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Predictors of Orthodontic Patient Compliance

by

Daniel Kenneth Hardy

THESIS

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Predictors of Orthodontic Patient Compliance

Daniel K. Hardy, DDS

ABSTRACT

Introduction: Compliance of orthodontic patients is important to provide efficient and effective treatment outcomes with minimal negative oral health effects. Predicting future patient compliance would be a valuable tool in aiding the orthodontist to create appropriate treatments with realistic goals for patients who are not compliant. Although many predictors of patient compliance have been analyzed in previous studies, only a few are highly correlated with compliance, such as good academic performance. This study seeks to determine if good oral hygiene status during the initial orthodontic examination is a predictor of future patient compliance during orthodontic treatment. **Methods:** During the initial orthodontic examination, 85 adolescent patients and their parents were asked to complete a questionnaire, based on the Orthodontic Attitude Survey. Patient oral hygiene was measured using the Gingival Index and Plaque Index at baseline (T0), 3 months into treatment (T1), and 6 months into treatment (T2). The treating orthodontic residents completed a modified Orthodontic Patient Cooperation Scale following 6 months of orthodontic treatment. Several statistical tests, including the Pearson correlation, Spearman's rank correlation, and logistic regression analysis were used to evaluate the association between predictor and outcome variables. **Results:** Patients with good Gingival and Plaque Index scores at the initial examination showed better compliance during orthodontic treatment ($p = 0.027$ and 0.039 , respectively). Marital status also showed significant correlation with compliance level ($p = 0.044$). Other factors, such as age or sex, did not show significant correlations with compliance. **Conclusions:** Oral hygiene status at the initial orthodontic evaluation is associated with patient compliance during orthodontic treatment.

TABLE OF CONTENTS

Introduction	1
Methods	8
Results	12
Discussion	15
Conclusions	23
References	24
Tables	31
Figures	36
Appendix A	39
Appendix B	44
Appendix C	47
Appendix D	48

LIST OF TABLES

Table 1. Descriptive statistics for Gingival and Plaque Indexes and age.....	31
Table 2a. Descriptive statistics and logistic regression for predictor variables	32
Table 2b. Descriptive statistics and logistic regression for predictor variables	33
Table 2c. Descriptive statistics and logistic regression for predictor variables	34
Table 3. Pearson correlations for predictor versus outcome variables	35
Table 4. Spearman rank correlations for predictor versus outcome variables.....	35

LIST OF FIGURES

Figure 1. Initial Gingival Index versus Orthodontic Patient Cooperation Scale scatter plot 36

Figure 2. Initial Gingival Index versus Orthodontic Patient Cooperation Scale linear prediction 36

Figure 3. Initial Plaque Index versus Orthodontic Patient Cooperation Scale scatter plot 37

Figure 4. Initial Plaque Index versus Orthodontic Patient Cooperation Scale linear prediction 37

Figure 5. Change in Plaque and Gingival Index over time 38

INTRODUCTION

Ideal orthodontic treatment outcomes are the result of at least two factors: the skill of the orthodontist and the compliance of the patient. However, patient compliance is one of the most challenging and potentially frustrating aspects of orthodontic treatment for the orthodontist. Successful treatment outcomes, such as ideal occlusion and the absence of white spot lesions, are directly associated with the compliance of the orthodontic patient. Additionally, good patient compliance is important to reduce overall treatment time, maintain good oral health, and provide increased clinic efficiency for the orthodontist (Skidmore *et al.* 2006, Mandall *et al.* 2008). Conversely, patients with poor compliance are more likely to require extra appointments and longer treatments, and exhibit more adverse dental and gingival effects (Beckwith *et al.* 1999). Poor patient compliance is a pervasive problem that affects all orthodontic clinics to some extent. Recent studies indicate that the rate of poor compliance is as high as 50% (Larsson and Bergstrom, 2005; Feil *et al.* 2002).

Areas of compliance

Compliance during orthodontic treatment is multifaceted and can be defined in many ways. First, patient compliance can be viewed as adherence to orthodontic treatment recommendations and goals. For example, compliant patients wear elastics or removable appliances as recommended by the orthodontist. They also accept treatment recommendations given to them by the orthodontist and avoid foods and activities that might damage orthodontic appliances. The importance of adherence to treatment recommendations can have dramatic ramifications regarding treatment progress and outcome (Skidmore *et al.* 2006; Allan and Hodgson 1968).

One common treatment modality that many orthodontists use to achieve their treatment goals is a headgear appliance. Headgear is essentially a removable double metal bow that attaches to intraoral appliances and is connected to the back of the head or neck with a strap. The appliance is

placed by the patient for a certain number of hours each day to achieve the desired orthopedic or orthodontic effect (Merrifield 1970). However, failure of the patient to wear the headgear the required amount of time will lead to less correction of the malocclusion. Patient compliance with headgear has been shown to be about 50% of the number of hours recommended by the orthodontist (Bos *et al.* 2007; Brandao *et al.* 2006). This level of compliance will often require that the patient use the appliance for a prolonged period of time to achieve the desired correction. Additionally, a reassessment of the treatment plan and mechanics may be indicated. In general, either of these outcomes results in wasted treatment time. Failure to use a headgear adequately may also require the orthodontist to alter the treatment to utilize non-patient compliant treatments, such as non-removable appliances. While these appliances may be able to assist in correction of the malocclusion, changing the treatment protocol will require a longer treatment period and increase the overall cost to the orthodontist and patient (Siarra-Olds *et al.* 2010). In extreme cases, failure to comply with recommended treatments could lead to orthognathic surgery. While a surgical correction may improve dental occlusion and facial harmony, it induces significant morbidity and financial burden on the patient's family (Kim and Park 2007). While this example demonstrates the need for good compliance with regard to a headgear appliance, similar arguments could be made for many other treatment modalities, such as facemask therapy, removable expanders, functional appliances, and intraoral elastics. Adherence to treatment recommendations is important to achieve the most ideal results in an efficient timeframe.

Another facet of good patient compliance is following oral health recommendations. This includes maintaining good oral hygiene, scheduling regular appointments with the general dentist, and making timely appointments when referred to a dental specialist. One of the most important requirements prior to initiating orthodontic treatment is an evaluation from the patient's dentist. Many patients that seek orthodontic treatment already have a dentist they visit regularly who often has referred the patient to the orthodontist for evaluation and treatment. In general, these cases have

already been checked thoroughly for dental and gingival disease and are ready to initiate treatment. However, some patients visit the orthodontist without a recent dental evaluation. It is important that these patients be referred back to their dentists to evaluate for caries, periodontal disease, or other pathology. Additionally, patients should receive a cleaning and oral hygiene instructions from the dental hygienist in preparation for the orthodontic treatment. Failure to receive such an examination from the dentist would result in delaying treatment until the patient is compliant.

Once the patient has started orthodontic treatment, the patient should continue to receive regular check-ups and cleanings with their dentist. This is important to prevent the development of dental decay, including white spot lesions. These lesions are areas of demineralized enamel caused by acid producing, intraoral bacteria (Zachrisson and Zachrisson 1971). Orthodontic appliances severely decrease the ability of patients to brush and floss their teeth effectively and efficiently. This leads to an increase in dental plaque, which contains cariogenic bacteria and carbohydrate-rich foods (Alstad and Zachrisson 1979). Dental cleanings with a hygienist should be conducted at least every six months to aid the patient in the removal of plaque, provide oral hygiene instructions, and check for signs of dental decay. In addition, the dentist should provide a complete oral exam at least once a year to check for dental caries. Failure of the patient to comply with these regular cleanings and check-ups could result in permanent areas of staining or require dental restorations, such as fillings, to eliminate areas of decay.

In addition to regularly scheduled cleanings, the orthodontist should provide each patient with instructions on maintaining good oral hygiene with braces, as many patients are unclear how to brush and floss around these appliances. They also should be informed of the consequences of not maintaining good oral hygiene, such as gum disease, dental decay, prolonged treatment times, and early removal of braces. On subsequent visits, the orthodontist should provide feedback and encouragement to the patient to aid them in maintaining good oral health. If patients are unclear on how to clean their teeth, or are unwilling to do so, then the risk for developing gum disease and dental decay, including

white spot lesions, increases dramatically (Zachrisson and Zachrisson 1971). Patients that chronically struggle with poor oral hygiene, in spite of the best efforts of the orthodontist and dentist, may often need to have their appliances removed, either temporarily or permanently, in the interest of their oral health. It is estimated that 5-10% of patients may need their appliances removed early due to poor oral hygiene (Mehra *et al.* 1998).

While orthodontically-induced gingivitis is generally transitory and resolves once the braces are removed, white spot lesions are often permanent defects in the enamel, resulting in an unaesthetic appearance. Although some white spot lesions may spontaneously resolve, many require either microabrasion therapy (removal of the outer layer of enamel) or dental restorations to produce an aesthetic outcome (Hammad *et al.* 2012). Both procedures are both invasive and financially burdensome to the patient. However, good compliance with brushing, flossing, and regular dental checks and cleanings can help eliminate these issues.

Another aspect of good patient compliance is following through with referrals from the orthodontist to see a medical or dental specialist. Orthodontists may refer patients to various specialists for many reasons: systemic health concerns, tooth extractions, impacted tooth exposures, additional radiology, temporomandibular joint disorders, periodontal defects, sleep apnea, tongue dysfunction, etc. Many patients may delay or fail to follow through with these recommendations due to inconvenience, lack of time, failure to understand the reason for the referral, or financial reasons. Delaying these recommended consultations can result in delayed treatment or extended treatment times.

A third aspect of good patient compliance involves adhering to clinic policy, including coming to all appointments, being punctual, and staying current with the financial contract. When a patient misses an appointment, overall treatment is extended by the amount of time it takes to reschedule the appointment. For patients with chronic attendance problems, this could translate into an increase of

several months or more to their total treatment time (Beckwith *et al.* 1999; Fink and Smith 1992). Additionally, when a patient is late to their appointments, it can be difficult for the orthodontist to fit them into an already busy clinic schedule. These appointments are often rescheduled. Financial problems can also create a dilemma for both the patient and the orthodontist. If the patient is delinquent on their payments, this could ultimately result in early termination of treatment and a sub-optimal treatment outcome. Additionally, patients will often miss appointments if they are worried about finances, leading to increased treatment times (Lindauer *et al.* 2009).

Orthodontic patients may be considered non-compliant and prone to extended treatment times if they have trouble with one or more of these areas (Skidmore *et al.* 2006). Any increase in treatment time can predispose the patient to more adverse health effects, increased treatment time, and dissatisfaction with treatment progress. For the orthodontist, increases in treatment time are frustrating, as this generally requires more patient visits, decreased clinical efficiency, and increased overhead costs for the extra appointments.

Predicting compliance

Due to the aforementioned negative consequences of poor compliance, many studies have sought to find correlations between patient characteristics and compliance during treatment. However, predicting future compliance in orthodontic patients has proven to be an elusive task. One of the most reproducible correlations with patient compliance is academic performance in school. Higher grades in school appear to be correlated with good oral hygiene habits during treatment (Al-Jewair *et al.* 2011). Additionally, higher academic achievers were also more likely to wear removable appliances correctly (Bartsch *et al.* 1993) and follow their orthodontist's instructions (Woollass *et al.* 1998, Richter 1996, Serogl and Zetner 2000, Albino 2000). Higher academic performers are generally more internally motivated, have an increased self-concept, and are more goal oriented individuals, which would explain their

increased ability to comply with orthodontic treatment protocols (Woollass *et al.* 1998, El-Mangoury 1981). It has been proposed that school teachers would be a good resource for evaluating potential orthodontic compliance based on academic performance, including characteristics such as self-reliance, reasonableness, willpower, and reliability (Sergl and Zetner 2000).

Another variable that has been found to correlate with orthodontic compliance is patient gender, with females having better compliance than males (Daniels *et al.* 2009). However, most studies showed no association between gender and compliance (Amado *et al.* 2008, Mandall 2008, Richter 1998, Bartsch 1993, Nanda and Kierl 1992, Sergl 1992). One reason for the difference in these outcomes could be the study methodology or the ages of the populations in question. Younger age groups might not show as much of a difference between males and females, while populations that include older adolescents may reveal significant differences along gender lines. This difference could be attributed to females' average maturation being earlier than males or because this group is more concerned about personal appearance and wants to improve their overall orthodontic outcome (Wedrychowska-Szulc and Syrynska 2010).

Another correlation to good orthodontic compliance that has been proposed in the literature is older adolescent patients (Albino 1991). However, other articles have shown that younger patients are better at compliance (Allan 1968). Others found no correlation with regard to age (Amado *et al.* 2008, Mandall *et al.* 2008, Sergl 1992). Age is a difficult measurement to evaluate, as every article has a different age range for their patient populations and does not necessarily describe the density of patients at any given age. Another confounding variable is the fact that not all patients mature at the same rate and females generally begin puberty 1-2 years before males. A possible theory for the discrepancy in outcomes regarding age and compliance is the changing psychosocial characteristics of children as they mature. Patients at an early age (pre-adolescents) are often described as being more compliant with orthodontic treatments, such as headgear. However, as patients age into puberty,

compliance may decrease due to psychosocial issues and behavior problems related to the onset of adolescence. As these patients progress through the adolescent period, there may be an increase in compliance as they get older and more mature.

Other variables that have been shown to correlate with good orthodontic compliance are as follows: being internally motivated (Lee *et al.* 2008, Albino 2000, El-Mangoury 1981), maintaining a positive relationship between the patient and orthodontist (Nanda and Kierl 1992), having a positive attitude towards braces (Hoogstraten and Prah-Andersen 2005, Sergl 2000), maintaining a normal body mass index (Bremen *et al.* 2013), and having a two-parent married family (Al-Jewair *et al.* 2011). However, many of these variables were also shown to have no correlation with compliance in other studies (Lee *et al.* 2008, Albino 2000, Nanda *et al.* 1992).

One variable that has been shown to predict negative compliance during orthodontic treatment is patients receiving financial assistance from the Medicaid program (Horsley *et al.* 2007). Many states offer free orthodontic treatment to certain patients that qualify for assistance and whose type of malocclusion is severe enough to be considered “handicapping”. It is unclear why these patients fail their appointments more frequently than other patients. A possibility is that patients on the Medicaid program are more economically disadvantaged and have trouble taking time off from work to attend appointments. Another possibility is that, generally, these patients are seen in university settings, as private orthodontic clinics rarely treat patients on government sponsored programs. Therefore, these patients may have to travel much further to make appointments, leading to an increased failure rate.

Most of this previous research has sought to quantify one or more aspects of patient compliance and correlate it to predictor variables, such as gender. Although many of these variables have been tested against compliance, initial oral hygiene status of the patient has not previously been used as a predictor variable. Generally, oral hygiene status is an outcome measure to determine the patients’ level of compliance. However, it is important to note that compliance with oral hygiene

regimens does not necessary correlate with compliance in other aspects of orthodontic treatment, such as wearing elastics (El-Mangoury 1981).

Determining if oral hygiene is a predictor of patient compliance is important, as this would be a simple way for the orthodontist to tell if a patient was likely to be compliant based on the initial orthodontic examination. Additionally, a more complete understanding of these issues is important to aid the orthodontist in setting treatment goals, determining treatment length, and choosing appropriate appliances and techniques. This will also be beneficial to the patient to provide realistic expectations regarding treatment length and risks associated with orthodontic treatment.

Hypothesis: Patients with good initial oral hygiene status will be more compliant during orthodontic treatment than patients with poor initial oral hygiene.

Specific Aims:

- 1) Evaluate the association between possible predictors of patient compliance, principally oral hygiene status at the initial examination, and patient compliance during treatment.
- 2) Assess predictor variables that determine whether or not a patient will initiate orthodontic treatment, specifically with regard to eligibility for the state-sponsored DentiCal program.

METHODS

Participants

This is a prospective observational cohort study evaluating patient compliance at three different time points. Approval for this prospective cohort study was obtained from the University of California, San Francisco (UCSF), Committee on Human Research (CHR #12-09560).

A total of 85 adolescent patients between 11 and 17 years of age (average age = 14 years 0 months, female = 46, male = 39) and the parents of these patients were recruited to this study from the

UCSF Orthodontic Clinic. Patients and parents were included in the study if they spoke either English or Spanish, and the patient was ready for comprehensive orthodontic treatment. Patients were excluded from this study if they presented with clefts of the lip and palate, craniofacial syndromes, or previous comprehensive orthodontic treatment (not including early orthodontic treatment). Patients enrolled in this study were informed that their name would be included in a raffle drawing for a \$50 Amazon giftcard.

Recruitment

Patients and parents were recruited during the initial orthodontic consultation and asked if they would participate in the study. Consent to participate in this study was obtained for all patients and parents once the study was explained to them in detail. Consent and assent forms were provided in both English and Spanish. Opportunity was given to patients and parents to ask any questions regarding the study prior to obtaining consent.

Questionnaires

Parents and patients that were recruited into the study were instructed to complete separate questionnaires (Appendix A and B) that included questions about past dental history, current oral hygiene habits, patient demographics, and a modified Orthodontic Attitude Survey (Fox *et al.* 1982). The modified Orthodontic Attitude Survey includes 17 questions regarding patient and parent attitudes towards braces. These questions include five subscales that measure positive attitude towards braces, concern for occlusion, wish for treatment, relative value placed on treatment, and importance of occlusion. The questionnaire has been validated previously in the literature for determining patient and parent attitudes towards orthodontic treatment (Fox *et al.* 1982, Albino *et al.* 1991). Questionnaires

were available in both English and Spanish. Patients and parents were free to ask questions of the primary research if clarification of any questions was needed.

Oral Hygiene Assessment

An oral hygiene assessment was performed on all patients during the initial consultation by the primary researcher (DH). The Gingival Index and Plaque Index (Loe 1967, Loe and Silness 1967) were used to score each patient on the buccal or facial surfaces of 6 index teeth as described by Ramfjord (1959). These indices have been validated in the literature and are widely used for epidemiologic studies regarding the periodontium. These teeth include the following: upper right 1st molar, the upper left central incisor, the upper left 1st premolar, the lower left 1st molar, the lower right central incisor, and the lower right 1st premolar. If a patient had the 1st premolar extracted during treatment, then the 2nd premolar was used for subsequent measurements. The Gingival Index is scored on a scale of 0-3 and assesses the amount of color change, swelling, and bleeding of the gingiva (Appendix C). The Plaque Index is also scored on a scale of 0-3 and assesses the amount of plaque load on the surface of the teeth and around the gingiva (Appendix D). Overall score for each index was averaged across the 6 reference teeth.

The primary researcher performed all oral hygiene exams to avoid inter-observer discrepancies. Intra-observer reliability testing was performed on 5 patients using three time points. These measurements were taken on 3 sequential days. This time interval was chosen because performing reliability testing on the gingival and plaque indices on the same day can be problematic, as the gingival can become irritated with multiple probing and the plaque load can decrease (Kingman *et al.* 1991). Allowing for a longer time interval is also problematic, as the gingival and plaque status can easily change over time.

Patients were followed for 6 months, starting when the first orthodontic appliances were placed intraorally. All missed appointments were recorded for this interval. Oral hygiene exams identical to the first exam were performed at approximately 3 and 6 months into treatment.

Subjective Evaluation

At the end of 6 months of treatment, the treating orthodontic resident was instructed to complete a modified Orthodontic Patient Cooperation Scale. This measurement tool has been validated in the literature to evaluate patient compliance during orthodontic treatment (Slakter *et al.* 1980). This subjective evaluation included 12 questions regarding the following: missed appointment, punctuality, broken appliances, psychosocial issues, compliance with elastic wear, compliance with removable appliance wear (e.g. headgear), overall attitude, and oral hygiene status. A 5-point Likert format was used to answer each question with answers including: Always, Frequently, Sometimes, Rarely, and Never. For each question, the answers were modified with data ranges to assist the orthodontic residents in answering the questions more consistently and objectively (Appendix E). The answers for each patient were totaled and averaged to give an overall score.

Statistical Analysis

Reproducibility of the scoring for the Gingival and Plaque indexes was evaluated using the Bland-Altman approach. Compliance was analyzed as both interval data and via dichotomization of the outcome variables based on the median value of 2.0 for the Orthodontic Patient Cooperation Scale and a clinical determination for the number of missed appointments (0-1 missed appointments was scored as good compliance, 2 or more missed appointments was scored as poor compliance). Similarly, the Gingival and Plaque Indexes were analyzed as both interval and dichotomous data, divided based on the median values of 1.00 and 0.67, respectively. Pearson and Spearman rank correlations were performed

between outcome variables (Orthodontic Patient Cooperation Scale and number of missed visits) and numerous predictor variables, including initial Gingival and Plaque Index scores. T-tests and Fisher's exact tests were also used to further test the dichotomized outcome variables against predictor variables. Logistic regression analyses were performed to determine correlations between compliance levels and predictor variables. The data was further analyzed for significant differences between patients that initiated orthodontic treatment and those who did not start treatment using logistic regression, Chi-squared, and Fisher's exact tests.

RESULTS

Descriptive Statistics

The average age of the patients in this study was 14.07 years (Table 1). The racial mix of the sample included 2 patients of American Indian/Alaska Native descent (2.35%), 6 patient of Asian descent (7.06%), 11 patients of Black or African American descent (12.94%), 1 patient of Native Hawaiian or Other Pacific Islander descent (1.18%), and 25 patients of White descent (29.41%). Patients of Hispanic ethnicity comprised 57.65% of the sample. A total of 57 parents (67.06%) reported that English was the primary language spoken at home and 39 parents (45.88%) marked that they were born outside of the United States of America (Table 2a-c).

The gender of the parent filling out the questionnaire was skewed towards mothers (72.94%) over fathers (23.53%). Two respondents declined to state their relationship and one respondent was the grandmother of the patient. Regarding marital status, 37 parents reported being married (43.53%), while 4 reported being in a domestic partnership (4.71%), 23 stated they were not married (27.06%), and 20 reported being divorced or separated (23.53%). The majority of patients lived in an urban environment (63.53%), followed by a suburban location (23.53%), and lastly a rural residence (4.71%). Most patients used a personal car to attend their orthodontic appointments (77.65%), while others used

public transportation (15.29%). The length of commute varied in the sample with the following pattern: 20.00% with a commute of 0-20 minutes, 45.88% with a commute of 20-40 minutes, 15.29% with a commute of 40-60 minutes, and 17.65% with a commute of greater than 60 minutes (Table 2a-c).

Educational level for the parents of this sample was spread fairly evenly. Two parents never attended any high school (2.35%), while 8 parents attended some high school but did not obtain a diploma (9.41%). Twenty parents completed high school but no college (23.53%), and 18 parents attended some college but did not receive a college degree (21.18%). Nineteen parents achieved a college degree alone (22.35%) while 16 parents achieved both a college degree and a professional or graduate degree (18.82%) (Table 2a-c).

Treatment Versus Non-Treatment

Of the 85 patients that were originally recruited for this study, only 30 patients actually initiated orthodontic treatment at the UCSF Orthodontic Clinic. The average age for these patients was 13 years 11 months (Table 1), with 18 females and 12 males. One patient that started treatment failed to return to the clinic for his regular orthodontic care after 3 months. The average age for those that did not initiate treatment was 14 years 1 month, with 28 females and 27 males. No statistical differences were found between the treatment and non-treatment groups regarding age. Among the 30 patients that started treatment, 13 had some form of private dental insurance (44.8%), 11 were covered by DentiCal (37.9%), and 5 had no coverage of any type (17.2%). By comparison, of those that did not initiate treatment, 14 had private dental insurance (25.5%), 39 had DentiCal coverage (70.9%), and 2 had no coverage (3.6%). Logistic regression analysis determined that the treatment and non-treatment group differed significantly on the number of DentiCal patients ($p = 0.029$) (Table 2a-c). The odds ratio for DentiCal patients was 0.33, indicating that these patients are 3 times less likely to initiate treatment than non-DentiCal patients. For patients that did not start treatment, the average Gingival and Plaque

Index scores were 1.02 and 0.76, respectively (Table 1). By comparison, the treatment group's Gingival and Plaque Index scores were 1.10 and 0.96, respectively. No significant differences were found in regarding initial oral hygiene between the treatment and non-treatment groups.

Patients in the non-treatment group showed a significant difference ($p = 0.01$) in their most recent dental check-up. Patients that did not start treatment were much more likely to have had a dental exam in the past six months. No significant differences were found between the treatment and non-treatment groups for the following variables: age, gender, ethnicity/race, acculturation, marital status, education level of parent, income level of parent, length of commute to orthodontist, type of transportation used, self reported flossing/brushing habits, orthodontic history of the family, patients'/parents' concern for occlusion, patients'/parents' wish for treatment, patients'/parents' understanding of the positive aspects of treatment, patients'/parents' understanding of the relative value of treatment, and patients'/parents' understanding of the importance of occlusion (Table 2a-c).

Statistical Evaluation of Compliance

Of the 30 patients that initiated treatment, 18 received 3-month follow-up visits to evaluate the Gingival and Plaque indexes. This group showed an increase in score to 1.51 for the Gingival Index and a slight decrease in score for the Plaque Index to 0.94 (Table 1). The six-month follow-up visit included 29 patients and they showed a relative decrease from the three month value for both the Gingival Index (1.41) and Plaque Index (0.93; Figure 5).

The Orthodontic Patient Cooperation Scale showed an average score of 2.02 (SD = 0.54) and a median score of 2.00 (range of 1.00 to 3.50). The average number of missed appointments was 1.10 (SD = 1.14) with a median score of 1.00 (range of 0.00 to 4.00). Nine patients had between 2-4 missed appointments during the six-month treatment interval and were labeled as non-compliant for the analysis. The remaining 20 patients were classified as compliant.

The Spearman's rank and Pearson correlation tests both generated a significant correlation between the initial Plaque Index and Gingival Index, and the Orthodontic Patient Cooperation Scale (Tables 3-4). For the Spearman's rank correlation test, the Plaque Index produced a correlation coefficient of 0.386 ($p = 0.039$) and the Gingival index produced a correlation coefficient of 0.410 ($p = 0.027$). The Pearson correlation test produced a correlation coefficient of 0.368 ($p = 0.049$) for the Plaque Index and a correlation coefficient of 0.423 ($p = 0.022$) for the Gingival Index (Figures 1-4). No other significant associations were detected with these models. Also, no significant associations were found between predictor variables and the number of missed appointments.

The Fisher's Exact test determined that the parent's marital status was significantly associated with the Orthodontist Patient Cooperation Scale ($p = 0.044$). This association was further tested by combining the respondents that reported being married and those in a domestic partnership and comparing them against single parents and divorced parents. Logistic regression of this consolidated group revealed a significant difference between the married/domestic partnership group and the single parent group ($p = 0.036$). The single parent group had an odds ratio of 0.08, indicating this group is 12.5 times less likely to have children that are compliant with their orthodontic treatment. No other significant associations were detected with the Fisher's Exact test regarding predictor variables and either the Orthodontist Patient Cooperation Scale or the number of missed appointments. Logistic regression analysis and t-tests detected no significant associations between predictor variables and outcome variables.

DISCUSSION

Predicting Compliance

The ability to predict patient compliance during orthodontic treatment would provide an enormous advantage to orthodontists, patients, and patient families. Careful evaluation of the goals of

treatment, predicted length of treatment, and treatment mechanics may all be modified based on projected compliance level of individual patients. While most orthodontic treatment is tailored for a specific patient, this extra knowledge will improve the delivery of customized health care for orthodontic patients. Nevertheless, detection of variables with strong and consistent predictive power has been difficult.

This study shows a significant correlation between initial oral hygiene and orthodontic compliance, which supports the original hypothesis. This finding is significant for several reasons. First, no other study has looked directly at initial oral hygiene as a predictor variable for orthodontic compliance. Secondly, the methodology used in the study to evaluate oral hygiene is very simple, involving only the buccal surfaces and associated gingiva of 6 reference teeth. This type of analysis could easily be added to an initial orthodontic examination to provide an assessment of how likely a patient is to be compliant. Most orthodontists perform a general estimate of the gingival and plaque condition prior to starting treatment. There are many rubrics for determining oral hygiene, most of which are subjective based on the experience of the orthodontist. However, a more objective and sensitive test can provide additional information to the orthodontist. Specifically, using a periodontal probe to assess bleeding sites upon gingival probing and the presence of plaque on the enamel surface can augment the general oral assessment of the orthodontist in a meaningful way. Finally, this study also shows that either the Gingival Index or the Plaque Index (Loe 1967, Loe and Silness 1967) is able to detect significant differences in compliance. This suggests that only one of these tests need be performed on a patient to assess their future compliance risk. However, using both tests may provide two independent methods of analysis, improving the ability to accurately predict compliance.

In spite of the obvious benefits of using the oral hygiene assessment to predict future compliance, caution should be used in the interpretation of these results. While the Pearson correlation and Spearman's rank correlation tests detected significant associations, the correlation coefficients were

relatively low (Tables 3-4). Additionally, while these two statistical tests found signal in the data, the logistic regression, t-tests, and Fisher's Exact tests found no significant association between initial hygiene and compliance. One possible explanation is the way in which the data were analyzed, with the logistic regression, t-tests and Fisher's exact test requiring dichotomization of the outcome variables. This may have limited some of the signal in the sample. Additionally, only 30 patients were analyzed for compliance, which is a relatively low sample size. This decreases the power of the analyses, resulting in less discriminating ability. Nevertheless, the fact that significant associations were detected in two of the analyses is promising.

Another interesting result of this study is the association between marital status of the parent and the compliance of the patient. Specifically, it appears that single parents are 12.5 times more likely to have poor compliant patients, as compared to parents that are married or in a domestic partnership. Of particular note is that parents that are divorced are not included in the "single parent" category. Both options were available for response on the parent questionnaire (Appendix A). Some parents may have been confused by the question and simply answered, "single parent," having not seen the "divorced" option. However, the high level of significance and large odds ratio seems to indicate that there is some merit to this association. These findings also support those of Al-Jewair *et al.* (2011), who found that patients of two-parent families had a significantly higher level of compliance with oral hygiene during orthodontic treatment than patients whose parents are not married ($p = 0.004$, OR = 29.6). One possible explanation for this association is the fact that while many divorced parents are still actively involved in their children's lives, parents who were never married may not have the ability or time to provide the attention and encouragement to their children to help reinforce compliance. Additionally, single parents often need to work more to support their family and may not have the ability to take time off of work to attend orthodontic appointments. Knowing the marital status of the parents could be valuable to the orthodontist. Generally, the marital information of the parents is collected prior to or during the initial

examination. Special attention should be provided to children of single parents, as these patients may need extra encouragement, reminder phone calls, or treatment mechanics that avoid the need for patient compliance.

The modified Orthodontic Attitude Survey (Fox *et al.* 1982) that was used in this study found no significant correlations between both the parents' or patients' responses and the outcome variables. The original survey was developed to have a "reliable and valid self-report for assessing attitudes toward malocclusion and the desire for orthodontic treatment." Their study identified 5 main factors that showed good consistency and could reliably be used in a survey: (1) Concern for own or child's occlusion, (2) Wish for own or child's treatment, (3) Positive aspects of treatment, (4) Relative value of treatment, and (5) Importance of occlusion in general. Based on these categories, a standard survey was generated to assess the patients' or parents' attitude toward orthodontics. The original study was adapted in several ways for this current study (Appendix A and B). First, some of the questions appeared redundant and the superfluous ones were dropped from the survey. Second, some questions required rewording based on the ability for patients and their parents to understand the question. Finally, all but one of the questions from the "Relative Value of Treatment" category were dropped. The question regarding the approximate value of treatment was kept, but the monetary value in the question was changed from \$1500 to \$5000 to more closely conform to current orthodontic costs.

Albino *et al.* (1991) used the Orthodontic Attitude Survey to determine if patient or parent attitude toward orthodontics is correlated with patient compliance. Their study of 39 adolescents showed that long-term stability of patient compliance, through an average of 26 months of treatment, was correlated with the category "Importance of Own Occlusion." However, within the initial 10 months of treatment, both the category "Importance of Own Occlusion" and "Parent Positive Attitude Toward Treatment" were significantly correlated with compliance. The authors reason that during the initial phase of treatment in early adolescence, the parents are largely providing the motivation for seeking

orthodontic treatment and ensuring good compliance. However, as the child matures and develops a relationship with the orthodontist, they take more responsibility over their treatment. This study did not detect any significant associations between the Orthodontic Attitude Survey and compliance over a 6-month period. The findings in this study support similar findings by Nanda and Kierl (1992), who also detected no association between the Orthodontic Attitude Survey and the Orthodontic Patient Cooperation Scale in the 100 patients enrolled in their study. Their protocol involved evaluation of compliance at 6 and 12 months into treatment. Possible reasons for the different outcomes of these studies could be due to the length of time elapsed when compliance was tested and the outcome assessment used. The Albino *et al.* (1991) study used a compliance questionnaire, which was filled out by the orthodontic assistant. The Orthodontic Patient Cooperation Scale (Slakter *et al.* 1980) was used in the present study and by Nanda and Kierl, with orthodontic residents in a university setting evaluating their patients. It is possible that differences in these methodologies could have resulted in the discrepancies previously noted.

A commonly cited predictor of patient compliance is gender, with females often being viewed as more compliant than males (Daniels *et al.* 2009). The present study did not find any association between gender and compliance during treatment, supporting the findings of numerous other authors (Amado *et al.* 2008, Mandall 2008, Richter *et al.* 1998, Bartsch 1993, Nanda and Kierl 1992, Sergl 1992). However, there are major differences in the protocols and approaches of all these studies. Daniels *et al.* (2009) tested this question by using a questionnaire to ask 227 patients in active treatment or about to begin treatment their perceived compliance level during orthodontic treatment. Males reported that they would be less likely to be compliant than females. However, this was not directly measured nor did it involve only patients during active treatment. The other studies sought to evaluate compliance in a more objective way, using the Orthodontic Patient Cooperation Scale (Amado *et al.* 2008, Richter *et al.* 1998, Nanda and Kierl 1992), average hours of use of bionators (Bartsch 1993), failed appointments

(Mandall 2008), or oral hygiene (Richter *et al.* 1998). The present study used both the Orthodontic Patient Cooperation Scale and the number of missed appointments as outcome variables. None of these outcomes measures detected any association between gender and compliance.

The age of the patient has often been discussed as a possible predictor of patient compliance, with younger patients being more compliant than older ones. Allen (1968) evaluated 30 patients between ages 12-18 for compliance during orthodontic treatment, assigning each patient a value from between 1-9 based on their level of cooperation. His findings indicate that patients <14 years of age are much more likely to be compliant. This present study uses a very similar sample, with 30 patients between ages 11-17. However, the evaluation of compliance was performed with a validated questionnaire. While this evaluation is still a subjective measure based on the assessment of the treating orthodontist, it utilizes many different criteria to assign a score to the overall patient compliance. There was no detectable correlation in any of the statistical tests between age and compliance in this study. This supports findings from several other studies (Amado *et al.* 2008, Mandall *et al.* 2008, Sergl 1992). The age range of these populations varied from 12-15 years old (Amado *et al.* 2008), 10-19 years old (Mandall *et al.* 2008), and 8-16 years old (Sergl 1992). The consensus from these studies is that age is not correlated with patient compliance. However, many orthodontists believe that use of certain types of appliances (e.g. headgear) during the pre-adolescent phase is useful because the level of compliance will be higher than for adolescents who are more affected by psychosocial issues. This assumption may still hold true, as the studies highlighted in this study did not seek to evaluate removable appliances, nor compare them between pre-adolescents and adolescents.

In addition to gender and age, all the remaining demographic variables showed no correlation with orthodontic compliance, including ethnicity, race, income level, education history of parent, place of residence, length of commute to the orthodontist, and type of transportation used. Some of these variables are interrelated, such as education and income level. Often, clinicians assume incorrectly that

families with less income, less education, and longer commute times will be more likely to miss appointments and have other compliance issues. However, the findings from this study do not support these assumptions. In addition, patients that receive financial assistance through the DentiCal (or other government sponsored programs) are often viewed as being less likely to be compliant during treatment. This has also been documented recently in Medicaid patients (Horsley *et al.* 2007). One explanation for this behavior is that patients that receive free treatment do not value the care they receive or the outcome as highly as patients from families that pay. Another possibility could be that parents of lower income patients on government sponsored programs have less ability to take time off from work to attend their appointments or may have to travel long distances to find a clinic that accepts government reimbursements. The results from this study do not support the conclusion that patients with government sponsored insurance are less likely to miss appointments or be compliant during treatment.

Treatment versus Non-Treatment Groups

This study enrolled 85 patients and their parents, 55 of which elected to not start orthodontic treatment in the University of California, San Francisco, Orthodontic Clinic. A secondary aim of this study was to compare these patients to those that did initiate treatment. While this analysis does not answer any questions regarding compliance, it provides meaningful information regarding motivations for patients and their parents to begin orthodontic treatment.

The logistic regression analysis between the two groups using all the variables collected revealed only two significant differences. First, patients that did not initiate treatment were 3 times more likely to be on the government sponsored DentiCal plan than those that did not start treatment. The patient population that utilizes the DentiCal plan is comprised of lower income families. Treatment under the DentiCal plan is only offered until age 21 for orthodontics and patients must qualify for

treatment based on the Handicapping Labio-Lingual Deviation Index (HLD) California Modification. This form has several automatic qualifiers, such as cleft palate and a deep, impinging with tissue damage. However, most patients receive a composite score based on several clinical presentations, such as crossbites, overjet, crowding, and deviation of teeth from the normal arch form. An HLD score of 26 or more qualifies a patient for full funding of their orthodontic treatment, meaning only the more severe presentations receive government assistance. Patients that score less than a 26 receive no funding and would have to pay out of pocket for treatment.

Due to the low reimbursement rates from DentiCal and the added paperwork required to process the claims for these patients, most private orthodontist do not accept DentiCal as a payment option. This leaves institutions such as the University of California, San Francisco, to care for this patient population. Naturally, many parents bring their DentiCal children to be evaluated, hoping they will score high enough to be funded. However, the vast majority does not qualify and most do not have the ability to pay for treatment, themselves. As such, it comes as no surprise that many more patients that did not initiate treatment had DentiCal, versus those that started treatment.

The other significant difference between the treatment and non-treatment groups was the patients' most recent check-up with their general dentist. The data show that for patients who started treatment, they were more likely to have had their last dental check-up between 6-12 months prior to their orthodontic evaluation. In contrast, patient who did not start treatment were more likely to have had their check-up within 6 months of the orthodontic evaluation. This difference could possibly be explained in two ways. Patients who did not start treatment were much more likely to have DentiCal, which covers check-ups and cleanings every 6 months with a general dentist. It is possible that more of these patients were seeking regular dental care because it was free. Alternatively, while the question clearly asks when the last dental check-up or cleaning took place, it is possible that parents associated any visit to the dentist with a check-up. This means that children with more dental visits, due to

restorations or extractions, would seem to have more frequent dental check-ups than children who had potentially healthier teeth. While restorative experience was not evaluated on this patient population, it is possible that the non-treatment group had more visits to the dentist for various reasons, thus overinflating the reporting and associated difference between these groups.

Interestingly, all the other variables analyzed were similar between the treatment and non-treatment groups. Of particular note, the Orthodontic Attitude Survey (Fox *et al.* 1982) did not detect any significant differences between these groups based on parent or patient attitude towards braces. It might be expected that patients that did not start treatment and their parents would have a less favorable attitude towards orthodontics, especially regarding the cost, their understanding of the importance of occlusion, and the positive versus negative aspects of treatment.

CONCLUSIONS

This study was able to detect predictor variables that are significantly correlated with future patient compliance during orthodontic treatment. This could have far-reaching implications for orthodontists, as a simple assessment of a patient's oral hygiene could help determine a patient's compliance risk. Understanding which patients are more likely to be compliant will allow for more reasonable expectations for the patients, their family, and the orthodontist. Additionally, it will allow the orthodontist to choose treatment mechanics that would limit the need for patient cooperation. The following are a summary of the main conclusions reached by this study:

- The hypothesis of this study was validated, as significant correlations were discovered between oral hygiene and orthodontic compliance. Specifically, the Gingival Index and Plaque Index (Loe 1967, Loe and Silness 1967) can be used to predict future patient compliance at 6 months into treatment based on the Orthodontic Patient Cooperation Scale (Slakter *et al.* 1980).

- A significant correlation was found between the parent's marital status and the compliance of the child during orthodontic treatment. Patients with single parents were 12.5 times more likely to have poor compliance compared to patients with two parent families.
- Patients that present for an orthodontic consultation visit and do not initiate treatment are significantly more likely to have DentiCal coverage than those who do initiate treatment.
- Patients that initiate treatment are more likely to have visited the general dentist between 6-12 months prior to their orthodontic consultation, compared to patients that did not initiate treatment.
- While this study discovered interesting correlations between oral hygiene and compliance in orthodontic patients, the protocol used should be repeated to test for validity. Additionally, due to the small sample size, results should be viewed with caution.

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TABLES

			95% CI	95% CI			
All Patients (N = 85)	Mean	SD	Lower	Upper	Min	Max	Median
Initial Gingival Index Score	1.00	0.57	0.87	1.12	0.00	2.17	1.00
Initial Plaque Index Score	0.75	0.57	0.63	0.88	0.00	2.33	0.67
Patient Age	14.07	1.89	13.66	14.48	11.00	17.83	13.83
			95% CI	95% CI			
Non-Treatment (N = 55)	Mean	SD	Lower	Upper	Min	Max	Median
Initial Gingival Index Score	1.02	0.56	0.87	1.17	0.00	2.00	1.00
Initial Plaque Index Score	0.76	0.59	0.60	0.92	0.00	2.33	0.67
Patient Age	14.16	1.94	13.63	14.68	11.00	17.83	13.92
			95% CI	95% CI			
Treatment (N = 30)	Mean	SD	Lower	Upper	Min	Max	Median
Initial Gingival Index Score	0.96	0.61	0.73	1.19	0.00	2.17	1.00
Initial Plaque Index Score	0.73	0.54	0.53	0.93	0.00	1.83	0.67
Patient Age	13.9	1.81	13.23	14.58	11.00	17.5	13.42

Table 1. Descriptive statistics of initial Gingival Index score, Plaque index score, and age for all patients, patients that did not being treatment, and patients that initiated treatment.

Variable	All Patients (N = 85)	Treatment (N = 30)	No Treatment (N = 55)	p- value
	N (Valid %)	N (Valid %)	N (Valid %)	
Gender				0.42
Male	39 (45.88)	12 (40.00)	28 (50.91)	
Female	46 (54.12)	18 (60.00)	27 (49.09)	
Insurance				0.029
Private	27 (31.76)	13 (43.33)	14 (25.45)	
DentiCal	51 (60.00)	12 (40.00)	39 (70.91)	
None	7 (8.24)	5 (16.67)	2 (3.65)	
Patient Brushing Habits				0.36
0 times/day	2 (2.35)	1 (3.33)	1 (1.82)	
1 times/day	20 (23.53)	4 (13.33)	16 (29.09)	
2 times/day	63 (74.12)	25 (83.33)	38 (69.09)	
Patient Flossing Habits				0.68
0 times/week	18 (21.18)	5 (16.67)	13 (23.64)	
1-2 times/week	36 (42.35)	12 (40.00)	24 (43.64)	
3-4 times/week	19 (22.35)	9 (30.00)	10 (18.18)	
5-6 times/week	6 (7.06)	3 (10.00)	3 (5.45)	
7 or more times/week	6 (7.06)	1 (3.33)	5 (9.09)	
Dental Home				0.92
Yes	79 (92.94)	28 (93.33)	51 (92.73)	
No	6 (7.06)	2 (6.67)	4 (7.27)	
Years with Current Dentist				0.59
<1 year	22 (25.88)	6 (20.00)	16 (29.09)	
1-2 years	14 (16.47)	5 (16.67)	9 (16.36)	
2-3 years	10 (11.76)	5 (16.67)	5 (9.09)	
>3 years	34 (40.00)	11 (36.67)	23 (41.82)	
Dental Visits Per Year				0.75
Less than once	12 (14.12)	4 (13.33)	8 (14.55)	
Once	18 (21.18)	5 (16.67)	13 (23.64)	
Twice	53 (62.35)	20 (66.67)	33 (60.00)	
More than twice	2 (2.35)	1 (3.33)	1 (1.82)	
Last Dental Check-up				0.01
<6 months ago	68 (80.00)	20 (66.67)	48 (87.27)	
6-12 months ago	13 (15.29)	9 (30.00)	4 (7.27)	
>12 months ago	4 (4.71)	1 (3.33)	3 (5.45)	

Table 2a. Descriptive statistics and *p*-values based on logistic regression analysis.

Variable	All Patients (N = 85)	Treatment (N = 30)	No Treatment (N = 55)	p-value
	N (Valid %)	N (Valid %)	N (Valid %)	
Patient had Braces Previously				0.12
Yes	6 (7.06)	4 (13.33)	2 (3.64)	
No	79 (92.24)	26 (86.67)	53 (96.36)	
Sibling had Braces Previously				0.14
Yes	28 (32.94)	13 (43.33)	15 (27.27)	
No	57 (67.06)	17 (56.67)	40 (72.73)	
Parent had Braces Previously				N./A
Yes	27 (31.76)	12 (40.00)	15 (27.27)	
No	58 (68.24)	18 (60.00)	40 (72.73)	
Parent Filling Out Questionnaire				0.97
Mother	62 (72.94)	22 (73.33)	40 (72.73)	
Father	20 (23.53)	7 (23.33)	13 (23.64)	
Other (Guardian, Grandparent)	1 (1.18)	0 (0.00)	1 (1.82)	
Ethnic Background				0.89
Hispanic	49 (57.65)	17 (56.67)	32 (58.18)	
Non-Hispanic	36 (42.35)	13 (43.33)	23 (41.82)	
Race				0.96
American Indian/Alaska Native	2 (2.35)	0 (0.00)	2 (3.64)	
Asian	6 (7.06)	1 (3.33)	5 (9.09)	
Black or African American	11 (12.94)	2 (6.67)	9 (16.36)	
Native Hawaiian or Other Pacific Islander	1 (1.18)	1 (3.33)	0 (0.00)	
White	25 (29.41)	14 (46.67)	11 (20.00)	
Primary Language Spoken in Home				0.65
English	57 (67.06)	19 (63.33)	38 (69.09)	
Other	26 (30.59)	10 (33.33)	16 (29.09)	
Parent Place of Birth				0.73
United States of America	46 (54.12)	17 (56.67)	29 (52.73)	
Foreign Born	39 (45.88)	13 (43.33)	26 (47.27)	
Marital Status of Parent				0.89
Married	37 (43.53)	14 (46.67)	23 (41.82)	
Domestic Partnership	4 (4.71)	1 (3.33)	3 (5.45)	
Single	23 (27.06)	8 (26.67)	15 (27.27)	
Divorced	20 (23.53)	7 (23.33)	13 (23.64)	

Table 2b. Descriptive statistics and *p*-values based on logistic regression analysis.

	All Patients (N = 85)	Treatment (N = 30)	No Treatment (N = 55)	
Variable	N (Valid %)	N (Valid %)	N (Valid %)	p-value
Location of Patient/Parent Home				0.95
Urban	54 (63.53)	17 (56.67)	37 (67.27)	
Suburban	20 (23.53)	8 (26.67)	12 (21.82)	
Rural	4 (4.71)	1 (3.33)	3 (5.45)	
Method of Transportation to Orthodontist				0.36
Public Transportation	13 (15.29)	3 (10.00)	10 (18.18)	
Personal Car	66 (77.65)	24 (80.00)	42 (76.36)	
Friend or Family Member	2 (2.35)	1 (3.33)	1 (1.82)	
Other	2 (2.35)	1 (3.33)	1 (1.82)	
Length of Commute				0.33
0-20 minutes	17 (20.00)	8 (26.67)	9 (16.36)	
20-40 minutes	39 (45.88)	13 (43.33)	26 (47.27)	
40-60 minutes	13 (15.29)	2 (6.67)	11 (20.00)	
More than 60 minutes	15 (17.65)	7 (23.33)	8 (14.55)	
Education Level of Parent				0.5
Never attended high school	2 (2.35)	1 (3.33)	1 (1.82)	
Some high school	8 (9.41)	2 (6.67)	6 (10.91)	
High school diploma	20 (23.53)	6 (20.00)	14 (25.45)	
Some college	18 (21.18)	5 (16.67)	13 (23.64)	
College degree	19 (22.35)	8 (26.67)	11 (20.00)	
Graduate or Professional degree	16 (18.82)	7 (23.33)	9 (16.36)	

Table 2c. Descriptive statistics and *p*-values based on logistic regression analysis.

Variable	Pearson Correlation	95% CI Upper	95% CI Lower	p-value
Initial Gingival Index Score	0.423	0.067	0.684	0.022
Initial Plaque Index Score	0.368	0.002	0.647	0.049
Age	-0.334	-0.624	0.037	0.077
Concern for Occlusion	0.002	-0.365	0.368	0.990
Wish for Treatment	-0.038	-0.412	0.347	0.850
Positive Aspects of Treatment	0.068	-0.328	0.444	0.740
Relative Value of Treatment	-0.139	-0.481	0.240	0.470
Importance of Occlusion	0.148	-0.231	0.488	0.440

Table 3. Pearson correlation values for comparisons between predictor variables and the Orthodontic Patient Cooperation Scale.

Variable	Spearman Rank Correlation	95% CI Upper	95% CI Lower	p-value
Initial Gingival Index Score	0.410	0.052	0.675	0.027
Initial Plaque Index Score	0.386	0.022	0.659	0.039
Age	-0.304	-0.604	0.070	0.110
Concern for Occlusion	0.143	-0.236	0.484	0.460
Wish for Treatment	0.066	-0.322	0.435	0.740
Positive Aspects of Treatment	0.071	-0.326	0.446	0.730
Relative Value of Treatment	-0.164	-0.500	0.215	0.400
Importance of Occlusion	0.173	-0.206	0.508	0.370

Table 4. Spearman Rank correlation values for comparisons between predictor variables and the Orthodontic Patient Cooperation Scale.

FIGURES

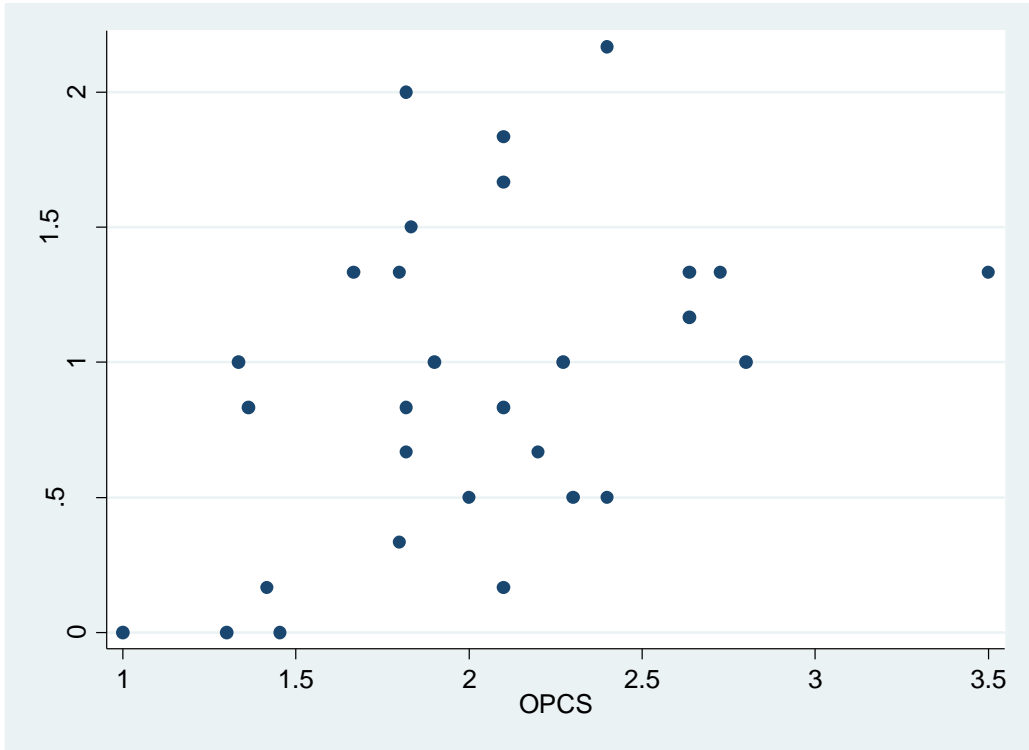


Figure 1: Initial Gingival Index (GI) score versus Orthodontic Patient Cooperation Scale (OPCS).

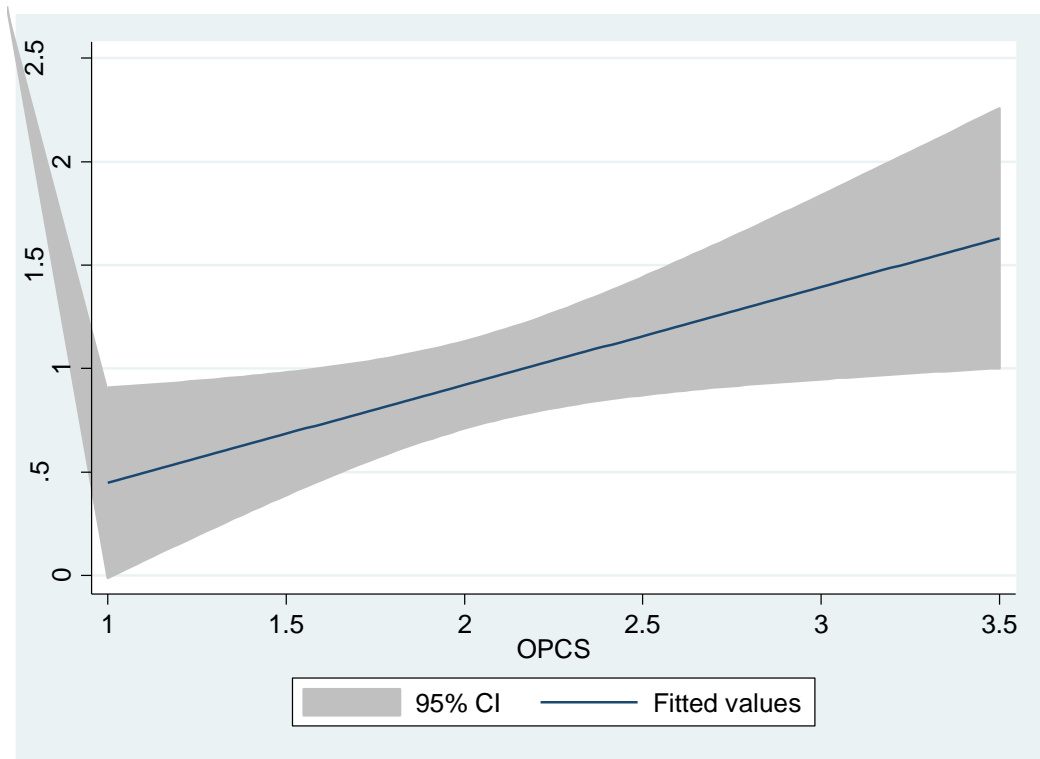


Figure 2: Linear prediction with 95% confidence interval for Initial GI versus OPCS

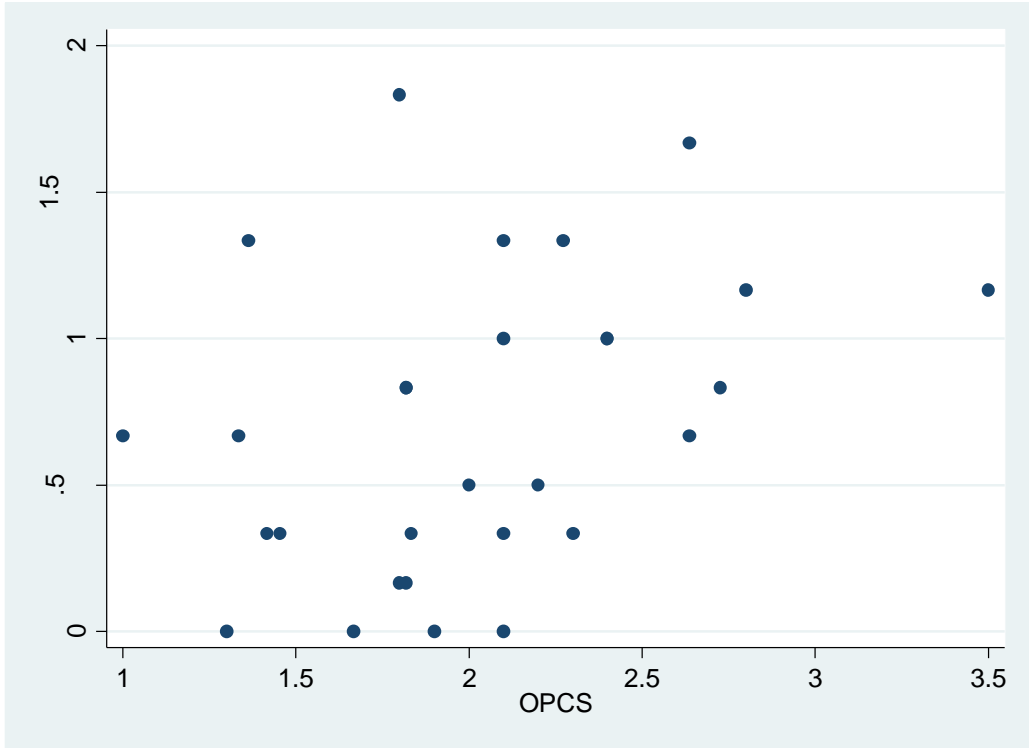


Figure 3: Initial Plaque Index (PI) score versus Orthodontic Patient Cooperation Score (OPCS)

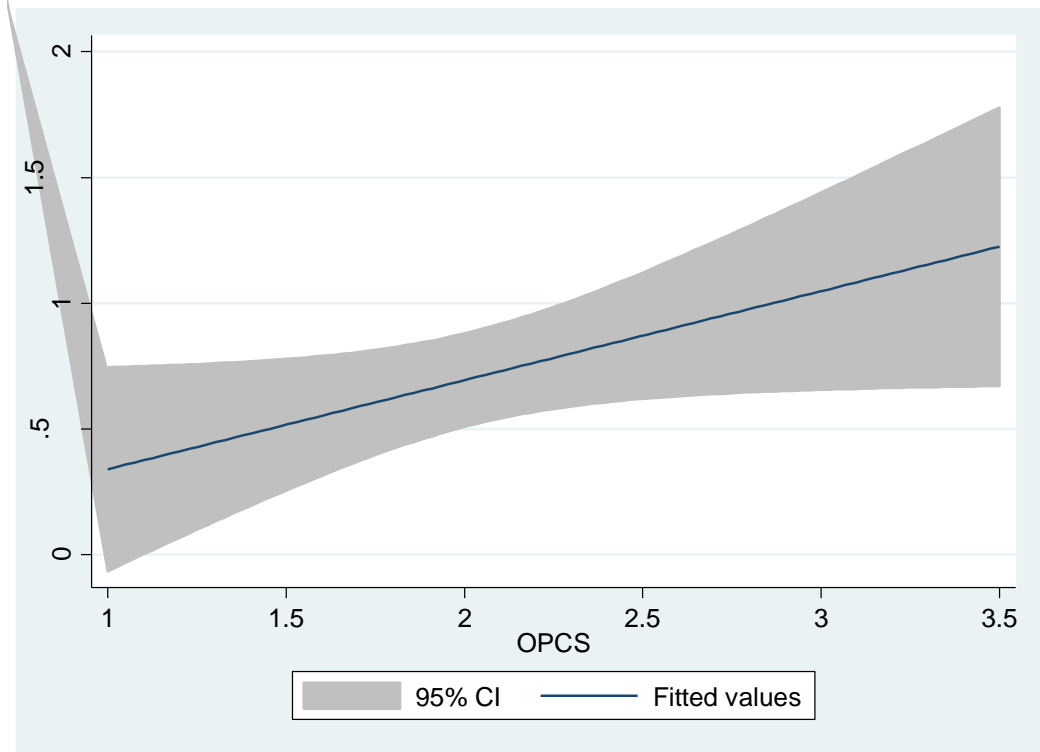


Figure 4: Linear prediction with 95% confidence interval for Initial PI versus OPCS

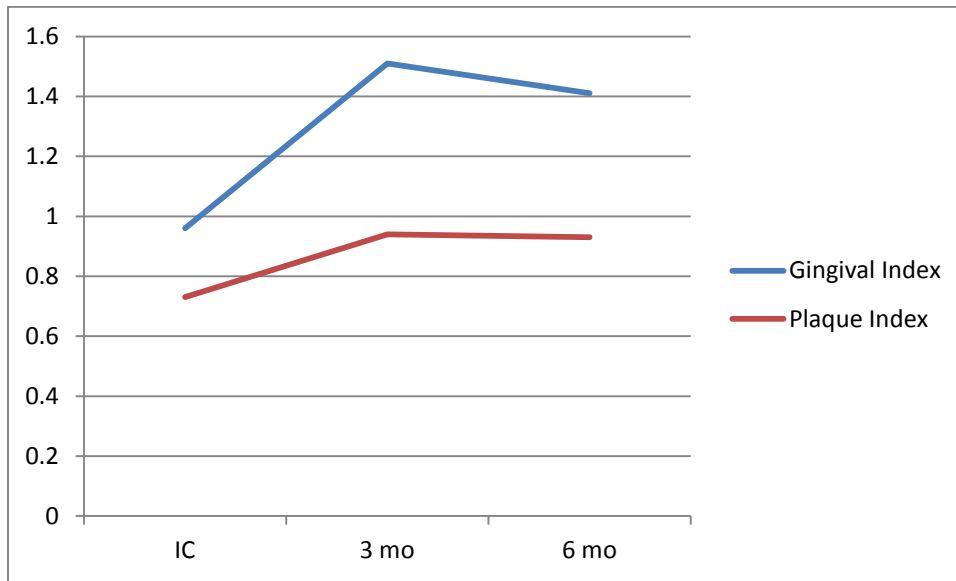


Figure 5. Change in Gingival Index and Plaque Index scores for the treatment group over time from Baseline (1), 3 month recall (2), and 6 month recall (3).

APPENDIX A

Parent Survey

Section 1: (Circle the answer that best applies to you)

- 1) Does your child have a dentist?
 - a. Yes
 - b. No
- 2) How many years have you been with your current dentist?
 - a. Less than 1
 - b. Between 1-2
 - c. Between 2-3
 - d. Greater than 3
- 3) How often does your child go to the dentist for check-ups or cleanings?
 - a. Less than once a year
 - b. Once a year
 - c. Twice a year
 - d. More than twice a year
- 4) When was your child's last dental check-up or cleaning?
 - a. Less than 6 months ago
 - b. Between 6-12 months ago
 - c. Greater than 12 months ago
- 5) Has your child ever had braces or orthodontic treatment before?
 - a. Yes
 - b. No
- 6) Do you have other children that have had braces or orthodontic treatment before?
 - a. Yes
 - b. No
- 7) Have you or your spouse/partner ever had braces or orthodontic treatment before?
 - a. Yes
 - b. No
- 8) If you had braces or orthodontic treatment before, how old were you at that time?
 - a. Less than 10 years old
 - b. 10-20 years old
 - c. 20-30 years old
 - d. Greater than 20 years old

Section 2: (Fill in or circle the answer that best applies to you)

- 1) Who is completing this form?
 - a. Mother
 - b. Father
- 2) What is your child's ethnic background?
 - a. Hispanic or Latino
 - b. Not Hispanic or Latino
- 3) What is your child's race?
 - a. American Indian/Alaska Native
 - b. Asian
 - c. Black or African American
 - d. Native Hawaiian or Other Pacific Islander
 - e. White
- 4) Is English the primary language spoken in your home?
 - a. Yes
 - b. No
- 5) Were you born in the United States?
 - a. Yes
 - b. No

- a. If you were not born in the United States, where were you born (country)? _____
- b. When did you move to the United States (Year YYYY)? _____
- 6) What is your marital status?
 - a. Married
 - b. Domestic partnership
 - c. Not married
 - d. Divorced/Separated
 - e. Widowed
- 7) How would you describe your place of residence?
 - a. Urban
 - b. Suburban
 - c. Rural
- 8) What is your primary method of transportation to the orthodontist?
 - a. Public transportation
 - b. Personal car
 - c. Friend or family member
 - d. Taxi
 - e. Other
- 9) How long does it take for you to commute to the orthodontist's office?
 - a. Less than 20 minutes
 - b. 20-40 minutes
 - c. 40-60 minutes
 - d. More than 60 minutes
- 10) What is the highest education level you and your spouse achieved?
 - a. Never attended high school
 - b. Some high school
 - c. High school diploma
 - d. Some college
 - e. College degree
 - f. Graduate or professional degree
- 11) What is your approximate family income level?
 - a. Less than \$20,000
 - b. \$20,000-\$40,000
 - c. \$40,000-\$60,000
 - d. \$60,000-\$80,000
 - e. \$80,000-\$100,000
 - f. More than \$100,000

Section 3: (Circle the answer that best applies to you)

- 1) I am satisfied with the way my child's teeth come together.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 2) I am bothered by the way my child's teeth don't fit together nicely.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 3) My child's crooked teeth bother me.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 4) I might be more willing to get braces for my child if I knew more about it.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 5) I wish I could afford to have my child's teeth straightened.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 6) I want to have my child's teeth straightened.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 7) Kids who have braces are more fortunate than my child.
 - a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much

- 8) Even if it cost a lot of money, it would be worth it to get my child's teeth straightened.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 9) Braces make people look silly.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 10) Braces look ugly on a person's teeth.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 11) I don't think I could stand my child wearing braces on his/her teeth.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 12) Wearing braces on your teeth is no worse than wearing glasses.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 13) Braces on my child's teeth wouldn't bother me at all.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 14) People with braces don't seem to mind them.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 15) Braces probably won't bother my child.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree

- d. Disagree a little
 - e. Disagree very much
- 16) Do you think it is worth the approximate \$5000 it costs to straighten teeth?
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 17) How important do you think it is to have good occlusion (teeth that close together properly and are straight)?
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 18) How important do you think it is for a person with malocclusion (crooked teeth that don't close together properly) to have his/her teeth straightened?
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much

APPENDIX B

Patient Survey

Instructions: Circle the answer that best applies to you.

- 9) How many times a day do you brush your teeth?
0 1 2 3 or more
- 10) How many times a week do you floss?
0 1-2 3-4 5-6 7 or more
- 11) What grade are you in currently?
6th 7th 8th 9th 10th 11th 12th Not in school
- 12) I am satisfied with the way my teeth come together.
f. Agree very much
g. Agree a little
h. Neither agree nor disagree
i. Disagree a little
j. Disagree very much
- 13) I am bothered by the way my teeth don't fit together nicely.
a. Agree very much
b. Agree a little
c. Neither agree nor disagree
d. Disagree a little
e. Disagree very much
- 14) My crooked teeth bother me.
a. Agree very much
b. Agree a little
c. Neither agree nor disagree
d. Disagree a little
e. Disagree very much
- 15) I might be more willing to get braces if I knew more about it.
a. Agree very much
b. Agree a little
c. Neither agree nor disagree
d. Disagree a little
e. Disagree very much
- 16) I wish I could afford to have my teeth straightened.
a. Agree very much
b. Agree a little
c. Neither agree nor disagree
d. Disagree a little
e. Disagree very much
- 17) I want to have my teeth straightened.
a. Agree very much
b. Agree a little
c. Neither agree nor disagree
d. Disagree a little
e. Disagree very much

- 18) Those who have braces are more fortunate than I am.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 19) Even if it cost very much money, it would be worth it to get my teeth straightened.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 20) Braces make people look silly.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 21) Braces look ugly on a person's teeth.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 22) I don't think I could stand wearing braces on my teeth.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 23) Wearing braces on your teeth is no worse than wearing glasses.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 24) People with braces don't seem to mind them.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 25) Braces probably won't bother me.
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree

- d. Disagree a little
 - e. Disagree very much
- 26) Do you think it is worth the approximate \$5000 it costs to straighten teeth?
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 27) How important do you think it is to have good occlusion (teeth that close together properly and are straight)?
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much
- 28) How important do you think it is for a person with malocclusion (crooked teeth that don't close together properly) to have his/her teeth straightened?
- a. Agree very much
 - b. Agree a little
 - c. Neither agree nor disagree
 - d. Disagree a little
 - e. Disagree very much

APPENDIX C

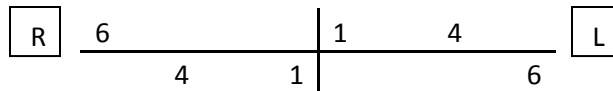
Patient: _____

Gingival Index and Plaque Index Worksheet

Gingival Index:

Instructions: Score only the buccal portion of the gingival around the following teeth.

Score	Criteria
0	<i>Normal Gingiva</i>
1	<i>Mild inflammation: slight change in color, slight edema, no bleeding on probing</i>
2	<i>Moderate inflammation: redness, edema and glazing, bleeding on probing</i>
3	<i>Severe inflammation: marked redness and edema, ulcerations; tendency toward spontaneous bleeding</i>



UR6: _____

UL1: _____

UL4: _____

Total: _____

LR4: _____

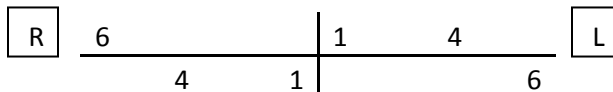
LR1: _____

LL6: _____

Plaque Index:

Instructions: Score only the buccal surface of the following teeth.

Score	Criteria
0	No plaque in gingival area.
1	No plaque visible by the unaided eye, but plaque made visible on the point of the probe
2	Gingival area is covered with a thin to moderately thick layer of plaque; deposit is visible to the naked eye.
3	Heavy accumulation of soft matter, the thickness of which fills out niche produced by gingival margin and tooth surface: interdental area is stuffed with soft debris.



UR6: _____

UL1: _____

UL4: _____

Total: _____

LR4: _____

LR1: _____

LL6: _____

APPENDIX D

Orthodontist Patient Cooperation Scale (OPCS)

Patient Name _____

- 1) This patient keeps appointments.
 - a. Always (No failed appointments or late cancellations)
 - b. Frequently (1 failed appointment or late cancellation)
 - c. Sometimes (2 failed appointments or late cancellations)
 - d. Rarely (3-4 failed appointments or late cancellations)
 - e. Never (5 or more failed appointments or late cancellations)
- 2) This patient comes to appointments on time.
 - a. Always (Never late)
 - b. Frequently (Has come late to 1 appointment)
 - c. Sometimes (Has come late to 2-3 appointments)
 - d. Rarely (Has come late to 4-5 appointments)
 - e. Never (Always comes late)
- 3) This patient distorts their wires and/or bands.
 - a. Always (Always has distorted wires/bands)
 - b. Frequently (Noticed distorted wires/bands at 4-5 appointments)
 - c. Sometimes (Noticed distorted wires/bands at 2-3 appointments)
 - d. Rarely (Noticed distorted wires/bands at 1 appointment)
 - e. Never (No distorted wires/bands)
- 4) The parent(s) of this child is (are) observed to be interested and involved in treatment.
 - a. Always (Parents present at every appointment and interested/involved)
 - b. Frequently (Parents present and interested/involved at most appointments)
 - c. Sometimes (Parents present and interested/involved at half of appointments)
 - d. Rarely (Parents seldom present and interested/involved at appointments)
 - e. Never (Parents never present and/or never interested/involved)
- 5) This patient speaks of family problems or a poor relationship with parent(s) or demonstrates such problems in interactions with parent(s) which I have observed.
 - a. Always (Hear or see family problems at every appointment)
 - b. Frequently (Hear or see family problems at 4-5 appointments)
 - c. Sometimes (Hear or see family problems at 2-3 appointments)
 - d. Rarely (Hear or see family problems at 1 appointment)
 - e. Never (Never hear or see family problems)
- 6) This patient acts enthusiastic and interested in treatment.
 - a. Always (Every appointment)
 - b. Frequently (Not interested/enthusiastic at 1 appointment)
 - c. Sometimes (Not interested/enthusiastic at 2-3 appointments)
 - d. Rarely (Not interested/enthusiastic at 4-5 appointments)
 - e. Never (Not interested/enthusiastic at all appointments)

- 7) This patient's behavior is sullen, hostile, belligerent, or rude.
- Always (Is sullen/hostile/belligerent/rude during all appointments)
 - Frequently (Was sullen/hostile/belligerent/rude at 4-5 appointments)
 - Sometimes (Was sullen/hostile/belligerent/rude at 2-3 appointments)
 - Rarely (Was sullen/hostile/belligerent/rude at 1 appointment)
 - Never (Never is sullen/hostile/belligerent/rude)
- 8) This patient cooperates in the use of removable appliances and/or expansion devices (e.g. headgear, functional appliances, active retainers, Haas rapid palatal expander, Hyrax rapid palatal expander, etc.)
- Always (Uses the appliances correctly for all treatment intervals)
 - Frequently (Uses appliances correctly most of the time)
 - Sometimes (Uses appliances correctly about half of the time)
 - Rarely (Uses appliances neither correctly nor frequently)
 - Never (Never uses appliances correctly)
 - Not applicable** (patient has not been instructed to wear/activate and appliance)
- 9) This patient cooperates in the use of elastics
- Always (Uses elastics correctly for all treatment intervals)
 - Frequently (Uses elastics correctly most of the time)
 - Sometimes (Uses elastics correctly about half of the time)
 - Rarely (Uses elastics neither correctly nor frequently)
 - Never (Never wears elastics correctly)
 - Not Applicable** (patient has not been instructed to wear elastics)
- 10) This patient complains about treatment procedures (e.g. sitting in patient chair, trying in appliances, changing wires, etc.).
- Always (Complains during every appointment)
 - Frequently (Has complained during 4-5 appointments)
 - Sometimes (Has complained during 2-3 appointments)
 - Rarely (Has complained during 1 appointment)
 - Never (Never complains)
- 11) This patient complains about having to wear braces.
- Always (Complains during every appointment)
 - Frequently (Has complained during 4-5 appointments)
 - Sometimes (Has complained during 2-3 appointments)
 - Rarely (Has complained during 1 appointment)
 - Never (Never complains)
- 12) This patient demonstrates excellent oral hygiene.
- Always (Is able to remove all dental plaque and maintains gingival health)
 - Frequently (Sometimes has some dental plaque and/or mild gingivitis)
 - Sometimes (Often has dental plaque and/or moderate gingivitis)
 - Rarely (Almost always has dental plaque and/or moderate to severe gingivitis)
 - Never (Always has heavy dental plaque and/or severe gingivitis)

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