[63]

Obtaining qualitative data on patient perspectives has been recently emphasized in the literature on research and audit. The assessment of patient satisfaction via questionnaires is becoming a more pertinent means to obtain this data.[64]

This cross-sectional survey study addressed:

1) Patient satisfaction with the treatment rendered
2) Stability and relapse of treatment
3) Common retention protocols at The University of Western Ontario
4) Patient compliance with retention protocols, and
5) Patient satisfaction with the prescribed retainers with respect to:
    a. Appearance
    b. Speech
    c. Ease of maintaining oral hygiene
    d. Ease of maintaining the retainer
    e. Need for replacement retainers, and
    f. Preferred types of retainers.

The study was conducted via an electronic interview format. Issues pertaining to mailed surveys as compared to interview surveys are reported as: low response rates, high levels of missing data on returned surveys, ambiguities in responses[65], and under-representation of low socio-economic classes.[66] Face-to-

face interview surveys are typically more expensive than mailed ones.[67] The study questionnaire was administered in person, at regularly scheduled retention appointments, and did not result in enhanced financial costs to the patients or the clinic. The electronic interview format resulted in a 99% response rate. Sample bias was reduced as all patients returning for one or two-year retention appointments were requested to participate. Only patients who attended retention appointments responded to the survey, thereby incorporating a different form of sample bias.

Mailed surveys allow larger samples to be surveyed in similar time periods.[10,15,67] The sample size used in this study was consistent with previous publications by Sinha, Al-Omiri and Palomares [25,43,45] that used an interview format. The sample consisted of 131 patients between the ages of thirteen years and eight months and sixty years and four months. At the time of the survey, half of the patients were aged seventeen to twenty-one years old. The patients attended the Graduate Orthodontic Clinic at Western University for comprehensive orthodontic treatment and had been debonded one or two years ago. Patients who had their appliances removed a minimum of one year prior to survey completion were recruited because less than one year would be insufficient to provide valuable data on stability and satisfaction.[35] Two thirds of the population was female which is consistent with previous publications that portray that an increased number of females seek orthodontic treatment.[68]

The most commonly prescribed maxillary retainer was the Essix, followed by the Hawley, and then the bonded retainer. Pratt et al[7] report a shift away from the prescription of Hawley retainers and towards Essix retainers over time. The bonded retainer was not frequently prescribed for the maxillary arch. This may be due to the fact that when occlusions are corrected to ideal parameters, the resulting dental overjet and overbite cause mastication forces to be directly applied to the upper fixed retainer, which leads to their frequent failure.[69]

Many respondents in this study were prescribed more than one type of retainer per arch. In the maxilla, the Essix alone followed by a combination of an Essix and a Hawley and finally a Hawley alone were the most commonly prescribed retainers. Singh et al[17] also found that the Essix was most commonly used in both hospital and private orthodontic practices. However, this result varies from the finding by Valiathan[20] where the Hawley was identified as the most commonly used maxillary retainer. The second most common maxillary retainer group of Essix and Hawley portrayed a regimen that allows the patient a choice to enhance compliance and also provides a back-up retainer.

In the mandibular arch the most commonly prescribed retainer was the bonded retainer, followed by the Essix and then the Hawley retainer. Similar results were also reported in two studies conducted in the United States.[15,20] Renkema et al[70] investigated the effectiveness of mandibular canine to canine bonded

retainers and concluded that they are effective in maintaining the alignment of the mandibular anterior region after active orthodontic treatment. Oltramari et al[71] published that a well inter-digitating functional occlusion ensures stability after completion of orthodontic treatment. A survey on retention practices in the United Kingdom found that, in private practice vacuum retainers were often used in conjunction with bonded retainers in both arches, particularly the mandible, which could help in stabilizing both posterior and anterior segments.[17] In the present study, Essix or Hawley overlays on top of the mandibular bonded retainer were prescribed less than 10% of the time.

There was no association between sample demographics (age, gender or retention time) and type of maxillary or mandibular retainers prescribed. Ten percent of the females and no males reported receiving all three types of maxillary retainers. Previous publications have indicated that more females seek orthodontic treatment and females tend to be more concerned about milder occlusal issues.[72] This may be reflected during the retention phase also, thereby resulting in more retainers being prescribed in response to concerns expressed. Older patients received mandibular Essix retainers and younger patients received mandibular bonded retainers most often. A mandibular bonded retainer that does not require compliance may be prescribed by orthodontists more frequently for younger patients, as it is believed that age influences compliance.[7] Older patients' desires for esthetic retainers may result in an increased prescription of Essix retainers in that age group.[14]

SATISFACTION

A larger percentage of males seem to be happy with the alignment of their mandibular dentition and the occlusion/fit of their bite at debond, when compared to females. Sheats et al,[68] in their study of occlusal traits and perception of orthodontic need, found that females are more dissatisfied with the appearance of their dentition than males are. Unlike these associations, a recent publication noted that gender differences do not predict patient satisfaction.[44] Similarly in 2011, smile esthetics from the patients' perspective were analyzed and it was found that rater sex did not make a difference.[73]

Reported satisfaction with the alignment of the dentition and the occlusion at both debond and retention was approximately 90% in all age groups, regardless of their time in retention. Mollov et al[74] reported a 96% satisfaction rate post-treatment and post-retention and Sheats et al[68] published that adults are generally less satisfied with their dentofacial appearance than adolescents are.

Satisfaction with maxillary dental alignment at debond portrayed a statistically significant relationship with groups of maxillary retainers prescribed per patient. The most satisfied patients received only an Essix or

only a Hawley, while the least satisfied patients received all three retainers. Respondents who received multiple retainers may have perceived their experience with the various types of retainers

differently than those respondents who received only one type of retainer. A significant association was noted between patients prescribed multiple retainers and a decreased level of patient satisfaction with treatment. This was especially apparent when an Essix retainer and another retainer were prescribed where patients who received the additional retainer were less likely to be satisfied with the alignment of the dentition. Since the reduced satisfaction was expressed at debond, it is possible that an increased number of retainers may have been prescribed early on, to address potential concerns or relapse, based on pre-treatment occlusion.

STABILITY AND RELAPSE

While males reported a greater degree of satisfaction with treatment rendered, an interesting finding was that a greater number of males reported relapse in their 'bite' post treatment. While cephalometrically evaluating orthodontically treated cases, Binda et al[75] also found relapse over time to be more pronounced in males than females. Fudalej et al[76] attribute this gender difference to late mandibular growth in males.

Relapse was reported more frequently in the maxillary arch than the mandibular arch. This may be related to the limited use of fixed retention in the maxillary arch.[77] Also, perhaps relapse in the maxillary arch is more visible to patients and is reported more often due to its effects on smile esthetics. The number of patients who reported relapse increased over the one to two year retention period, but the changes were not statistically significant. Previous studies have reported most relapse to occur over the first five years post treatment.[75]

When groups based on retainers prescribed per patient were analyzed for relapse, no significant differences were detected in the maxilla or mandible. Millett et al[28] found higher relapse with Essix retainers as compared to bonded, and cited probable loss or breakage of the Essix as a cause. Rowland et al[52] reported that Essix retainers are more effective than Hawley retainers in preventing incisor relapse, probably because of increased compliance with use, but the difference was not clinically significant. Similar to our findings, Lindauer and Shoff[78] reported mandibular anterior relapse in both Essix and Hawley groups and the differences between the groups were not statistically significant. Kumar and Bansal[14] found that both Hawley and Essix retainers allowed some relapse of teeth post-treatment, but the six month differences were small and they stated that the differences were not clinically significant.

RETENTION PROTOCOLS

A large number of patients (72% maxilla, mandible 74%) were asked to wear their removable retainer on a full-time (>20hrs per day) basis. There was an association between the type of removable maxillary retainer prescribed and the precise retention protocol. Maxillary Essix retainers were most frequently associated with a one to six month full-time wear regimen, while maxillary Hawley retainers were more commonly associated with a three month to one year full-time wear regimen. Fifteen percent of the population reported that they were advised to wear their retainers for a lifetime on a part time basis. This study found that 68% of patients continued to wear a removable retainer one or two years after debond and this result is similar to that reported by Kacer et al.[61] Additionally, the majority of this sample (67% maxilla, 71% mandible) stated that they still wore their retainers every night. A study conducted in the United States revealed that most orthodontists prescribe less than nine months of full-time removable retainer use, and thereafter advised lifetime, part-time wear.[20] In Australia and New Zealand it has been reported that orthodontists more commonly prescribed a regular retention period of more than two years.[10] It has also been recently reported that there is no difference in the retention of the aligned dentition, whether Essix retainers are worn on a full- or part-time basis.[58]

Most patients who still wore their removable retainer at the retention appointment were prescribed Hawley retainers as compared to Essix retainers but this was not statistically significant in either the maxillary or mandibular arch. Patients with mandibular Hawley retainers also tended to wear them for longer periods of time and more often than patients with Essix retainers. The pleasing esthetics of Essix retainers result in their increased use initially, however, over time the thermoplastic material stains and wears, and Hawley retainers are then favored.[15]

COMPLIANCE

Pratt et al[15]stated that patient compliance with removable retainer use is not acceptable and bonded retention should be evaluated as a preferable alternative to removable retainers. In this sample, compliance with full-time prescribed retainer use ranged from 75% in the maxilla to 84% in the mandible. Compliance with part-time prescribed retainer wear was about the same in both arches at 82-83%%. The association between full-time maxillary retainer use and age was statistically significant, with compliance the greatest in the seventeen to twenty-one year old age group, and least in adults over twenty-one years of age. Overall compliance decreased with age when part-time retainer use was investigated, but this was not statistically significant. Enhanced compliance at the beginning of the retention phase, in younger patients, has been reported in other studies. These studies also depict a rapid decline in the younger groups' compliance as time since debond elapses.[15] There is variability in the literature in regards to age and compliance. Some studies found a significant association,[79,80] while others did not.[61,81]

Unlike the findings of Pratt et al[15] this study did not find gender to be significantly associated with compliance. Females were more compliant with overnight retainer wear, while males were more compliant with full time wear but these associations were not statistically significant. The gender differences in compliance may be attributed to females' enhanced concerns with retainer esthetics leading to their reduced use of the retainers during the day. Kacer et al[61] reported similar findings.

Time since debond did not affect compliance with retention regimens. Previous studies have reported a reduction in compliance as time since debond elapsed.[15,61] However, they also noted that this reduction in compliance may be due to the strict definition of compliance. If a more generic question such as whether patients wore their retainer "part-time", instead of a specific question pertaining to 'the number of hours per day that the retainer was worn', or a 'regimen used on a daily basis' was asked, rates of compliance in patients debonded two years ago may increase significantly.[61]

Patients with maxillary Essix retainers were more compliant, as compared to patients with maxillary Hawley retainers. However in the mandibular arch there was increased compliance with Hawley use as compared to Essix use. These differences were not statistically significant. Previous publications on compliance with retainer wear in the United States have shown increased compliance with Essix use until two years post debond, after which compliance with Hawley wear is greater than Essix wear.[15] Mollov et al[24] found that only 50% of the patients with Hawley retainers still wore them one year after debond while two-thirds of bonded retainers were still in place. Wong and Freer[10] found fewer than 50% of patients compliant with removable retainer protocols. Kacer et al[61] found that often patients do not wear their retainers as instructed by the orthodontist, but rather choose their own regimen. In this study, since patient charts were not reviewed to determine actual prescribed regimens, statements pertaining to the accuracy of respondents' report on compliance cannot be made. The responses may be biased which is limitation of survey studies.

SATISFACTION WITH THE RETAINERS

APPEARANCE

In both the maxillary and mandibular arch, bonded retainers were rated the most esthetic, followed by Essix retainers. Hawley retainers were rated the least esthetic. Kumar and Bansal[14] studied the effectiveness and acceptability of Essix and Begg (Hawley) retainers. They reported that patients in the Essix group scored the appearance of their Essix retainers more positively than subjects in the Begg group. Hichens et al[82] also found that Hawley retainers caused greater embarrassment than Essix retainers specifically with respect to retainer esthetics.

Three quarters of the patients who received only a mandibular Essix retainer rated the appearance of the retainer as good but receiving an additional retainer affected this response. Exposure to another retainer reduced the rating of the appearance of the mandibular Essix retainer by 30%. This result was not statistically significant. Patients may initially believe that vacuum formed retainers are more esthetic than other types. Receiving an additional retainer may change their perspective towards the unaesthetic appearance of that retainer thereby reducing the rating of the Essix in comparison.

SPEECH

In the present study a maxillary retainer caused more speech impediment than a mandibular retainer (62% vs 35%), regardless of the retainer type. With respect to the maxillary arch, Hawley retainers affected speech most often (81%), followed by Essix (62%) and then bonded retainers (8%). Hichens et al[82] published that Hawley retainers cause greater humiliation as compared to Essix retainers due to their interference with speech. This may be explained by the palatal acrylic coverage of the maxillary Hawley.[83] Stratton et al[83] suggested that a key to minimizing speech difficulties is to reduce the amount of acrylic coverage. In the mandible, Essix and Hawley retainers were each reported to affect speech in about 60% of the patients, while mandibular bonded retainers only affected speech in 6%. The minimal interference of the mandibular bonded retainers with tongue position, as compared to mandibular Essix and Hawley retainers, that sit adjacent to the tongue and cover the arch perimeter, are potentially associated with these findings.[53,84]

ORAL HYGIENE AND EASE OF MAINTAINING THE RETAINER

In the literature it has been noted that bonded retainers can complicate oral hygiene procedures and accumulate plaque and calculus.[85] Some studies report that multistranded wires tend to accumulate more plaque than stainless steel round wires,[51] while others report no difference in plaque accumulation based on the type of wire used as a bonded retainer.[86]

The present survey found no significant association between age and oral hygiene maintenance with the prescribed retainer, but a trend was noted that with increasing age the respondent found it more difficult to maintain their oral hygiene. A greater number of females reported difficulty in keeping their teeth clean when prescribed a maxillary retainer. Females are more concerned about dental esthetics.[72] may work towards better oral hygiene,[87] and experience greater difficulty in maintaining it with any type of prescribed retainer. In a study on caries incidence, Zachrisson et al[87] found that females had better plaque index scores than males did.

As time since debond elapsed patients found it more difficult to keep their teeth clean, and this association was significant in the mandibular arch. A greater number of bonded retainers were prescribed for the

mandibular arch. Storman and Ehmer[50] found increased plaque accumulation around fixed retainers. Perhaps deterioration of the appliance over time resulted in further increased accumulation of plaque.

Turkoz et al[16] investigated the influence of thermoplastic retainers on Streptococcus mutans and Lactobacillus colonies and found that Essix may create oral conditions stimulating accumulation of these bacteria on dental surfaces. Takeuchi et al[54] detected viable strains of bacteria in the acrylic used for dentures, which is similar to the acrylic used in Hawley retainers. While all three types of retainers can harbor bacteria, this study compared relative ease of keeping the retainer clean and the ease of keeping the oral cavity clean when a particular retainer was prescribed.

This study found that maxillary Essix retainers were the easiest for patient to maintain oral hygiene, while bonded retainers were the most difficult. The inability to remove the appliance and brush and floss may be a potential reason.[86] With respect to the mandibular arch, 76% of the patients reported that when attempting to keep their teeth clean it was easy to work with either the Hawley retainer or the Essix retainer. Only half of the patients reported this for bonded retainers.

Overall 12-17% of the patients found it difficult to keep their retainers clean. Maxillary and mandibular Essix retainers were the easiest to keep clean and bonded retainers the most difficult. Heier and colleagues[88] studied the periodontal implications of bonded versus removable retainers and concluded that limited gingival inflammation was found in the presence of both bonded and removable retainers. However, more plaque and calculus was found in the bonded retainer group.

The patient group that received a mandibular Hawley reported that the retainer was difficult to keep clean. This is in contrast to the patient group that received a mandibular Hawley plus another retainer who found it easy to keep the Hawley clean. It would appear that the exposure to another type of retainer changes the perspective on maintaining Hawley retainers. The reverse was seen for maxillary Essix retainers, where having another retainer seems to make patients think maintaining the Essix was not as easy.

Replacement Retainers

Artun et al[56] assessed the survival rate of three types of bonded and one removable retainer. No difference in survival of any of the retainers was found after a three year period. A small sample size was cited as a possible cause for this finding. Zachrission[48] reported the clinical failure rate of direct bonded retainers to be low, at 5%. In another study Artun[89] and his colleagues reported the failure rate of a well-contoured bonded retainer placed close to the alveolar ridge as 10%. Mollov et al[25] and Schneider et al[24,69] reported a high rate of failure of bonded retainers (up to 35%) and a lack of operator experience was suggested as a potential cause.

The results of this survey showed that mandibular retainers needed to be replaced in fewer subjects than maxillary retainers did (18% vs 31%). This may be associated with the fact that removable retainers are more frequently prescribed for the maxillary arch, and are reported to be easily lost or broken.[90] Also, the failure rate of bonded retainers in the maxilla is twice that of the mandible, due to occlusal loading factors.[49]

Unlike Lumsden,[83] this study found a greater number of females had their retainers replaced as compared to males. In a study on factors affecting satisfaction of dental appearance Baubiniene and Sidlauskas[91] found that girls were more critical of their dental esthetics. Minor relapse may result in females more frequently pursuing follow-up action and obtaining new retainers.

In the maxilla bonded retainers were replaced most often (50%), followed by Essix (33%) and Hawley (21%) retainers. As noted above occlusal loading may contribute to the failure of maxillary bonded retainers. A review by David Bearn[49] found inadequate amounts of bonding resin, and low resin abrasion resistance, to be the cause of failure of bonded retainers. Mandibular Essix retainers were replaced in 28% of the sample and Hawley retainers in 18% of the sample. Mandibular bonded retainers were replaced least often at 9%. Hichens et al[15] found that patients with Hawley retainers returned to the office due to retainer failure more often than patients with Essix retainers. They also found that vacuum-formed retainers were more cost effective, for both the practitioner and the patient, over a six month period. The difference between our findings and the report by Hichens et al[15] may be due to the fact that their study investigated a six month retention period only. The thermoplastic material that Essix retainers are made of may be more prone to failure over a longer period of time.[15] The present study involved patients returning for one and two year retention checks, which provides a more long-term assessment of retainer survival.

The most common reasons for needing replacement of the removable retainers were losing it (40% maxilla, 39% mandible), followed by tooth movement resulting in the retainer no longer fitting (24% maxilla, 28% mandible) and breakage (24% maxilla, 22% mandible). There were no significant differences between age or gender and reasons for replacement. As time in retention increased the percentage of mandibular retainers that broke or were lost increased as expected (10-20% per category). Pratt et al[15] found that approximately 10% of their sample population lost their removable retainers over a two-year retention period, and Pandis et at[92] reported that 46% of fixed retainers would require replacement due to failure over a similar two-year observation term.

PREFERRED RETAINERS

The majority of patients stated that they were satisfied with the retainer they were given. Satisfaction with the prescribed maxillary retainer was reported as 77%, and with the prescribed mandibular retainer was 86%. A greater number of patients in the two year retention group indicated that they would have

preferred a different type of maxillary retainer. This may be due to wear and tear of the prescribed retainer.[15] Trends noted were that patients with maxillary or mandibular Hawleys were most likely to indicate that they would have preferred a different retainer and patients with bonded retainers were least likely to prefer a different retainer. Of those who would have preferred a different retainer, Essix retainers were most frequently desired in the upper arch and bonded retainers in the lower arch. It was found that age may play a role in retainer preferences as younger patients were more likely to prefer maxillary bonded or Hawley retainers while older patients were more likely to prefer Essix retainers.

Retainer preferences, based on the type of retainer the patient had, depicted that patients with maxillary or mandibular bonded retainers, who would have preferred another retainer, most often preferred an Essix retainer. The maxillary Essix group preferred Hawleys and vice versa. The mandibular Essix and Hawley groups denoted a preference for bonded retainers. Hichens et al[82] noted that Essix retainers were generally preferred over Hawley retainers. Kumar and Bansal[14] found mixed responses pertaining to Essix and Begg (Hawley) retainers. Essix retainers were appreciated for their appearance and comfort and Begg retainers were preferred for chewing and biting abilities. Different patients, for different reasons, preferred each one. Millet et al[28] reported a preference for bonded retainers by patients and Essix retainers by orthodontists.

Study Critique and Future Research

During the survey design, protocols from previous publications of surveys on patient compliance,[15] retention practices[20] and patient satisfaction[46] were reviewed. The survey was administered to all consecutive patients attending their one or two-year retention appointment, and as a result, there was a very high response rate and reduced response bias. Another strength of the study were the systematic survey design and the stratified questionnaire. Advanced skip logic was used to streamline the response process and limit overall patient burnout. Questions were designed to address the maxillary and mandibular arch independently and the 'I don't know' response option was available for patients to select. Continuously moving, sliding selection indicators were not used, thereby making it easier to determine an exact response. Patients surveyed were debonded one or two years ago and it has been reported that half of the total relapse occurs during the first two years of retention.[35]

The data collected allows previously published results to be supported or refuted thereby enhancing their clinical significance. Repeating research in different populations allows readers to compare conclusions, as variations in patients' socioeconomic status and cultural influences can alter the results. The study also provides a different outlook on treatment satisfaction and retention. Patients' perspectives are evaluated and various contributing factors to patient satisfaction and relapse can be co-related. Subsections created

based on types of retainers, is a novel means of analyzing retention regimens, prescribed protocols and compliance.

Limitations of the study include the small sample size, especially when assessing groups of patients with multiple prescribed retainers. The patients surveyed attended retention appointments. Attendance of the retention appointment may introduce bias into the study sample, as those patients who attend the

appointment may demonstrate increased compliance when compared to others, or may have an increased number of concerns, which brought them back to the clinic. Data with respect to patients who did not attend their retention appointment was not collected or analyzed. When individual retainers prescribed were assessed, as compared to groups of retainers prescribed per patient, exposure to another retainer may be reported as a confounding factor, but an attempt was made to account for this during the data analysis. Responses to questions pertaining to stability and satisfaction with treatment could not be directly correlated to individual types of retainers, as patients may have been prescribed more than one type of retainer per arch.

Other limitations included variability in the response rate with respect to each question. Patients had the ability to skip questions they did not want to answer. Information on the non-respondents (individuals who skipped questions) was not collected or analyzed. The data collected was self-reported and based on the patients' recollection. This may introduce bias and there may be a degree of over reporting of compliance. The age range of the sample was limited; most patients were in the adolescent age group. Type of orthodontic treatment rendered or the original malocclusion was not analyzed and these factors may affect stability and satisfaction.

Areas of future research, may include:

a) Continue collection of current survey data to obtain a larger sample size and increase power so that clinical/statistical significance may be determined for a larger number of variables.

b) A follow up to the current study, assessing patient charts and models and determining the actual retention protocols and relapse rates as compared to the reported ones.

c) A study on retention protocols detailing the associations between full-time regimes, part-time regimens and satisfaction and stability.

CONCLUSIONS

With respect to the population surveyed, the following conclusions were established:

1) The most commonly prescribed maxillary retainer at Western University is the Essix and the most commonly prescribed mandibular retainer is the bonded. Age, gender or time since debond did not affect the orthodontists' choice of retainer prescribed.
2) Satisfaction with dental alignment at deband was approximately 90% with little change at the retention appointment. Females and those receiving multiple retainers in the maxilla reported reduced satisfaction.
3) Relapse was reported more frequently in the maxillary arch as compared to the mandibular arch. Retainers prescribed depicted no associations with reported relapse.
4) Essix retainers were most frequently associated with a one to six month full-time wear regimen and Hawley retainers a three months to one year full-time wear regimen. Two-thirds of the patients still wore their retainers at least part-time at the one and two year retention appointments.
5) Self-reported compliance with full time retainer use ranged from 75-84% and part time retainer wear was 82-83%. Removable retainer type did not significantly influence compliance.
6) Bonded retainers were rated the most esthetic and Hawley retainers the least esthetic.
7) Maxillary Hawley retainers were reported to affect speech most often. Bonded retainers affected speech the least.
8) Females had the greatest difficulty in maintaining their oral hygiene with the prescribed maxillary retainer and as time since debond increased patients found it more difficult to keep their teeth clean with the prescribed mandibular retainer. Bonded retainers made it the most difficult to maintain oral hygiene in both the maxillary and mandibular arches.
9) Mandibular bonded retainers were the most difficult to keep clean and Essix retainers the easiest.
10) More females required retainer replacement during the retention period than males did. Bonded retainers required replacement most frequently in the maxilla while Essix retainers required replacement most frequently in the mandible.
11) The most frequent reason for replacement of a maxillary or mandibular removable retainer was that it was lost.
12) Satisfaction with the type of retainer prescribed was found to be 77% in the maxillary arch and 86% in the mandibular arch. If another retainer was preferred, Essix retainers were most frequently requested in the maxilla and bonded retainers in the mandible.

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APPENDICES

APPENDIX A (SURVEY)

Retention: Patient Compliance and Satisfaction

Q1 You have received this survey because you have agreed to participate in a research study investigating post orthodontic treatment retention. Your participation in this study is voluntary and you may drop out at any time or refuse to answer any specific question included in this survey. Your decision to participate in the study, or not, and to refuse to answer any questions in this survey will have no impact on your current or future orthodontic care at the Graduate orthodontic Clinic at Western University.

Q.2 What is your name?

_____

Q.3 What is your date of birth? dd/mm/yyyy

_____

Q.4 What is your gender?

Male	1
Female	2

Q.5 This survey will refer to the time you wore braces and a period of time after your braces were removed, during which you may or may not have worn a retainer. For this survey, braces were used for the purpose of moving, straightening or aligning your teeth. A retainer, if provided, was used for the purpose of preventing your teeth from moving or shifting after the braces were removed?

Q.6 How long ago were your braces removed?

1 year ago	1
2 years ago	2

Q.7 The following three questions refer to how happy you were with your teeth immediately after your braces were removed.

Q.8 Select one of the following options, indicate how happy you were with the appearance of your upper teeth immediately after your braces were removed.

Very unhappy	1
Somewhat unhappy	2
Neither unhappy nor happy	3
Somewhat happy	4
Very happy	5
Do not know	6

Q.9 Select one of the following options, indicate how happy you were with the appearance of your lower teeth immediately after your braces were removed.

Very unhappy	1
Somewhat unhappy	2
Neither unhappy nor happy	3
Somewhat happy	4
Veryhappy	5
Do not know	6

Q.10 Select one of the following indicate how happy you were with your bite (i.e. the way your top and bottom teeth fit together) immediately after your braces were removed

Very unhappy	1
Somewhat unhappy	2
Neither unhappy nor happy	3
Somewhat happy	4
Very happy	5
Do not know	6

Q.11 The following three questions refer to how happy you are with your teeth today

Q.12 Select one of the following, indicate how happy you are with the appearance of your upper teeth today

Very unhappy	1
Somewhat unhappy	2
Neither unhappy nor happy	3
Somewhat happy	4
Very happy	5
Do not know	6

Q.13 Select one of the following, indicate how happy you are with the appearance of your lower teeth today.

Very unhappy	1
Somewhat unhappy	2
Neither unhappy nor happy	3
Somewhat happy	4
Very happy	5
Do not know	6

Q.14 Select one of the following, indicate how happy you are with your bite (i.e. the way your upper and lower teeth fit together) today

Very unhappy	1
Somewhat unhappy	2
Neither unhappy nor happy	3
Somewhat happy	4
Very happy	5
Do not know	6

Q.15 The next three questions refer to how much your teeth have shifted or moved since your braces were removed.

Q.16 Select one of the following, indicate how much you think your upper teeth have moved or shifted since your braces were removed

Moved a lot	1
Moved a little	2
Have not moved	3
Do not know	4

Q.17 Select one of the following, indicate how much your lower teeth have moved or shifted since your braces were removed

Moved a lot	1
Moved a little	2
Have not moved	3
Do not know	4

Q.18 Select one of the following, indicate how much your bite (i.e. the way your upper and lower teeth fit together) has changed since your braces were removed

Changed a lot	1
Changed a little	2
Has not changed	3
Do not know	4

Q.19 In some cases, after the brackets were removed patients were given an orthodontic retainer appliance. A retainer is used to prevent your teeth from shifting after your braces are removed. These retainers can be Bonded to teeth so that they are worn all the time or you may be able to remove them from your mouth. Next there are pictures of retainers used for upper and lower teeth following orthodontic tooth movement.

Q.20 Upper Hawley Retainer

Q.21 Upper Clear Retainer

Q.22 Upper Bonded Retainer

Q.23 Lower Hawley Retainer

Q.24 Lower Clear Retainer

Q.25 Lower Bonded Retainer

Q.26 Did the graduate orthodontic resident provide you with any type of upper retainer after your braces were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 87]

Q.27 The following questions are related to your upper jaw and the use of a retainer

Q.28 With respect to your upper jaw, did your orthodontic resident give you a Hawley Retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 52]

Q.29 Did your orthodontic resident INSTRUCT you to wear your upper Hawley retainer full time (both day and night, including sleeping, i.e. >20 hours per day)?

Yes	1
NO	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 30]

Q.30 Did you actually wear your upper Hawley retainer full time (both day and night including while sleeping, i.e. >20hrs per day)?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 33]

Q.31 Please estimate how long you actually wore your upper Hawley retainer full time (both day and night including while sleeping, i.e. >20hrs per day)?

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 33]

Q.32 Please specify...

_____

Q.33 Did your orthodontic resident INSTRUCT you to wear your upper Hawley retainer overnight only (only while sleeping, not during the day)?

Orthodontists occasionally ask you to wear your upper retainer >20hrs for a short while and then switch to overnight i.e. when you are sleeping only.

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 34]

Q.34 Did you actually wear your upper Hawley retainer overnight (not during the day but you wore it when you slept)?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 37]

Q.35 Please estimate how long you wore your upper Hawley retainer overnight?

This may pertain to the period you wore your retainer while sleeping only, after you switched from full time wear >20 hrs.

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 37]

Q.36 Please specify....

_____

Q.37 Do you currently wear your upper Hawley retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 40]

Q.38 How often do you wear your upper Hawley retainer at present?

Every night	1
Every two days	2
Once a week	3
Once a month	4
Once every few months	5
Once a year	6
Other	7
I do not know	8

[IF THE ANSWER IS 1-6 OR 8, THEN SKIP TO QUESTION 40]

Q.39 Please specify...

_____

Q.40 Please select all of the following that pertain to the use of your upper Hawley retainer.

I do not like the way it looks	1
I do not like the way it feels	2
I forget to wear it	3
I lost it	4
It does not fit right	5
I find it affects my speech	6
Other	7
None of the above	8

[IF THE ANSWER IS 1-6 OR 8, THEN SKIP TO QUESTION 42]

Q.41 Please specify...

_____

Q.42 Please select one of the following to indicate how you would rate the appearance of your upper Hawley retainer?

Very poor	1
Somewhat poor	2
Neither poor nor good	3
Somewhat good	4
Very good	5
Do not know	6

Q.43 Please select one of the following to indicate if your upper Hawley retainer affected your speech**.**

Not at all	1
Somewhat affected my speech	2
Severely affected my speech	3
Do not know if it affected my speech	4

Q.44 Please select one of the following to indicate how easy/difficult it was to maintain the oral hygiene of your upper teeth and gums?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.45 Please select one of the following to indicate how easy/difficult it was to keep your upper Hawley retainer clean?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.46 Did you have to get your upper Hawley retainer replaced since the original one was provided when your brackets were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 49]

Q.47 Why did you replace your upper Hawley retainer?

It is not fit right from the first day	1
It broke	2
I lost it	3
My teeth moved so it no longer fit after a while	4
Do not know	5
Other	6

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 49]

Q.48 Please specify...

_____

Q.49 Would you have preferred a different type of upper retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 52]

Q.50 Please indicate what type of upper retainer you would have preferred.

None	1
Clear retainer	2
Bonded wire retainer	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 52]

Q.51 Please specify....

_____

Q.52 With respect to your upper jaw, did your orthodontic resident give you a Clear retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 76]

Q.53 Did your orthodontic resident INSTRUCT you to wear your upper Clear retainer full time (both day and night, including sleeping, i.e. >20 hours per day)?

Yes	1
NO	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 54]

Q.54 Did you actually wear your upper Clear retainer full time (both day and night including while sleeping, i.e. >20hrs per day)?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 57]

Q.55 Please estimate how long you actually wore your upper Clear retainer FULL TIME (both day and night including while sleeping)?

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 57]

Q.56 Please specify

_____

Q.57 Did your orthodontic resident INSTRUCT you to wear your upper Clear retainer overnight only (only while sleeping, not during the day)?
This may pertain to a switch to overnight use only after a period of full time wear.

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 58]

Q.58 Did you actually wear your upper Clear retainer OVERNIGHT (not during the day but you wore it when you slept)?
This may pertain to a period of overnight use only after switching from full time use.

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 61]

Q.59 Please estimate how long you actually wore your upper Clear retainer OVERNIGHT?
This may pertain to the period after wearing the retainer full time when you were asked to then wear it overnight only.

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 61]

Q.60 Please specify...

_____

Q.61 Do you currently wear your upper Clear retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 64]

Q.62 How often do you wear your upper Clear retainer at present?

Every night	1
Every two days	2
Once a week	3
Once a month	4
Once every few months	5
Once a year	6
other	7
I do not know	8

[IF THE ANSWER IS 1-6 OR 8, THEN SKIP TO QUESTION 64]

Q.63 Please specify...

_____

Q.64 Please select all of the following that pertain to the use of your upper Clear retainer.

I do not like the way it looks	1
I do not like the way it feels	2
I forget to wear it	3
I lost it	4
It does not fit right	5
I find it affects my speech	6
Other	7
None of the above	8

[IF THE ANSWER IS 1-6, THEN SKIP TO QUESTION 66]

Q.65 Please specify...

_____

Q.66 Please select one of the following to indicate how you would rate the appearance of your upper Clear retainer**.**

Very poor	1
Somewhat poor	2
Neither poor nor good	3
Somewhat good	4
Very good	5
Do not know	6

Q.67 Please select one of the following to indicate if your upper Clear retainer affected your speech**.**

Not at all	1
Somewhat affected my speech	2
Severely affected my speech	3
Do not know if it affected my speech	4

Q.68 Please select one of the following to indicate how easy/difficult it was to maintain the oral hygiene of your upper teeth and gums?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.69 Please select one of the following to indicate how easy/difficult it was to keep your upper Clear retainer clean?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.70 Did you have to get your upper clear retainer replaced since the original one was provided when your brackets were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 73]

Q.71 Why did you replace your upper clear retainer?

It is not fit right from the first day	1
It broke	2
I lost it	3
My teeth moved so it no longer fit after a while	4
Do not know	5
Other	6

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 73]

Q.72 Other, please specify...

_____

Q.73 Would you have preferred a different type of upper retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 76]

Q.74 Please indicate what type of upper retainer you would have prefered.

None	1
Hawley retainer	2
Bonded wire retainer	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 76]

Q.75 Please specify....

_____

Q.76 With respect to your upper jaw, did your orthodontic resident give you a Bonded upper retainer?

Yes	1
No	2

Q.77 Please select one of the following to indicate how you would rate the appearance of your upper Bonded retainer?

Very poor	1
Somewhat poor	2
Neither poor nor good	3
Somewhat good	4
Very good	5
Do not know	6

Q.78 Please select one of the following to indicate if your upper Bonded retainer affected your speech**.**

Not at all	1
Somewhat affected my speech	2
Severely affected my speech	3
Do not know if it affected my speech	4

Q.79 Please select one of the following to indicate how easy/difficult it was to maintain the oral hygiene of your upper teeth and gums?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.80 Please select one of the following to indicate how easy/difficult it was to keep your upper Bonded retainer clean?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.81 Did you have to get your upper Bonded retainer replaced since the original one was Bonded when your brackets were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 84]

Q.82 Why did you replace your upper Bonded retainer?

It broke	1
My front teeth moved even with the retainer on	2
It debonded from my teeth	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-3, THEN SKIP TO QUESTION 84]

Q.83 Please specify...

_____

Q.84 Would you have preferred a different type of upper retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 87]

Q.85 Please indicate what type of upper retainer you would have prefered.

None	1
Hawley retainer	2
Clear retainer	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 87]

Q.86 Please specify...

_____Q.87 Did the graduate orthodontic resident provide you with any type of lower retainer after your braces were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 148]

Q.88 The following questions are related to your lower jaw and the use of a retainer

Q.89 With respect to your lower jaw, did your orthodontic resident give you a Hawley retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 113]

Q.90 Did your orthodontic resident INSTRUCT you to wear your lower Hawley retainer full time (both day and night, including sleeping, i.e. >20 hours per day)?

Yes	1
NO	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 91]

Q.91 Did you actually wear your lower Hawley retainer full time (both day and night including while sleeping, i.e. >20hrs per day)?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 94]

Q.92 Please estimate how long you actually wore your lower Hawley retainer full time (both day and night including while sleeping, i.e. >20hrs per day)?

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 94]

Q.93 Please specify...

_____

Q.94 Did your orthodontic resident INSTRUCT you to wear your lower Hawley retainer overnight only (only while sleeping, not during the day)?

Your orthodontic resident may have asked you to switch from full time wear to overnight wear only. This would pertain to how long they then told you to wear the retainer overnight.

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 95]

Q.95 Did you actually wear your lower Hawley retainer overnight (not during the day but you wore it when you slept)?

This may pertain to the period of overnight use only which may be after full time use.

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 98]

Q.96 Please estimate how long you wore your lower Hawley retainer overnight?

This would pertain to wearing your retainer while sleeping only, it may be after a period of full time use or right from the beginning.

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 98]

Q.97 Please specify...

_____

Q.98 Do you currently wear your lower Hawley retainer**?**

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 101]

Q.99 How often do you wear your lower Hawley retainer at present?

Every night	1
Every two days	2
Once a week	3
Once a month	4
Once every few months	5
Once a year	6
other	7
I do not know	8

[IF THE ANSWER IS 1-6 OR 8, THEN SKIP TO QUESTION 101]

Q.100 Please specify...

_____

Q.101 Please select all of the following that pertain to the use of your lower Hawley retainer.

I do not like the way it looks	1
I do not like the way it feels	2
I forget to wear it	3
I lost it	4
It does not fit right	5
I find it affects my speech	6
Other	7
None of the above	8

[IF THE ANSWER IS 1-6 OR 8, THEN SKIP TO QUESTION 103]

Q.102 Please specify..

_____

Q.103 Please select one of the following to indicate how you would rate the appearance of your lower Hawley retainer?

Very poor	1
Somewhat poor	2
Neither poor nor good	3
Somewhat good	4
Very good	5
Do not know	6

Q.104 Please select one of the following to indicate if your lower Hawley retainer affected your speech**.**

Not at all	1
Somewhat affected my speech	2
Severely affected my speech	3
Do not know if it affected my speech	4

Q.105 Please select one of the following to indicate how easy/difficult it was to maintain the oral hygiene of your lower teeth and gums?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.106 Please select one of the following to indicate how easy/difficult it was to keep your lower Hawley retainer clean?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.107 Did you have to get your lower Hawley retainer replaced since the original one was provided when your brackets were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 110]

Q.108 Why did you replace your lower Hawley retainer?

It is not fit right from the first day	1
It broke	2
I lost it	3
My teeth moved so it no longer fit after a while	4
Do not know	5
Other	6

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 110]

Q.109 Please specify....

_____

Q.110 Would you have preferred a different type of lower retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 113]

Q.111 Please indicate what type of lower retainer you would have prefered.

None	1
Clear retainer	2
Bonded wire retainer	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 113]

Q.112 Please specify...

_____

Q.113 With respect to your lower jaw, did your orthodontic resident give you a Clear retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 137]

Q.114 Did your orthodontic resident INSTRUCT you to wear your lower Clear retainer full time (both day and night, including sleeping, i.e. >20 hours per day)?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 115]

Q.115 Did you actually wear your lower Clear retainer full time (both day and night including while sleeping, i.e. >20hrs per day)?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 118]

Q.116 Please estimate how long you actually wore your lower Clear retainer FULL TIME (both day and night including while sleeping)?

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 118]

Q.117 Please specify

_____

Q.118 Did your orthodontic resident INSTRUCT you to wear your lower Clear retainer **o**vernight only (only while sleeping, not during the day)?

Your orthodontic resident may have asked you to switch from full time wear to overnight use of your retainer only. This would pertain to any period of overnight use only (even if it is after full time wear).

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 119]

Q.119 Did you actually wear your lower Clear retainer OVERNIGHT (not during the day but you wore it when you slept)?

This pertains to wearing your retainer while you are sleeping only, including if this was after you switched from full time use.

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 122]

Q.120 Please estimate how long you actually wore your lower Clear retainer OVERNIGHT?

While sleeping only, even it is was after you switched from full time use.

1 week	1
2 weeks	2
1 month	3
3 months	4
6 months	5
1 year	6
2 years	7
other	8
I don't know	9

[IF THE ANSWER IS 1-7 OR 9, THEN SKIP TO QUESTION 122]

Q.121 Please specify...

_____

Q.122 Do you currently wear your lower Clear retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 125]

Q.123 How often do you wear your lower Clear retainer at present?

Every night	1
Every two days	2
Once a week	3
Once a month	4
Once every few months	5
Once a year	6
other	7
I do not know	8

[IF THE ANSWER IS 1-6 OR 8, THEN SKIP TO QUESTION 125]

Q.124 Please specify....

_____

Q.125 Please select all of the following that pertain to the use of your lower Clear retainer.

I do not like the way it looks	1
I do not like the way it feels	2
I forget to wear it	3
I lost it	4
It does not fit right	5
I find it affects my speech	6
Other	7
None of the above	8

[IF THE ANSWER IS 1-6, THEN SKIP TO QUESTION 127]

Q.126 Please specify....

_____

Q.127 Please select one of the following to indicate how you would rate the appearance of your lower Clear retainer.

Very poor	1
Somewhat poor	2
Neither poor nor good	3
Somewhat good	4
Very good	5
Do not know	6

Q.128 Please select one of the following to indicate if your lower Clear retainer affected your speech.

Not at all	1
Somewhat affected my speech	2
Severely affected my speech	3
Do not know if it affected my speech	4

Q.129 Please select one of the following to indicate how easy/difficult it was to maintain the oral hygiene of your lower teeth and gums?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
I do not know	6

Q.130 Please select one of the following to indicate how easy/difficult it was to keep your lower Clear retainer clean?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.131 Did you have to get your lower clear retainer replaced since the original one was provided when your brackets were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 134]

Q.132 Why did you replace your lower clear retainer?

It is not fit right from the first day	1
It broke	2
I lost it	3
My teeth moved so it no longer fit after a while	4
Do not know	5
Other	6

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 134]

Q.133 Please specify....

_____

Q.134 Would you have preferred a different type of lower retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 137]

Q.135 Please indicate what type of lower retainer you would have prefered.

None	1
Hawley retainer	2
Bonded wire retainer	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 137]

Q.136 Please specify....

_____

Q.137 With respect to your lower jaw, did your orthodontic resident give you a Bonded lower retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 148]

Q.138 Please select one of the following to indicate how you would rate the appearance of your lower Bonded retainer?

Very poor	1
Somewhat poor	2
Neither poor nor good	3
Somewhat good	4
Very good	5
Do not know	6

Q.139 Please select one of the following to indicate if your lower Bonded retainer affected your speech**.**

Not at all	1
Somewhat affected my speech	2
Severely affected my speech	3
Do not know if it affected my speech	4

Q.140 Please select one of the following to indicate how easy/difficult it was to maintain the oral hygiene of your lower teeth and gums?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.141 Please select one of the following to indicate how easy/difficult it was to keep your lower Bonded retainer clean?

Very easy	1
Somewhat easy	2
Neither easy nor difficult	3
Somewhat difficult	4
Very difficult	5
Do not know	6

Q.142 Did you have to get your lower Bonded retainer replaced since the original one was Bonded when your brackets were removed?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 145]

Q.143 Why did you replace your lower Bonded retainer?

It broke	1
My front teeth moved even with the retainer on	2
It debonded from my teeth	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-3, THEN SKIP TO QUESTION 145]

Q.144 Please specify

_____

Q.145 Would you have preferred a different type of lower retainer?

Yes	1
No	2

[IF THE ANSWER IS 2, THEN SKIP TO QUESTION 148]

Q.146 Please indicate what type of lower retainer you would have prefered.

None	1
Hawley retainer	2
Clear retainer	3
Do not know	4
Other	5

[IF THE ANSWER IS 1-4, THEN SKIP TO QUESTION 148]

Q.147 Please specify...

Q.148 Thank you for your participation

APPENDIX B (ETHICS APPROVAL)

Western Research

Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Mr. Ali Tassi
File Number:102797
Review Level: Delegated
Approved Local Adult Participants:0
Approved Local Minor Participants:120
Protocol Title: Retention: types of retainers, patient compliance & satisfaction, and long term stability of orthodontic treatment
Department & Institution: Schulich School of Medicine and Dentistry\Schulich School of Medicine & Dentistry;Western University
Sponsor:
Ethics Approval Date: August 22, 2012 **Expiry Date:**June 30, 2013
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Western University Protocol		
Other	Phone Script	
Letter of Information & Consent		2012/06/26

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REBs as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

[redacted]

Signature

Ethics Officer to Contact for Further Information

[redacted]

This is an official document. Please retain the original in your files.

Western University, Support Services Bldg., Rm. 5150
1393 Western Rd., London, ON, N6G 1G9 t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/ethics

APPENDIX C (LETTER OF INFORMATION/CONSENT)

Western

Orthodontic treatment and retention protocols:

Patient compliance and Satisfaction

Letter of Information/Consent

The pronouns 'you' and 'your' should be read as referring to the participant rather than the parent/guardian who may be signing the consent form for the participant.

Purpose of Study

The purpose of the study is to determine the types of retainers prescribed by orthodontists after completion of treatment, typical retention protocols (periods of time retainers are prescribed for), patient compliance with wearing the retainers, long-term stability of treatment, and patient satisfaction with the treatment received and the long term results. The information may help clinicians modify their retention protocols. The study will be administered by Dr. Bhavana Sawhney at the University of Western Ontario, Graduate Orthodontic Clinic and will consist of a survey to be filled on an android tablet.

Procedures

We are inviting orthodontic patients of the UWO Graduate Orthodontic Clinic, who had treatment completed 1-2 years prior to the study initiation to participate in the study. This research study will be run involving only those who choose to take part. This letter of information and consent document describe the study so you can make an informed decision on participating. Please take time to make a decision and if necessary, discuss this proposal with your family and friends, as you feel inclined. Please feel free to ask questions if anything is unclear or there are words or phrases you do not understand. You have been asked to participate because you had orthodontic treatment completed at the Graduate Orthodontic Clinic at UWO 1-2 years ago.

If you agree to participate, you will be asked to come for a visit and fill in a questionnaire. A sample questionnaire will be shown to you prior to your final decision to participate. Additionally, if you have any treatment/retention related concerns or questions we will attempt to address/answer them.

Number of Participants

This study will require 120 participants.

Participant Inclusion and Exclusion Criteria

Participants will be included if they have received orthodontic treatment at the Graduate Orthodontic Clinic at UWO, if treatment was completed 1-2 years ago and if participants are willing to be included. Participants who are unable to make an informed consent will be excluded.

Description of Research

As a participant in this study you will be asked to:

1. Fill in a questionnaire

Time Requirements

The completion of the questionnaire should take approximately 10-15 minutes and will be completed during a scheduled visit to the clinic.

Risks

No known harm will be caused to the study participants due to their participation in the study. No personal identifiers will be used in the study.

Benefits

Participants in the study will be given an opportunity to express their opinions and concerns pertaining to both treatment and retention or relapse.

Right to Refuse

Your participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or you may withdraw from the study at any time with no effect on your future orthodontic treatment or retention follow up. You do not waive any of your legal rights by signing the consent form

Compensation for Participation

There is no compensation for the study.

Participation in concurrent or future studies

This study should not interfere with other studies you may choose to participate in. If you received orthodontic retreatment after being treated at our clinic please advise us as this will alter the results of our study.

Use of Data

Data collected via the questionnaires will be kept for 1 year. The data will be kept secured, password protected and locked in appropriate University facilities.

New Findings

If, during the course of this study, new information becomes available that may relate to your willingness to continue to participate, this information will be provided to you by the investigator.

Confidentiality

Your privacy will be respected. If the results of this study are published, your name will not be used and no information that discloses your identity will be collected or released.

To monitor the conduct of research, the research team, authorized study personnel and University of Western Ontario Health Science Research Ethics Board (UWO HSREB) may require access to your study-related records. Additionally, representatives of UWO HSREB may follow-up with you directly for the same purpose.

All participants will be given a study number. Only that number will be used on any study analysis related documents.

By signing the consent form you allow Dr. Sawhney to review the questionnaire you will fill in.

We cannot guarantee that the results of this study will be made accessible to you, but if you would like to be informed of the outcome of the study you are asked to provide current contact information.

Contacts

If you have any questions or concerns about your rights as a research study participant or the conduct of the study you may contact [ ] Scientific Director care of the Lawson Research Institute at [ ]

If you have any questions during the study, or wish to withdraw from the study at any time, you may contact Dr. [ ] at [ ]

Consent

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

Participant Name (Please Print): _____

Legal Guardian Name (Please print): _____

Legal Guardian Signature: _____ _____ Date: _____

Person Obtaining Informed Consent:_____

Signature: _____ Date: _____

APPENDIX D (TABLES)

RETAINER DISTRIBUTION

Table 54 Combinations of Maxillary Retainers Prescribed Per Patient

	Frequency (Percent)
Bonded	4 (3.1)
Hawley and Bonded	7 (5.5)
Essix	47 (37.0)
Essix and Bonded	7 (5.5)
Essix, Hawley and Bonded	8 (6.3)
Essix and Hawley	31 (24.4)
Hawley	23 (18.1)
Total	130 (99.2)

Table 55 Combinations Of Mandibular Retainers Prescribed Per Patient

	Frequency (Percent)
Bonded	53 (43.1)
Bonded and Hawley	2 (1.6)
Essix	42 (34.1)
Essix and Bonded	11 (8.9)
Essix, Hawley and Bonded	1 (0.8)
Essix and Hawley	7 (5.7)
Hawley	7 (5.7)
Total	123 (100.0)

Table 56 Maxillary Retainers Prescribed Per Patient By Demographics

	Maxillary Retainers Prescribed Per Patient During Retention								Total
	Bonded	Hawley and Bonded	Essix	Essix and Bonded	Essix, Hawley and Bonded	Essix and Hawley	Hawley	None	
13.0 - 16.9	0(0.0%)	2(5.9%)	14(41.2%)	3(8.8%)	0(0.0%)	8(23.5%)	6(17.6%)	1(2.9%)	34
17.0-20.9	4(5.6%)	3(4.2%)	22(30.6%)	2(2.8%)	7(9.7%)	19(26.4%)	13(18.1%)	2(2.8%)	72
>21.0	0(0.0%)	2(8.3%)	11(45.8%)	2(8.3%)	1(4.2%)	4(16.7%)	4(16.7%)	0(0.0%)	24
				p=.49					
Male	2(4.3%)	0(0.0%)	19(40.4%)	2(4.3%)	0(0.0%)	12(25.5%)	9(19.1%)	3(6.4%)	47
Female	2(2.4%)	7(8.4%)	28(33.7%)	5(6.0%)	8(9.6%)	19(22.9%)	14(16.9%)	0(0.0%)	83
				p=.1					
1yr	2(3.4%)	5(8.6%)	17(29.3%)	3(5.2%)	3(5.2%)	20(34.5%)	6(10.3%)	2(3.4%)	58
2yrs	2(2.8%)	2(2.8%)	30(41.7%)	4(5.6%)	5(6.9%)	11(6.9%)	17(23.6%)	1(1.4%)	72
				p=.07					
Total	4(3.1%)	7(5.4%)	47(36.2%)	7(5.4%)	8(6.2%)	31(23.8%)	23(17.7%)	3(2.3%)	130(100%)

Table 57 Mandibular Retainer Groups Per Patient By Demographics

	Mandibular Retainers Prescribed Per Patient During Retention							
	Bonded	Bonded and Hawley	Essix	Essix and Bonded	Essix, Hawley and Bonded	Essix and Hawley	Hawley	Total
13.00-16.99	17(51.5%)	1(3.0%)	12(36.4%)	1(3.0%)	0(0.0%)	1(3.0%)	1(3.0%)	
17.00-20.99	27(40.3%)	1(1.5%)	20(29.9%)	7(10.4%)	1(1.5%)	6(9.0%)	5(7.5%)	67
>21.00	9(39.1%)	0(0.0%)	10(43.5%)	3(13.0%)	0(0.0%)	0(0.0%)	1(4.3%)	23
				p=.76				
Male	17(39.5%)	0(0.0%)	15(34.9%)	5(11.6%)	1(2.3%)	2(4.7%)	3(7.0%)	43
Female	36(45.0%)	2(2.5%)	27(33.8%)	6(7.5%)	0(0.0%)	5(6.3%)	4(5.0%)	80
				p=.78				
1yr	22(39.3%)	0(0.0%)	22(39.3%)	6(10.7%)	0(0.0%)	4(7.1%)	2(3.6%)	56
2yrs	31(46.3%)	2(3.0%)	20(29.9%)	5(7.5%)	1(1.5%)	3(4.5%)	5(7.5%)	67
				p=.66				
Total	53(43.1%)	2(1.6%)	42(34.1%)	11(8.9%)	1(0.8%)	7(5.7%)	7(5.7%)	123(100%)

RETENTION REGIMENS

Table 58 Current Use Of The Maxillary Retainer By Time Since Debond

		Do you currently wear your UR		Total
		yes	no	
How long ago were your braces removed	1yr	54(69.2%)	24(30.8%)	78
	2yrs	54(67.5%)	26(32.5%)	80
Total		108(68.4%)	50(31.6%)	158(100.0%)

chi square p=.5

APPEARANCE OF THE RETAINERS

Table 59 Retainer Esthetics Associated With Exposure To Only A Maxillary Essix Versus An Additional Retainer

		Rate the appearance of your upper retainer			Total
		Poor	Neither poor nor good	Good	
UR groups multi R groups combined	Maxillary Essix plus another retainer	2(4.4%)	7(15.6%)	36(80.0%)	45
	Essix	2 (4.3%)	10(21.3%)	35(74.5%)	47
Total		4(4.3%)	17(18.5%)	71(77.2%)	92(100.0%)

fisher's exact p=.78

Table 60 Retainer Esthetics Associated With Exposure To Only A Maxillary Hawley Versus An Additional Retainer

		Rate the appearance of your upper retainer			Total
		Poor	Neither poor nor good	Good	
UR groups multi R groups combined	Mx Hawley retainer plus another retainer	6(14.0%)	10(23.3%)	27(62.8%)	43
	Hawley	5(21.7%)	6(26.1%)	12(52.2%)	23
Total		11(16.7%)	16(24.2%)	39(59.1%)	66(100.0%)

chi square p=.64

Table 61 Retainer Esthetics Associated With Exposure To Only A Mandibular Essix Versus An Additional Retainer

		Rate the appearance of your LR			Total
		Poor	Neither poor nor good	Good	
LR groups	Mandibular Essix plus another retainer	2(10.5%)	8(42.1%)	9(47.4%)	19
	Essix	0 (0.0%)	10(23.8%)	32(76.2%)	42
Total		2 (3.3%)	18(29.5%)	41(67.2%)	61(100.0%)

fisher's exact p=.24

Table 62 Retainer Effects On Speech Associated With Exposure To Only A Maxllary Essix Versus An Additional Retainer

		Does your upper retainer affect your speech		Total
		Did not affect my speech	Affected my speech	
UR groups multi R groups combined	Maxillary Essix plus another retainer	18(41.9%)	25(58.1%)	43
	Essix	15(34.1%)	29(65.9%)	44
Total		33(37.9%)	54(62.1%)	87(100.0%)

chi square p=.46

Table 63 Retainer Effects On Speech Associated Wtih Exposure To Only A Maxillary Bonded Versus An Additional Retainer

		Does your upper retainer affect your speech		Total
		Not at all	Somewhat	
UR groups multi R groups combined	Bonded	3(93.1%)	1(6.9%)	4
	Mx Bonded plus another retainer	18(90.9%)	3(9.1%)	21
Total		21(84.0%)	4(16.0%)	25(100.0%)

fisher's exact p=.53

Table 64 Retainer Effects On Speech Associated With Exposure To Only A Maxillary Hawley Versus An Additional Retainer

		Does your upper retainer affect your speech		Total
		Does not affect my speech	Affects Speech	
UR groups multi R groups combined	Mx Hawley retainer plus another retainer	8(18.2%)	36(81.8%)	44
	Hawley	4(19.0%)	17(81.0%)	21
Total		12(18.5%)	53(81.5%)	65(100.0%)

fisher's exact p=1.0

ORAL HYGIENE

Table 65 Ease Of Maintaining Oral Hygiene Associated With Exposure To Only A Maxillary Hawley Versus An Additional Retainer

		How easy was if to keep your teeth clean with the UR you were given			Total
		Easy	Neither easy nor difficult	Difficult	
UR groups multi R groups combined	Mx Hawley retainer plus another retainer	34(79.1%)	6(14.0%)	3(7.0%)	43
	Hawley	13(59.1%)	7(31.8%)	2(9.1%)	22
Total		47(72.3%)	13(20.0%)	5(7.7%)	65(100.0%)

fisher's exact p=.18

RETAINER HYGIENE

Table 66 Ease Of Maintaining The Maxillary Essix Retainer And Influence Of Exposure To Another Type Of Retainer

	How easy was it to keep your UR clean			Total
	Easy	Neither easy nor difficult	Difficult	
Maxillary Essix plus another retainer	30(69.8%)	8(18.6%)	5(11.6%)	43
Essix	39(83.0%)	4(8.5%)	4(8.5%)	47
Total	69(76.7%)	12(13.3%)	9(10.0%)	90(100.0%)

fisher's exact p=0.29

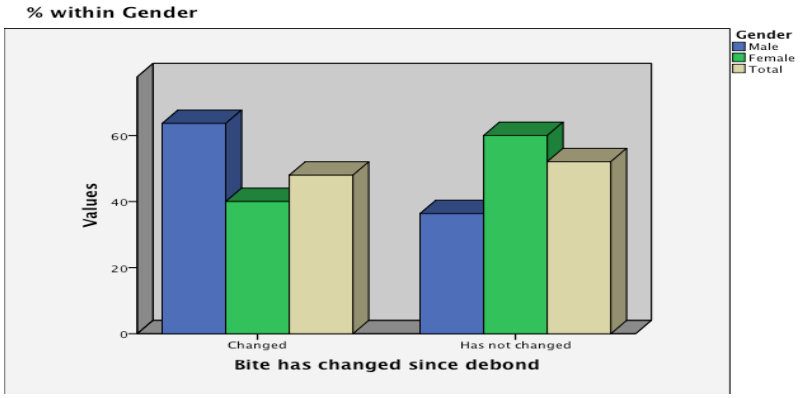
RETAINER REPLACEMENT

Table 67 Retainer Replacement If Only A Mandibular Essix Was Prescribed Versus An Additional Retainer

	Did you have to have your LR replaced		Total
	yes	no	
Mandibular Essix plus another retainer	1(5.3%)	18(94.7%)	19
Essix	16(38.1%)	26(61.9%)	42
Total	17(27.9%)	44(72.1%)	61(100.0%)

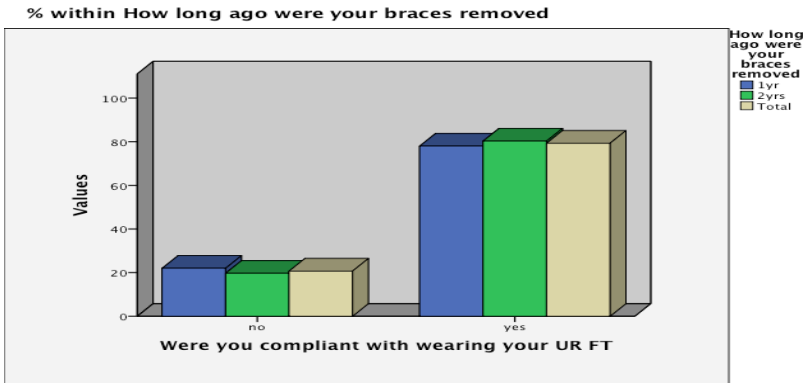
chi square p=.012

APENDIX E (FIGURES)



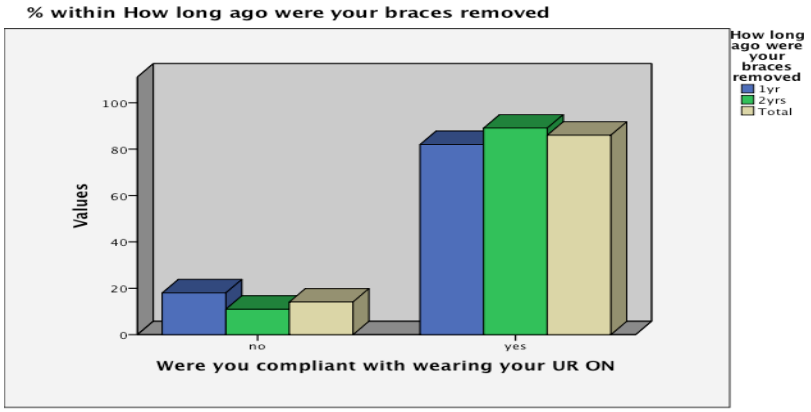
p=.03

Figure 19 Changes In The Occlusion Since Debond By With Gender



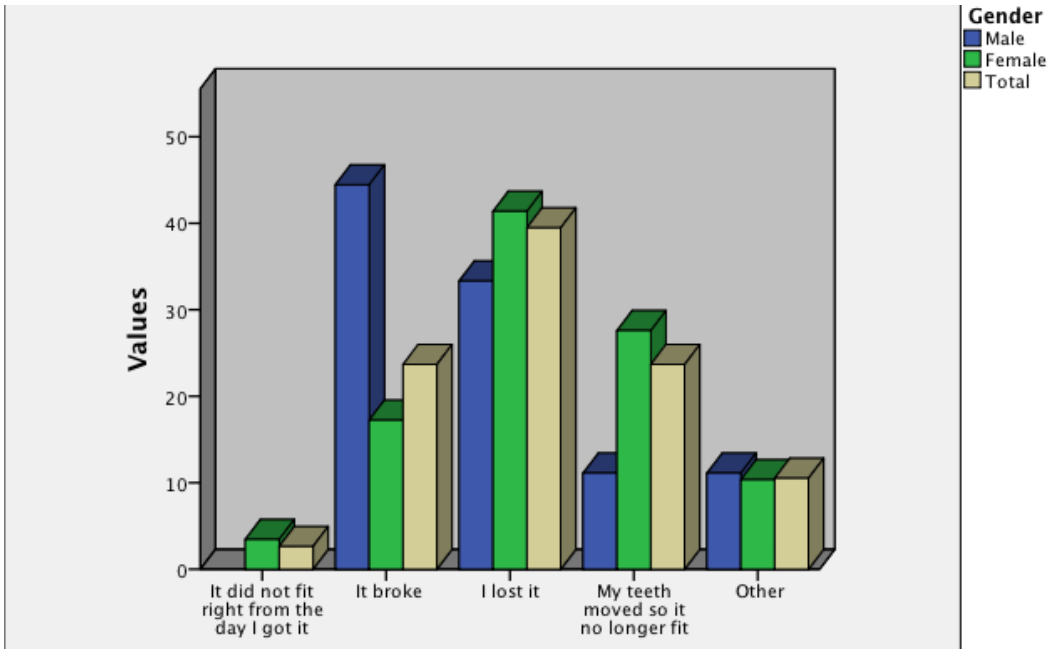
p=0.52

Figure 20 Compliance With Maxillary Retainer Full-time Use By Time Since Debond



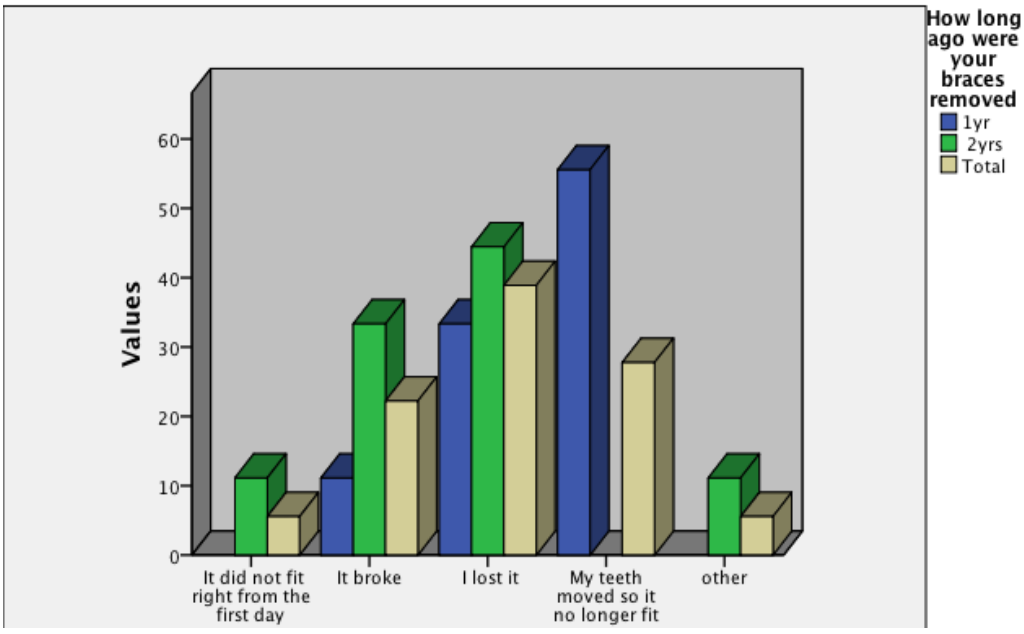
p=0.33

Figure 21 Compliance With Maxillary Retainer Part-time Use By Time Since Debond



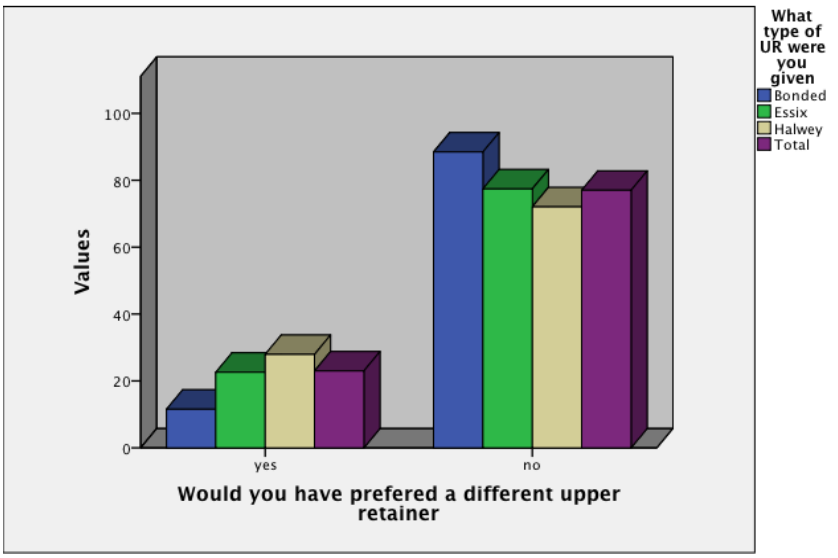
p=0.58

Figure 22 Reasons For Replacement Of The Maxillary Removable Retainer Associated With Gender



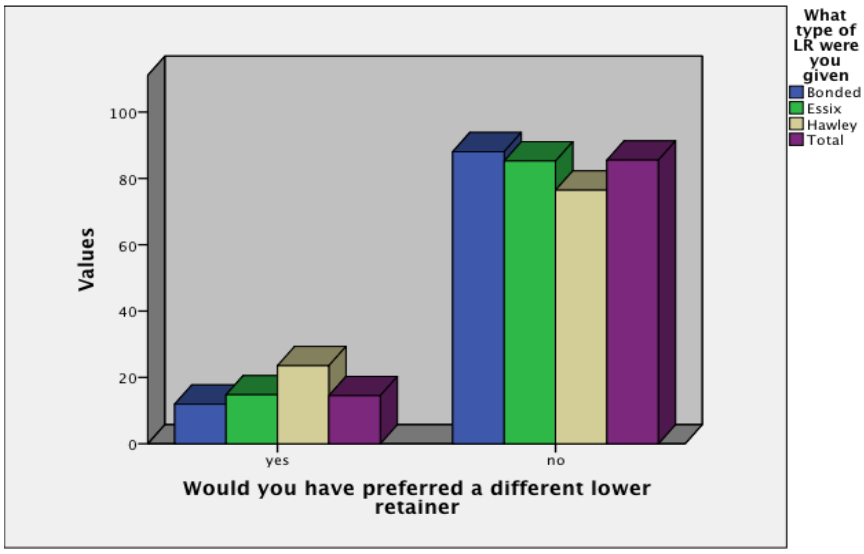
p=0.05

Figure 23 Reasons For Replacement Of The Mandibular Removable Retainer Associated With Time Since Debond



p=.24

Figure 24 Preference For A Different Maxillary Retainer



p=.45

Figure 25 Preference For A Different Mandibular Retainer

APPENDIX F (SUMMARY TABLES)

Summary Table 1 Satisfaction With The Maxillary Retainer

Maxillary Retainer	Bonded	Essix	Hawley	p value
Liked the appearance of the retainer	89%	77%	59%	p=0.01
Speech affected	8%	62%	82%	p<.001
Easy to maintain oral hygiene	56%	81%	72%	p=0.03
Easy to keep the retainer clean	68%	77%	65%	p=0.53
Had to replace the retainer	50%	33%	21%	p=0.03
Would have preferred another type of retainer	12%	23%	28%	p=0.24

Summary Table 2 Satisfaction With The Mandibular Retainers

Mandibular Retainer	Bonded	Essix	Hawley	p value
Liked the appearance of the retainer	88%	67%	53%	p<.001
Speech affected	6%	60%	59%	p<.001
Easy to maintain oral hygiene	52%	76%	77%	p=0.04
Easy to keep the retainer clean	54%	77%	71%	p=0.02
Had to replace the retainer	9%	28%	18%	p=0.02
Would have preferred another type of retainer	12%	15%	24%	p=0.45

Summary Table 3 Maxillary Retainers: Compliance and Retention Regimens

Maxillary Retainer Compliance and Retention Regimens	Essix	Hawley	p value
Most common full-time regimen	1 to 6 months	3 months to 1 year	p=0.05
Most common part-time regimen	1 year	6 months to 1 year	p=0.16
Compliant with full-time wear	77%	72%	p=0.41
Complaint with part-time wear	86%	77%	p=0.16
Currently wear the retainer	63%	76%	p=0.09
How often it is currently worn	67%=every night 21%=Every 2 days	68%=every night 15%=Once a week	p=0.44

Summary Table 4 Mandibular Retainers: Compliance and Retention Regimens

Mandibular Retainer Compliance and Retention Regimens	Essix	Hawley	p vlaue
Most common full-time regimen	1 to 6 months	3 months to 1 year	p=0.42
Most common part-time regimen	1 year	1 year	p=0.99
Compliant with full-time wear	82%	93%	p=0.26
Complaint with part-time wear	82%	87%	p=0.5
Currently wear the retainer	63%	73%	p=0.76
How often it is currently worn	65%=Every night 23%=Every 2days	91%=Every night 20%=Every 2days	p=0.72

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