Masthead Logo

College of Dental Medicine Student Theses, Dissertations and Capstones

College of Dental Medicine

11-1-2015

Adjunctive appliance wear and gender affect patients' oral health-related quality of life during the late stage of orthodontic treatment in adolescents

Monica Dinh
Nova Southeastern University

This document is a product of extensive research conducted at the Nova Southeastern University College of Dental Medicine. For more information on research and degree programs at the NSU College of Dental Medicine, please click here.

Follow this and additional works at: https://nsuworks.nova.edu/hpd_cdm_stuetd

Part of the Dentistry Commons

Share Feedback About This Item

ADJUNCTIVE APPLIANCE WEAR AND GENDER AFFECT PATIENTS' ORAL HEALTH-RELATED QUALITY OF LIFE DURING THE LATE STAGE OF ORTHODONTIC TREATMENT IN ADOLESCENTS

MONICA T. DINH, D.D.S.

Submitted to the College of Dental Medicine of Nova Southeastern University in Partial Fulfillment of the Requirements for the Degree of:

MASTER OF SCIENCE IN DENTISTRY

November 2015

ADJUNCTIVE APPLIANCE WEAR AND GENDER AFFECT PATIENTS' ORAL HEALTH-RELATED QUALITY OF LIFE DURING THE LATE STAGE OF ORTHODONTIC TREATMENT IN ADOLESCENTS

By

Monica T. Dinh, D.D.S.

Submitted to the College of Dental Medicine of Nova Southeastern University
In Partial Fulfillment of the Requirements for the Degree of Master of Science in Dentistry

Department of Orthodontics
College of Dental Medicine
Health Professions Division
Nova Southeastern University
November 2015

Approved as to content and style by:

APPROVED BY: _____
        Chin-Yu Lin, D.D.S., M.S., M.S.D., Ph.D. (Committee Chair)   Date

APPROVED BY: _____
        Patrick Hardigan, M.S., Ph.D. (Committee Member)   Date

APPROVED BY: _____
        Gisela Contasti, D.D.S. (Committee Member)   Date

APPROVED BY: _____
        Linda Niessen, D.M.D., M.P.H. (Dean, College of Dental Medicine)   Date

NOVA SOUTHEASTERN UNIVERSITY

Health Professions Division
College of Dental Medicine
Department of Orthodontics

RESIDENT NAME: Monica T. Dinh, D.D.S.

RESIDENT EMAIL ADDRESS: md1746@nova.edu

RESIDENT TELEPHONE NUMBER: (703) 409-8487

COURSE DESCRIPTION:
   Master of Science in Dentistry,
   Certificate in Orthodontics and Dentofacial Orthopedics

TITLE OF SUBMISSION:
   Adjunctive appliance wear and gender affect patients' oral health-related quality of life during the late stage of orthodontic treatment in adolescents

SUBMISSION DATE: November 2015

I certify that I am the sole author of this thesis, and that any assistance I received in its preparation has been fully acknowledged and disclosed in the thesis. I have cited any sources from which I used ideas, data, or words, and labeled any directly quoted phrases or passages, as well as providing proper documentation and citations. This thesis was prepared by me, specifically for the Master of Science in Dentistry degree for this assignment.

Resident Signature: _____
   Monica T. Dinh, D.D.S.   Date

Dedication

To my family who have supported me throughout my education and my life. Without your generous help and encouragement, I would not be where I am today.

Acknowledgements

I would like to thank:

Abstract

ADJUNCTIVE APPLIANCE WEAR AND GENDER AFFECT PATIENTS' ORAL HEALTH-RELATED QUALITY OF LIFE DURING THE LATE STAGE OF FIXED ORTHODONTIC TREATMENT IN ADOLESCENTS

DEGREE DATE: NOVEMBER 2015

MONICA T. DINH, D.D.S.

COLLEGE OF DENTAL MEDICINE NOVA SOUTHEASTERN UNIVERSITY

Thesis Directed By:

Chin-Yu Lin, D.D.S., M.S., M.S.D., Ph.D., Committee Chair

Patrick Hardigan, M.S., Ph.D., Committee Member

Gisela Contasti, D.D.S., Committee Member

Objective: This study was conducted to determine how oral health-related quality of life (OHQoL) changes during the late stage of comprehensive fixed orthodontic treatment in adolescents and what factors may be involved. **Background**: Completion of orthodontic treatment has been shown to improve patients' OHQoL due to the changes in esthetics, function and emotional well-being[1-3]. The levels of OHQoL fluctuate throughout treatment where an initial decrease within the first 6 months occurs followed by an improvement towards patients' pre-treatment levels[3-6]. At 18 months of fixed orthodontic treatment, the level is unclear[6]. The aims of this study were to clarify the changes of OHQoL during this late stage of fixed orthodontic treatment beyond 18 months in adolescents and to identify factors, including dental extractions, patient compliance, use of adjunctive appliances, and patient demographics, which may contribute to the OHQoL. **Methods**: This case-control study consisted of 154 adolescent patients undergoing comprehensive fixed orthodontic treatment from the Nova Southeastern University

orthodontic department. Subjects were selected based upon the number of months in comprehensive fixed orthodontic treatment. Completion of the Oral Health Impact Profile short form (OHIP-14) as well as occurrence of dental extraction during orthodontic treatment, use of adjunctive appliances, frequency of emergency and failed appointments, level of oral hygiene, and subjects' age and gender were all recorded. Statistical analysis using structural equation modeling was used to determine the direct and indirect effects to subjects' OHQoL. **Results**: The model accounted for 35% of the variance in OHQoL. There were no significant differences in average OHIP-14 scores between the initial stage of 5-7 months and final stage of 18 months and over in orthodontic treatment. The analysis of direct factors showed that females and subjects with adjunctive appliances possessed higher OHIP-14 scores. **Conclusions**: Treatment time beyond 18 months of treatment was not a significant factor affecting adolescents' OHQoL. Female patients and those with adjunctive appliances expressed poorer levels of OHQoL. These factors may be attributed to the scores within the physical and psychological domains as these patients experienced pain and discomfort from appliance wear as well as negative impact on their self-esteem during comprehensive fixed orthodontics.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1. Oral Health-Related Quality of Life

Quality of life is a ubiquitous term that may be defined differently across individuals and disciplines. A holistic view with multiple components must be considered, but health is arguably one of the most important domains for measuring overall quality of life[7]. The biopsychosocial model of health exemplifies how health and quality of life are related stating that symptoms, physical functioning, and emotional and social well-being are used to determine an individual's health status[8]. Similarly, the World Health Organization Quality of Life Assessment includes parameters to evaluate physical and mental health, including oral health[9].

As described above, quality of life may be narrowed to health-related quality of life but it may be further differentiated into oral health-related quality of life (OHQoL). The presence of oral diseases negatively impact quality of life[7]. For example, dental caries extending to the pulpal chamber of the tooth may elicit severe pain interfering with normal eating and sleeping patterns. A patient with periodontal infection suffers from chronic inflammatory conditions which have been shown to lead to systemic effects and concurrent cardiovascular disease typically resulting in negative consequences on quality of life[10]. Even in the absence of active oral disease, there are other issues related to the oral cavity which affect quality of life. Dental malocclusion may result in dental esthetic concerns[11]. A person's satisfaction with respect to their oral health is reflected in their self-esteem. Additionally, oral health affects aspects of social

life including social interactions, school and job performance[8]. The goals of orthodontic treatment include improving patient satisfaction and their esthetic appearance. In this way, orthodontists along with other dental professionals are interested in OHQoL research and its implications in clinical practice.

1.1.1.   Oral Health Impact Profile

The topic quality of life has been around for decades but the emergence of oral health-related quality of life is more recent. Despite the youth of this field, several measures have been designed to assess OHQoL including one of the most widely used instruments called the Oral Health Impact Profile (OHIP) [12,13].

Measurements of quality of life consist of both positive and negative elements. For instance, improvements in health are positive measurements whereas progression of disease is a negative measurement. Traditionally, studies on OHQoL measure only the negative elements until 1994 when the OHIP instrument was designed which evaluates both elements[14]. Although the instrument was originally designed with a sample from South Australia, it is validated across numerous countries including the United States[15]. To simplify the use and improve the application of the questionnaire, a shorter version has been derived and shown to have good reliability and validity[16]. This questionnaire is highly versatile across different age groups with validation among adolescents aged 14-17 years and has been used in the literature in populations as young as 9 years old[17-19].

To properly measure OHQoL, the Oral Health Impact Profile consists of seven conceptual domains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. In the short version, called the OHIP-14, there are two questions for each domain measuring the individual's self-reported dysfunction, discomfort and disability attributed to their oral condition. Responses are on a five-point Likert-like scale where respondents indicate how frequently they experience each problem. These responses are coded as 0 (never or not applicable), 1 (hardly ever), 2 (occasionally), 3 (fairly often), or 4 (very often). High scores indicate more diminished levels of oral well-being.

1.2. Timing during Orthodontic Treatment

Completion of orthodontic treatment in both children and adults has been shown to improve patients' OHQoL due to changes in esthetics, function and emotional well-being[1-3]. When comparing adolescents who had comprehensive orthodontic treatment to those who never had any orthodontic treatment, multiple studies show that OHQoL is significantly better in the treated group[1,2,11,20-23]. This improvement in quality of life may be correlated with the correction of dental malocclusion from orthodontic treatment. It may be expected that higher levels of quality of life are present in those with normal occlusion as the literature shows these individuals are rated more positively with the perception of attractiveness, intelligence, personality, and desire to interact in personal and professional settings[24]. Conversely, those with malocclusion tend to have lower levels of quality of life, albeit only a modest association[25-27].

Although improvement may be noted as an outcome of treatment, during orthodontic treatment the patients' level of OHQoL may fluctuate. Previous research shows that it varies the most during the first 6 months[5]. The most diminished levels, worse than at pre-treatment, occurred one week after bonding fixed appliances with the greatest effects in the physical pain, psychological discomfort, physical disability, and functional limitations domains[3,28]. After the first month, OHQoL improved, particularly the emotional well-being domain[4]. Similar levels were found prior to bonding and after 6 months of fixed appliances as the detrimental effects reduced with ongoing treatment[3]. At 18 months of fixed orthodontic treatment, the level is unclear[6]. This demonstrates that timing during orthodontic treatment is an important factor in patients' OHQoL. The average treatment time for comprehensive fixed orthodontic treatment is about 23-24 months. The final finishing and detailing stage lasts about 6 months therefore it may be during this portion of patients' treatment where levels of OHQoL have yet to be clarified[29-31].

As described above, treatment duration is directly related to patients' OHQoL. Possible indirect determinants include all factors that play a role in patients' treatment time. Treatment mechanics in extraction and non-extraction cases are drastically different often resulting in increased treatment time when teeth are removed and large spaces need to be closed[29-31]. Similarly, patient compliance, particularly the ability to follow directions relating to orthodontic mechanics such as wearing elastics or palatal expansion, can extend treatment time if not reliable[30]. Finally, the more appliances present

intraorally, the more the patients need to physically adjust and the more likely for a part to break delaying treatment progress[30,32]. Each of these components were examined for their direct effect on OHQoL as well as possible associations between each variable.

1.3.   Dental Extractions

In orthodontics, dental extractions may be indicated to help obtain adequate stability, function and esthetics. Treatment plans involving such extractions are common across many practitioners[33]. The rate of extraction for orthodontic purposes has changed over the course of history varying between 10% in the 1950's to 76% the following decade[34]. With the constant flux, it is apparent that the controversy between extraction and non-extraction for fixed orthodontic treatment in borderline patients is ongoing.

As with any dental procedure, extractions come with multiple risks as well as causing patients discomfort and physical pain. About one third of subjects experienced significant deterioration in OHQoL during the first 3 days postoperatively with average healing complete after 2 weeks[35]. Interestingly, patients are unable to differentiate their perceptions of recovery between one tooth versus two or more teeth extracted simultaneously[36]. When dental extractions are indicated during fixed orthodontic treatment, they are often removed early during treatment, include multiple teeth, and involve healthy teeth. These results show that dental extraction do have an effect on OHQoL but there is no current literature to support extended effects long after healing has completed.

The indirect effect of dental extractions and OHQoL may exist through its effect on treatment time. Studies show there is a significant relationship between duration of treatment when teeth are extracted. Varying biomechanics and distance teeth are moved in extraction cases result in longer treatment times[29-31]. Conversely, many articles found no difference between these variables concluding that the decision to extract or not does not affect treatment time[37,38].

1.4.   Patient Compliance

Patients' level of compliance may be related to their OHQoL. There are many factors that contribute to patient compliance; this study focused on patient attendance rate and oral hygiene. Keeping

up with recall appointments with the general dentist has been shown to affect patient's quality of life. Those who reported dental attendance within the last year felt that oral health enhanced their quality of life[39]. In a study with children with oral clefts, the group that had poorer quality of life also had poorer oral hygiene[40]. Another study that measured quality of life and their treatment need in children showed that those with higher scores indicated more concern due to their tooth arrangement. This suggested that children with poor OHQoL were more concerned about their teeth and hence may be more likely to cooperate with their treatment[41]. Whether a positive or negative correlation exist, our goal was to determine if patient compliance had an impact on their OHQoL.

Poor patient compliance has been correlated with extended treatment time[30]. Conversely, long treatment times may cause poor compliance as patients become burnt out[31]. Both points indicate patient compliance indirectly affects OHQoL through its influence over time. In order to maintain within the estimate treatment time presented, patients need to come regularly to appointments on time as scheduled to complete the procedures planned. Poor attendance rate measured by the frequency of failed appointments significantly extend treatment duration[30,31,38]. Poor oral hygiene also leads to significantly extended treatment time[38]. Another component of patient compliance is the patient's ability to follow directions relating to orthodontic mechanics such as wearing elastics or palatal expansion. Even with the use of compliance-free appliances, orthodontist are still relying on patients to cooperate in order for treatment to be rendered within the estimated time frame[37]. Patient compliance, whether due to appointment attendance or oral hygiene, is related to OHQoL but the direction of this relationship and its impact during the late stage of orthodontic treatment has yet to be determined.

1.5.   Adjunctive Appliances

Additional appliances may be used to reinforce desired tooth movements. These may be attached extraorally or intraorally. Unfortunately, the presence of adjunctive appliances causes physical discomfort from increased pain intensity initially[42,43]. Overtime, patients are able to adapt, especially psychologically, with pain intensity diminishing after 2-3 days[5]. A study using the Forsus appliance showed that more than 80% of patients reported they had "gotten used to the [Forsus]" within 4 weeks[42]. When comparing the use of headgear and functional appliances to those without any orthodontic

appliances, OHQoL was poorer[44]. Although healing and adaptation occur, it may be expected that the more appliances placed, the harder it is for patients to cope. There is currently no literature evaluating the effect of adjunctive appliances in conjunction with the traditional bracket system on OHQoL.

In addition to appliances causing physical discomfort, the more appliances used, the more likely for something to break, which extends treatment time[30,31,38,45]. There are multiple reasons for broken appliances but one major cause is due to patient's inability to follow dietary limitations associated with braces. When appliances are broken or brackets are debonded, not only is the procedure for that appointment altered, but often times more flexible wires need to be placed setting them even further back in their treatment. Especially with functional appliances, if used improperly, treatment may progress in the wrong direction[45].

1.6. Significance of Study

The current paradigm shift towards an autonomous approach exemplifies why quality of life studies are important. This shift focuses on the patients' social and emotional experience and allowing them to play a more active role in determining the treatment needed. It is the doctor's responsibility to educate the patient of the problems and present treatment options available that carry out their goals. Studies about the quality of life better equip the doctor during this process. The literature shows that OHQoL levels fluctuate throughout orthodontic treatment as it takes times to adapt to fixed orthodontic appliances. Quality of life studies improve the doctors' ability to provide informed consent and adequately prepare patient expectations for orthodontic treatment. Additionally, these types of studies quantify the potential benefits of orthodontic treatment. It is up to the patient to weigh these risks and benefits involved and provide the final decision on treatment rendered[8].

This study evaluates what factors during orthodontic treatment most affect patients' OHQoL during the late stage of treatment. After 18 months of treatment, the majority of patients should be within the finishing and detailing stage of orthodontic treatment. As treatment proceeds, the alignment of teeth becomes visible and adolescents' physical and psychological perspective would expected to be different compared to when they started orthodontic treatment. With the contradicting existing literature, this study will shed light on adolescents' OHQoL during the late stage of orthodontic treatment. Due to the limited

recovery time following dental extractions, the expected outcome is that there is no difference between patients treated with or without extractions. In this way, the mode of treatment may not affect patients' OHQoL negatively. The choice of extraction or non-extraction for borderline cases should be up to the practitioner's discretion based upon the patient's facial esthetics, stability of teeth, and health of the periodontium[33]. It is predicted that patient compliance diminishes as treatment duration proceeds due to patient burnout. By understanding the factors of OHQoL, treatment plans may be adjusted for use of non-compliance mechanics during the late stage of orthodontic treatment to help finish treatment. The addition of adjunctive appliances often causes physical discomfort and makes oral hygiene maintenance more difficult[42]. By determining how all of the factors relate to one another, a deeper understanding of changes in patients' OHQoL is discovered. Guidance in orthodontic treatment modalities and implementation helps improve patients' experience, treatment outcome and building a successful practice.

1.7. Purpose, Specific Aims and Hypotheses

1.7.1. Purpose

The purpose of this study was to evaluate the level of oral health-related quality of life in adolescents during the late stage of their comprehensive fixed orthodontic treatment. To determine this, select patients were asked to complete the OHIP-14 questionnaire. The patients' duration in treatment, inclusion of dental extractions, level of compliance, use of adjunctive appliances, age and gender were also recorded as possible determinants to their OHQoL.

1.7.2. Specific Aims

1. To clarify the changes of OHQoL during the late stage of fixed orthodontic treatment beyond 18 months in adolescents.

2. To determine if dental extractions during orthodontic treatment affects patients' OHQoL in adolescents.

3. To determine if the level of patient compliance affects patients' OHQoL during orthodontic treatment in adolescents.

4. To determine if the use of adjunctive appliances during orthodontic treatment affects patients' OHQoL in adolescents.

5. To determine if there are any indirect effects between the examined factors, including dental extractions, patient compliance, use of adjunctive appliances, age and gender, which affect patients' OHQoL during orthodontic treatment in adolescents.

1.7.3.   Hypotheses

H_o: The factors of orthodontic treatment with dental extractions, adjunctive appliances, level of patient compliance, age and gender do not have any direct or indirect effects on OHQoL between initial and late stage of orthodontic treatment in adolescents.

H_a: The factors of orthodontic treatment with dental extractions, adjunctive appliances, level of patient compliance, age and gender do have a direct and indirect effect on OHQoL between initial and late stage of orthodontic treatment in adolescents.

Chapter 2: Material and Methods

2.1. Study

2.1.1. IRB Approval

IRB approval to conduct research accessing patients' personal health information was granted at Nova Southeastern University. All data collected form the subjects' electronic health record were labelled with a number so that data was viewed and analyzed without personal identifiers present. All photographs reviewed were intraoral only therefore did not contain potential identifiers.

2.1.2. Ethical Issues

All potential ethical issues were addressed accordingly. The selected subjects were active patients from the principal investigator's department clinic, some of which were the principle investigator's own clinical patients. During clinic hours, selected subjects and their parent guardians were approached and invited to participate in the study by either the principle investigator or by a research assistant. To avoid any potential coercion in subject recruitment, subjects who were immediate clinical patients of the principle investigator were approached about the study by an assistant. Additionally, all data obtained by the subjects were coded so that all potential markers were de-identified. Participation was confined to a short survey which could be completed in one sitting. Due to the format of the study, therapeutic misconception was avoided.

2.1.3. Grant

This study was awarded a grant by the Health Professions Division at Nova Southeastern University.

2.2. Treatment Groups and Variables

The independent variables include length of time in orthodontic treatment, dental extractions during orthodontic treatment, patient compliance, use of adjunctive appliances, age and gender. The dependent variable was their OHIP-14 score.

The research study proposed four treatment groups based upon their duration of orthodontic treatment. The first group represented the baseline level for OHQoL as the literature shows similar scores prior to orthodontic treatment and at 6 months of treatment. The remaining three groups included treatment beyond 18 months. The grouping is as follows.

1. Patients at 5-7 months of treatment

2. Patients at 18 to <24 months of treatment

3. Patients at 24 to <36 months of treatment

4. Patients ≥36 months of treatment

The predicted structural equation model provides a pathway analysis of the direct and indirect effects on OHQoL (Figure 1).

Figure 1. Initial pre-analysis structural equation model.
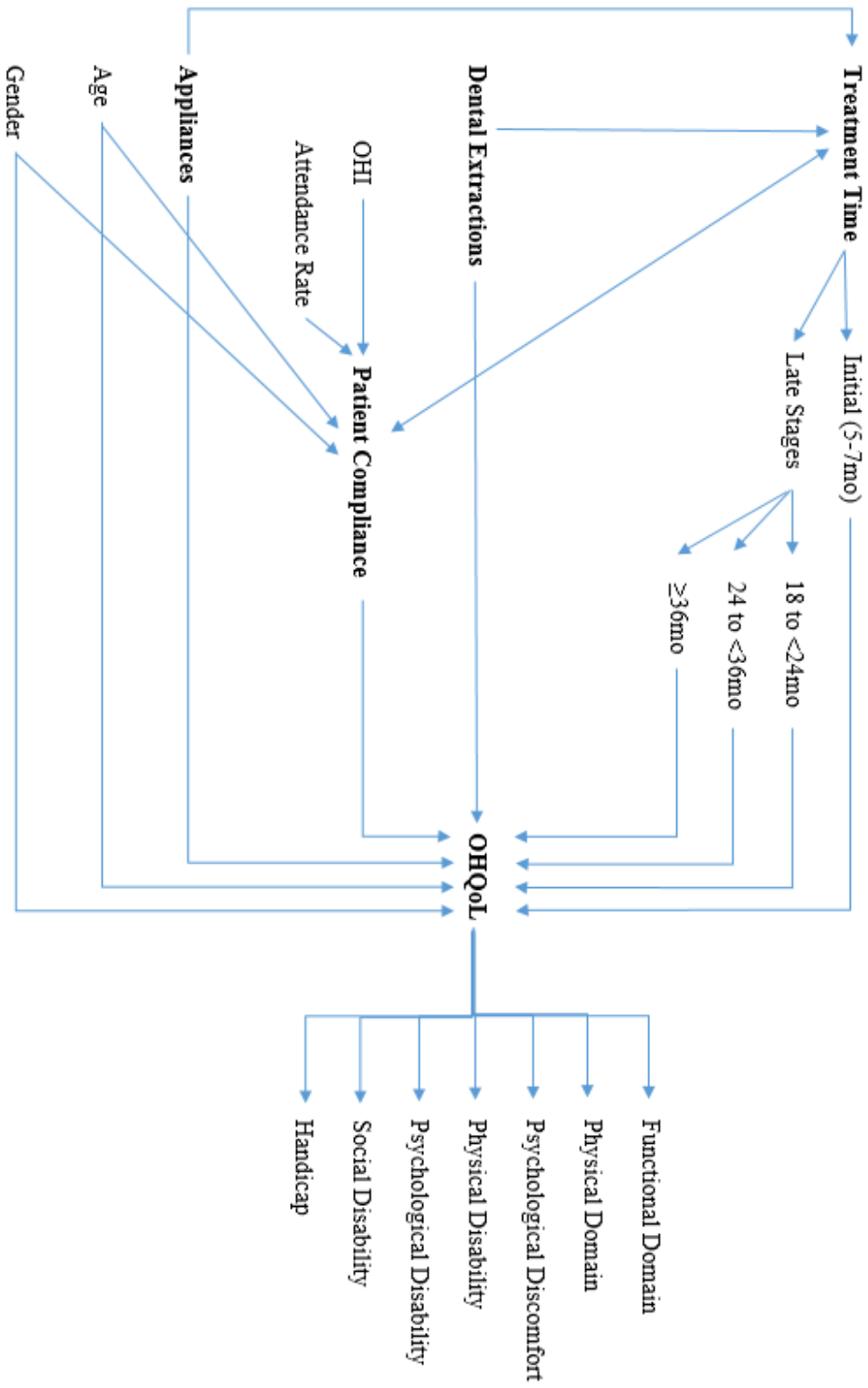
2.3. Sample Size Estimate

Sample size calculations were initially developed for five different treatment stage groups. Using a Cochran's formula developed for categorical outcomes, a calculation of the baseline sample size was conducted and then adjusted for dropouts. Using a standard deviation of 0.85, a significance level of α = 0.05 and 80% power, the sample size was 50 patients per group. Assuming a response rate of 90%, a minimum of 55 subjects per group were needed. Groups, therefore sample sizes, were subsequently reorganized to the four treatment groups described above.

2.4. Inclusion and Exclusion Criteria

Inclusion criteria involved being in active comprehensive fixed orthodontic treatment at the Nova Southeastern University. Patients from both the Post-Graduate clinic as well as Faculty Practice were accepted. Subjects had to be 13-17 years of age. Fixed orthodontic appliances must have been worn for consecutive months during their treatment time. Both subject and subject's parent guardian must have been comfortable reading and speaking English as documents were present in that language only. If dental extractions were conducted during orthodontic treatment, they must be done at least 2 weeks prior to when the survey was taken to allow for sufficient healing in the average patient. In this way, cases where extractions were initially planned and cases where delayed extractions were indicated were both included.

Exclusion criteria include medical or dental histories that indicated severe medical conditions. Subjects with interdisciplinary treatment plans such as orthognathic surgery, periodontal surgery, and surgical exposure of impacted teeth were not included in the study. Only valid responses on the OHIP-14 questionnaire were analyzed. If any responses were left blank, the questionnaire was discarded.

2.5. Data Collection

2.5.1. OHIP-14

A non-probability sampling by quota was used to select potential subjects. Those subjects who passed the inclusion and exclusion criteria were approached when they presented in clinic for their periodic orthodontic appointments. Either the principle investigator (PI) or a research assistant administered the surveys. If the selected subject was a patient directly treated by the PI, an assistant proctored the data collection. Once subjects were selected, an informed consent form was reviewed and signed by the parent guardian. The informed consent described the risks and benefits involved in the study, participation in the study was completely voluntary, and that a $10 Target gift card was provided to the subject to compensate them for their time. If any questions were skipped, the questionnaire was considered incomplete and no gift card was awarded. Following parent consent, adolescent assent was obtained. Finally the modified OHIP-14 questionnaire was to be completed by the adolescent (Figure 2). Minor alteration to the original questionnaire were made to apply to the target population such as removing statements referring to the use of dentures. Instructions emphasized that responses to the questions were to be based on their current status, not on any past history or experience.

Figure 2. Modified OHIP-14.

Please answer the following questions based on how you *feel right now*, even if you felt differently in the past.

* 1. Do you have trouble *pronouncing any words* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 2. Do you feel that your *sense of taste* has worsened because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 3. Do you have *painful aching* in your mouth?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 4. Do you find it *uncomfortable to eat any foods* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 5. Are you *self-conscious* because of your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 6. Do you *feel tense* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 7. Is your *diet unsatisfactory* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 8. Do you have to *interrupt meals* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 9. Do you find it *difficult to relax* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 10. Do you feel a bit *embarrassed* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 11. Do you feel a bit *irritated with other people* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 12. Do you have *difficulty doing your usual jobs* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 13. Do you feel that life in general is *less satisfying* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 14. Are you *totally unable to function* because of problems with your teeth, mouth or braces?

Never	Hardly Ever	Occasionally	Fairly Often	Very Often
○	○	○	○	○

* 15. What is your age?

○ 13

○ 14

○ 15

○ 16

○ 17

* 16. What is your gender?

○ Male

○ Female

* 17. What grade are you in?

○ 7th

○ 8th

○ 9th

○ 10th

○ 11th

○ 12th

○ Other (please specify)

[   ]

2.5.2. Treatment Determinants

Access to the subjects' electronic health record for treatment notes were reviewed. Extraction procedures during treatment, whether completed initially or after a few months of treatment were recorded. If extractions were completed, at least 2 weeks of healing was required before subjects were asked to take the survey. Extractions of primary teeth as well as extractions during interceptive fixed orthodontic treatment were not included. Prior to beginning orthodontic treatment, patients needed to be free of oral disease. No active caries were present and a healthy periodontium are required to initiate orthodontic therapy.

Patient compliance was measured by examining appointments and patient oral hygiene. Access to the patient's electronic health record were used to tally the type and number of appointments. The frequency of broken appliance was measured by counting the number of extra appointments the patient came into the clinic to address an emergency separate from their scheduled periodic orthodontic adjustments. The frequency of failed or cancelled appointments were also recorded. These values were compared to the patient's total number of appointment to create an attendance rate for each subject; attendance rate equaled the total number of appointments minus the sum of number of broken and emergency appointments divided by the total number of appointments. Oral hygiene was evaluated by viewing clinical intraoral photographs of the subjects prior to orthodontic treatment. The Simplified Oral Hygiene Index (OHI-S) was used to quantify the level of oral hygiene[46]. This grading system is based on the presence of plaque and extrinsic staining of teeth. A score of 0 represents no debris or staining present, 1 represents soft debris covering not more than one third of the tooth surface, 2 represents soft debris covering more than one third but not more than two thirds of the exposed tooth surface, and 3 represents soft debris covering more than two thirds of the exposed tooth surface (Figure 3).

Figure 3. Simplified Oral Hygiene Index (OHI-S) scores based on plaque accumulation.
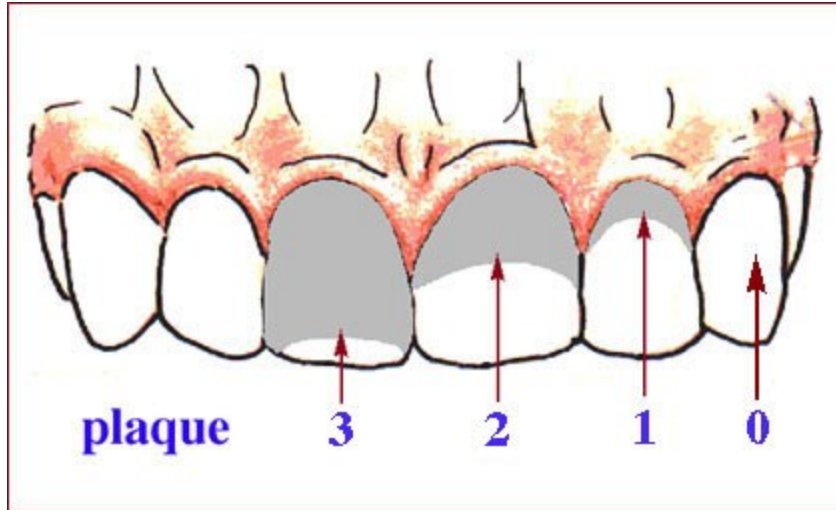
Other determinants of OHQoL include the use of adjunctive appliances and their demographic background. Any additional appliance used to reinforce tooth anchorage besides the bands, brackets and arch wires were considered as adjunctive appliances in this study. Appliances used to reinforce anchorage such as a mandibular lingual holding arch, Nance appliance, and transpalatal arch were included. Similarly, other intraoral class II correctors including Herbst, Powerscope, and Forsus appliances were recorded as well as extraoral appliances like headgears. Intermaxillary elastics were not considered as adjunctive appliances. Documentation of the subject's age and gender were recorded.

2.6. Statistical Analysis

After data collection, the sample sizes were too small to draw significant finding. Certain factors were collapsed to determine possible mixed factors that had an effect on adolescents' OHQoL. Subjects were subsequently divided into two groups based on their duration of orthodontic treatment, initial stage and late stage of comprehensive fixed orthodontics (Figure 4). The adjusted models included patients at 5-7 months of treatment as the Initial Stage, and patients ≥18 months of treatment as Late State.

Figure 4. Adjusted pre-analysis structural equation model.
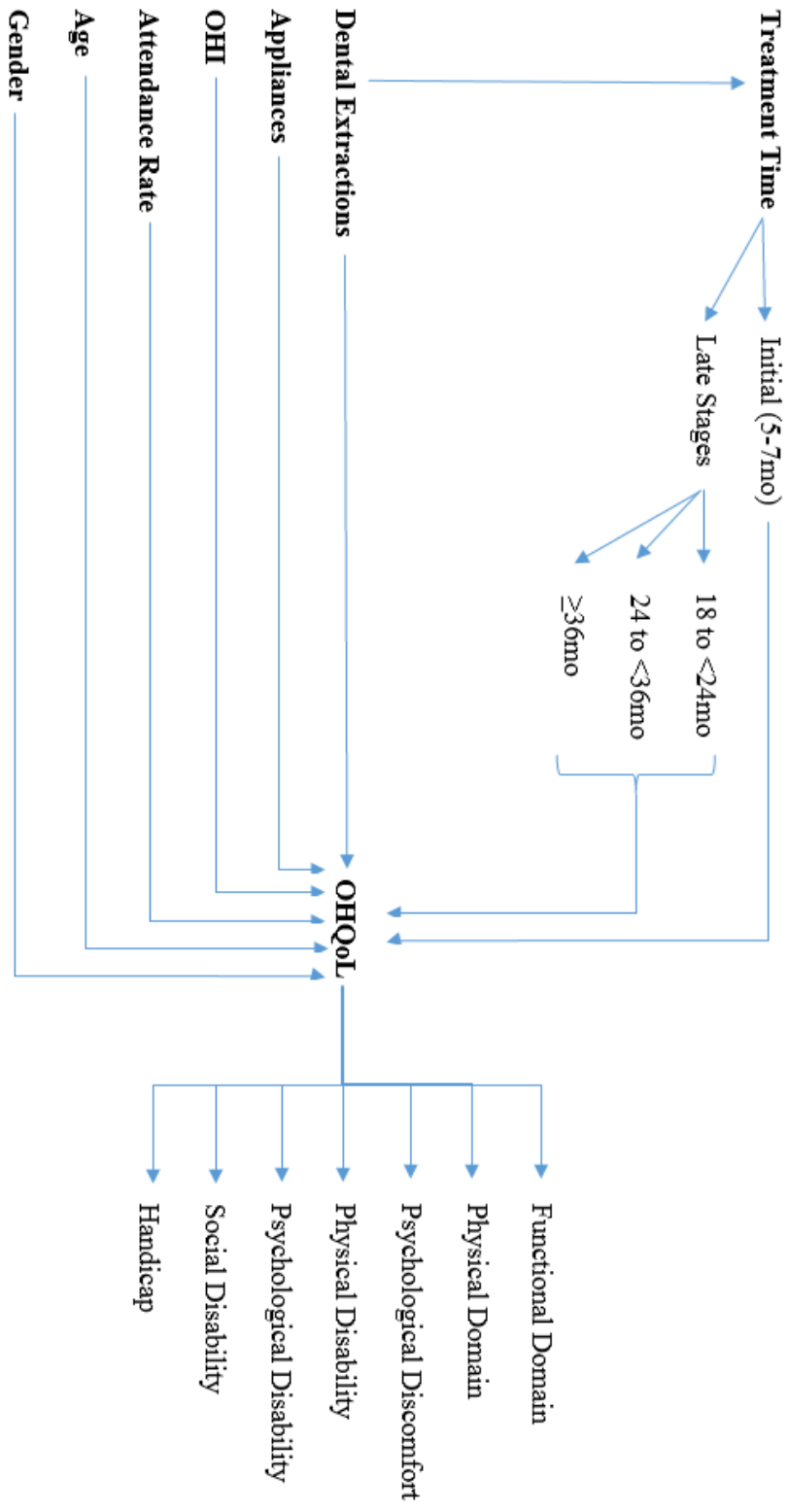
Structural equation modeling (SEM) with maximum likelihood estimation and robust standard errors was used to estimate the models with STATA (StateCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorpLP). The main a priori hypotheses were that comprehensive orthodontic treatment would interact, which, in turn, would predict OHQoL. As we used all manifest variables (measured variables) the SEM approach was essentially a path analysis.

The tested models estimate the total effects, which are made up of both the direct effects (a path direct from one variable to another, e.g., age → OHQoL) and indirect effects (a path mediated through other variables, e.g., extractions → OHQoL via treatment time).

We assessed whether mediation was present by testing the significance of the indirect effect using the bias-corrected bootstrap confidence intervals. The bootstrap framework has been advocated as the best approach for SEM with small-moderate sample sizes, and for testing mediation models[47,48].

Chapter 3: Results

3.1. Descriptive Statistics

Table 1. Descriptive statistics for OHQoL.

		N	M	SD	Min	Max
Stage	Stage 1	30	8.86	1.51	5.80	11.63
	Stage 2	124	8.21	1.58	4.32	11.64
Extractions	No	89	8.21	1.59	4.32	11.64
	Yes	65	8.51	1.57	5.33	11.63
Appliance	No	100	7.64	1.36	4.32	10.45
	Yes	54	9.63	1.08	7.19	11.64
OHI-S	0	10	10.08	0.75	8.48	11.30
	1	63	8.62	1.35	6.26	11.64
	2	46	7.92	1.64	5.19	11.63
	3	35	7.88	1.65	4.32	10.22
Attendance Rate		154	0.77	0.11	0.41	1.00
Gender	F	80	9.05	1.23	6.25	11.64
	M	74	7.57	1.57	4.32	11.30
Age		154	14.71	1.29	13.00	17.00

N=sample number, M=mean, SD=standard deviation, Min=minimum, Max=maximum.

A sample of 161 adolescents were asked to participate in the study with a response rate of 95.7%. Two declined participation while five were later found not to qualify for the inclusion and exclusion criteria. The final sample consisted of 154 adolescents. Descriptive statistics were used to analyze the sample (Table 1). Among the 154 participants, 80 were females (51.9%) and 74 were males (48.1%). The adolescents were all 13-17 years of age, with the average age of 14.71 years old (SD=1.29). After collapsing all of the late stages into a single group with treatment time ≥18 months of comprehensive fixed orthodontics, there were 30 individuals in the initial stage 1 group (19.5%) and 124 in the late stage 2 group (80.5%). The majority of the patients sampled, 64.9%, did not have an additional appliance used besides the brackets, bands and arch wires. Of the patients sampled, 57.8% were treated without extractions during their orthodontic treatment. A review of the simplified OHI scores show that nearly all subjects, 93.5%, had scored 1-3 on the index scale reflecting some degree of plaque accumulation on their teeth. 63 subjects scored a 1 (40.9%), 46 subjects scores a 2 (29.9%), 35 scores a 3 (22.7%), and only 10 scores a 0 (6.5%). The average attendance rate was 0.77 when the number or failed or missed appointments were considered.

3.2. Structural Equation Model

Data was processed using a structural equation model which accounted for 35% of the variance in OHQoL. The statistical reliability of these findings is 0.81 with α = 0.05. The upper limit is 0.87 and lower limits is 0.75 with 95% confidence boundaries.

Structural equation modeling (Table 2) showed that the presence of adjunctive appliances (2.76) and females (-1.91) were found to be significant factors on OHQoL. Stage, occurrence of extractions, attendance rate, oral hygiene scores and age were not significant predictors for OHQoL. Overall, results suggest that on the OHIP-14, those wearing adjunctive appliances score 3 points higher than those without these additional appliances, and females score 2 points higher than males with higher scores indicating poorer OHQoL.

Table 2. Model estimates for direct effects on OHQoL.

	Coef.	Std. Err.	z	P>z	Lower 95% CI	Upper 95% CI
OHQOL	<-					
OHI-S	-0.88	0.56	-1.56	0.12	-1.98	0.22
Attend	0.16	3.75	0.04	0.97	-7.19	7.51
Age	0.09	0.41	0.22	0.83	-0.72	0.90
Gender	**-1.91**	**0.98**	**-1.96**	**0.05***	**-3.83**	**0.00**
Stage	-0.43	0.54	-0.81	0.42	-1.49	0.62
Appliance	**2.76**	**0.99**	**2.78**	**0.01***	**0.82**	**4.70**
Extractions	0.35	0.93	0.38	0.71	-1.48	2.18
_cons	8.02	6.54	1.23	0.22	-4.80	20.83

*Significant at the level *P*<0.05. OHQoL=oral health-related quality of life, OHI-S= simplified oral hygiene index, Attend=attendance rate, cons=constant, Coef=predictor value coefficient where negative values represent poor oral hygiene, young age, females, initial stage, without appliances, and non-extraction, Std. Err=standard error, z=z score, CI=confidence interval.

Table 3. Model estimates for indirect effects on OHQoL.

	Coef.	Std. Err.	z	P>z	Lower 95% CI	Upper 95% CI
OHI-S	<-					
Stage	**0.18**	**0.08**	**2.39**	**0.02***	**0.03**	**0.33**
_cons	1.24	0.21	5.95	0.00	0.83	1.65
Attend	<-					
Stage	-0.01	0.01	-1.47	0.14	-0.03	0.00
_cons	0.80	0.02	34.76	0.00	0.76	0.85
Age	<-					
Stage	0.13	0.11	1.11	0.27	-0.10	0.35
_cons	14.40	0.31	46.57	0.00	13.80	15.01
Gender	<-					
Stage	0.02	0.04	0.36	0.72	-0.07	0.10
_cons	1.44	0.12	12.40	0.00	1.21	1.67
Stage	<-					
Appliance	**0.33**	**0.16**	**2.08**	**0.04***	**0.02**	**0.64**
Extractions	**0.37**	**0.15**	**2.48**	**0.01***	**0.08**	**0.66**
_cons	1.47	0.30	4.81	0.00	0.87	2.07

*Significant at the level *P*<0.05. OHI-S=simplified oral hygiene index, cons=constant, Attend=Attendance rate, Coef=predictor value coefficient where negative values represent poor oral hygiene, young age, females, initial stage, without appliances, and non-extraction, Std. Err=standard error, z=z score, CI=confidence interval.

The significant indirect factors (Table 3) on OHQoL were between initial stage of orthodontic treatment and poor oral hygiene (0.18), presence of an adjunctive appliance (0.33), and occurrence of dental extractions (0.37) during comprehensive fixed orthodontic treatment. The indirect findings are a result of the inclusion criteria, therefore they were not considered to have a true effect on adolescents' OHQoL.

Figure 5. Model estimate for OHQoL as measured by OHIP-14 scores by gender and appliance.
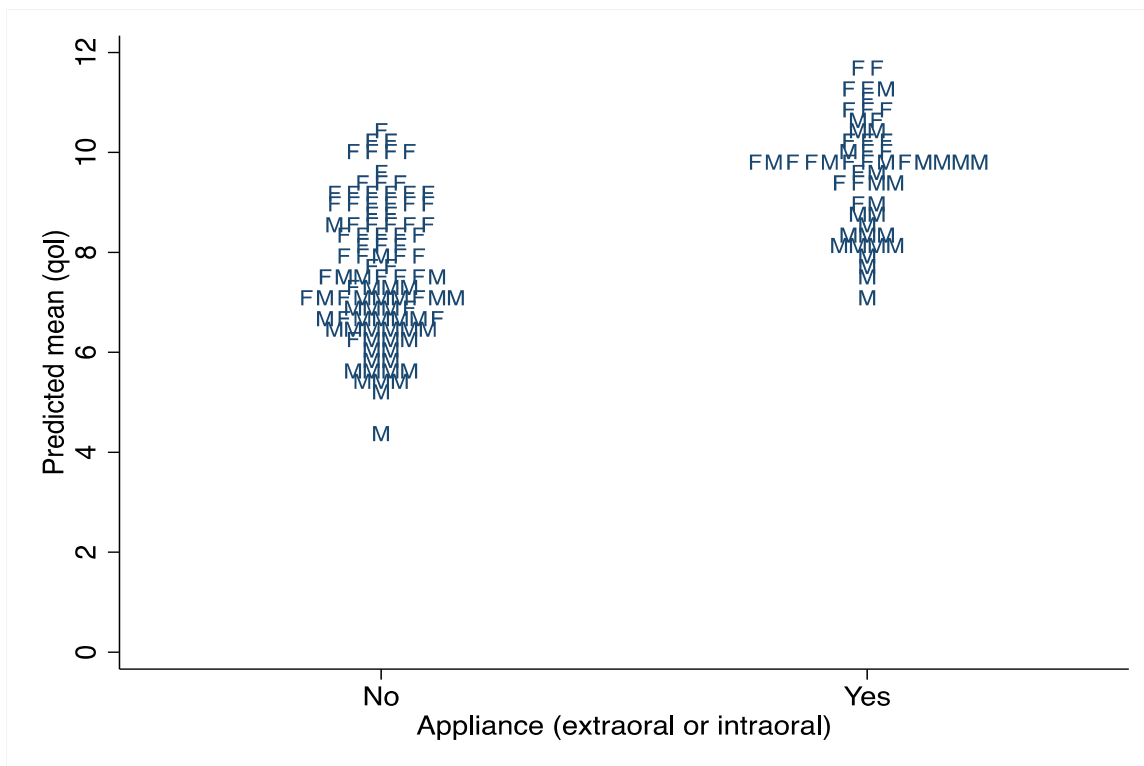
There were two significant factors that affect adolescents OHQoL. We plotted OHQoL by OHIP-14 scores from subjects by presence of an adjunctive appliance and by gender (Figure 5). The cluster on the right, which represent subjects with an adjunctive appliance, has significantly higher OHIP-14 scores than the cluster on the left. Additionally, for each cluster, females score significantly higher OHIP-14 values than males. These high scores represent poorer levels of OHQoL.

Figure 6. Bar plot with 95% CI for OHQoL by appliance, age and extraction as measured by OHIP-14 scores.
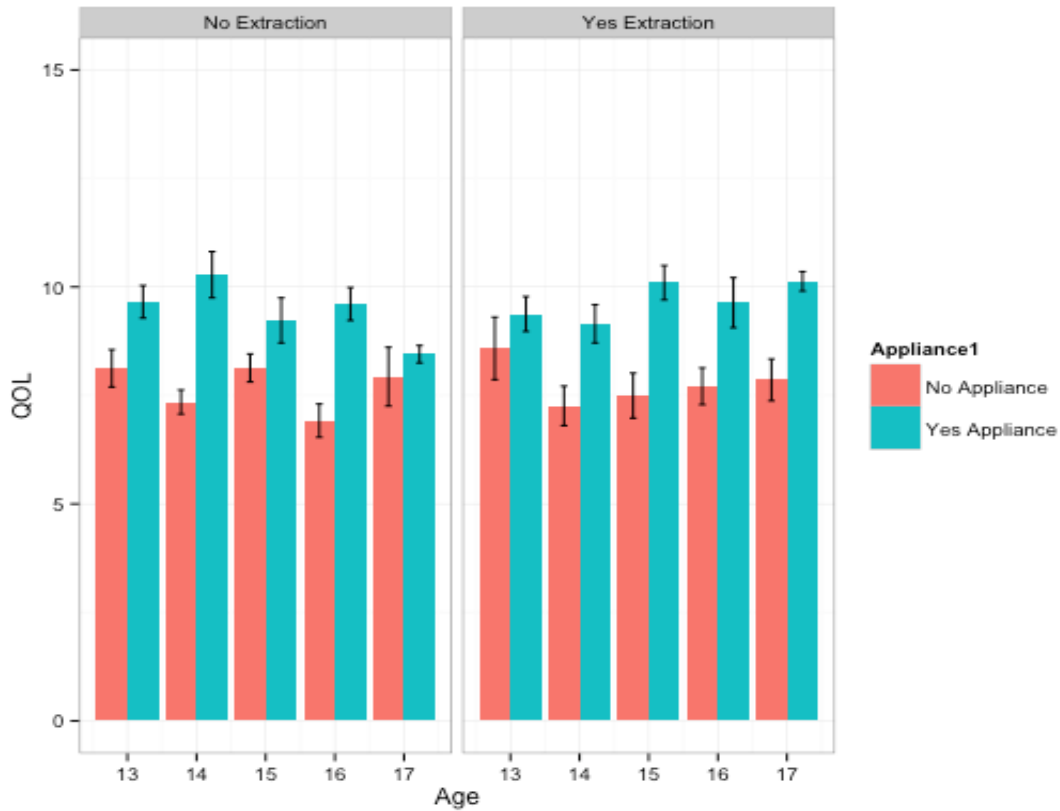
When comparing the use of appliances with the other factors evaluated in this study, the impact of appliances dominates and predictably results in higher OHIP-14 scores suggesting poorer OHQoL (Figure 6). Those subjects with appliances reported higher scores compared to those without adjunctive appliances, which can be visualized in the blue bars consistently higher than the red bars. No differences were found between ages nor extraction compared to non-extractions subjects.

Figure 7. Bar plot with 95% CI for OHQoL by gender, age and extraction as measured by OHIP-14 scores.
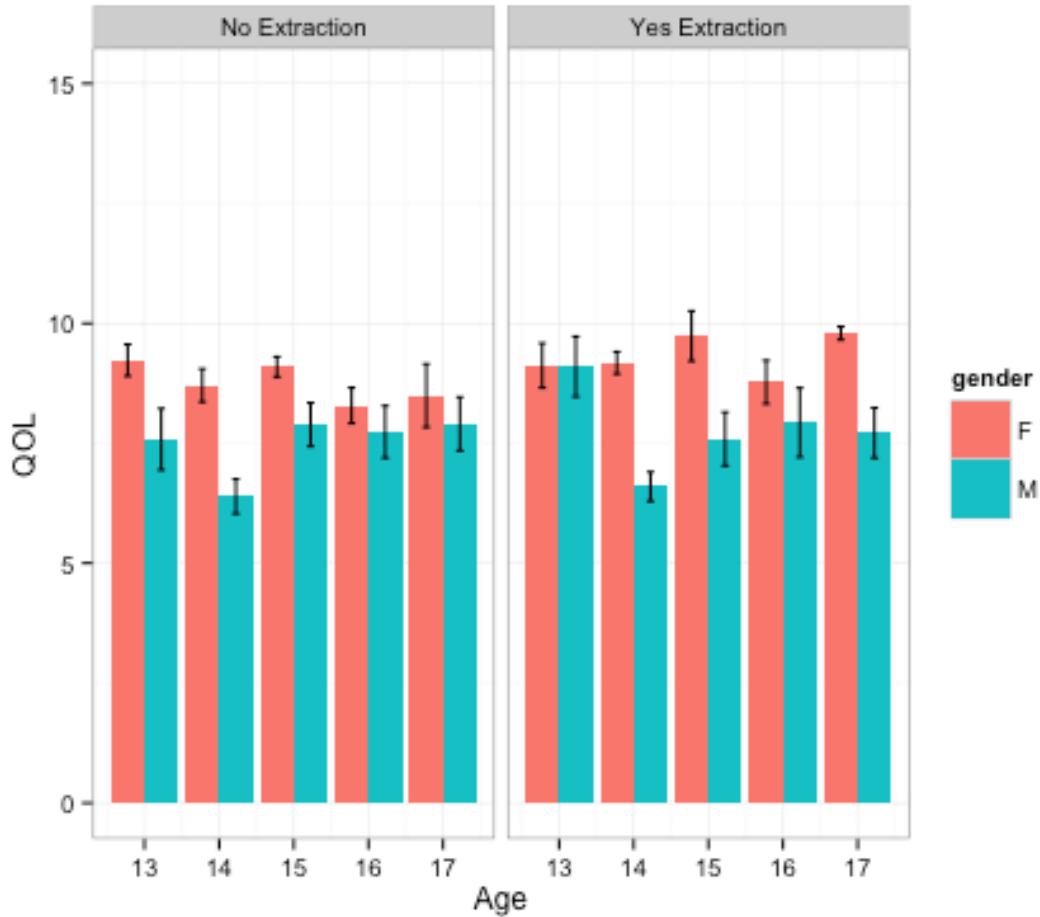
When comparing the gender with the other factors evaluated in this study, the impact of gender dominates and predictably results in higher OHIP-14 scores and poorer OHQoL (Figure 7). Females consistently scored higher than males, which can be visualized in the red bars consistently higher than the blue bars. No differences were found between the ages therefore collectively, these subjects are a good representation of adolescents. Similarly, there were no differences found between extraction and non-extraction patients in their OHQoL.

Chapter 4: Discussion

4.1. Goals of the Study

Evaluating quality of life is important for developing a patient-oriented treatment plan. Especially for teenagers who are a self-conscious population, by providing them with this evidence-based improvement, they may become more motivated for their orthodontic treatment. Malocclusion and OHQoL are related, as those who have completed orthodontic treatment have higher levels of quality of life. There are no studies that examine the late stage of orthodontic treatment beyond 18 months of comprehensive fixed orthodontics in adolescents. The purpose of this study was to determine the direct effects on OHQoL by examining timing during orthodontic treatment, inclusion of extractions, use of adjunctive appliances, attendance rate, oral hygiene levels, age and gender, as well as any indirect effects among these factors.

4.2. Insignificant Findings

Figure 8. Structural equation model estimates of direct effects.
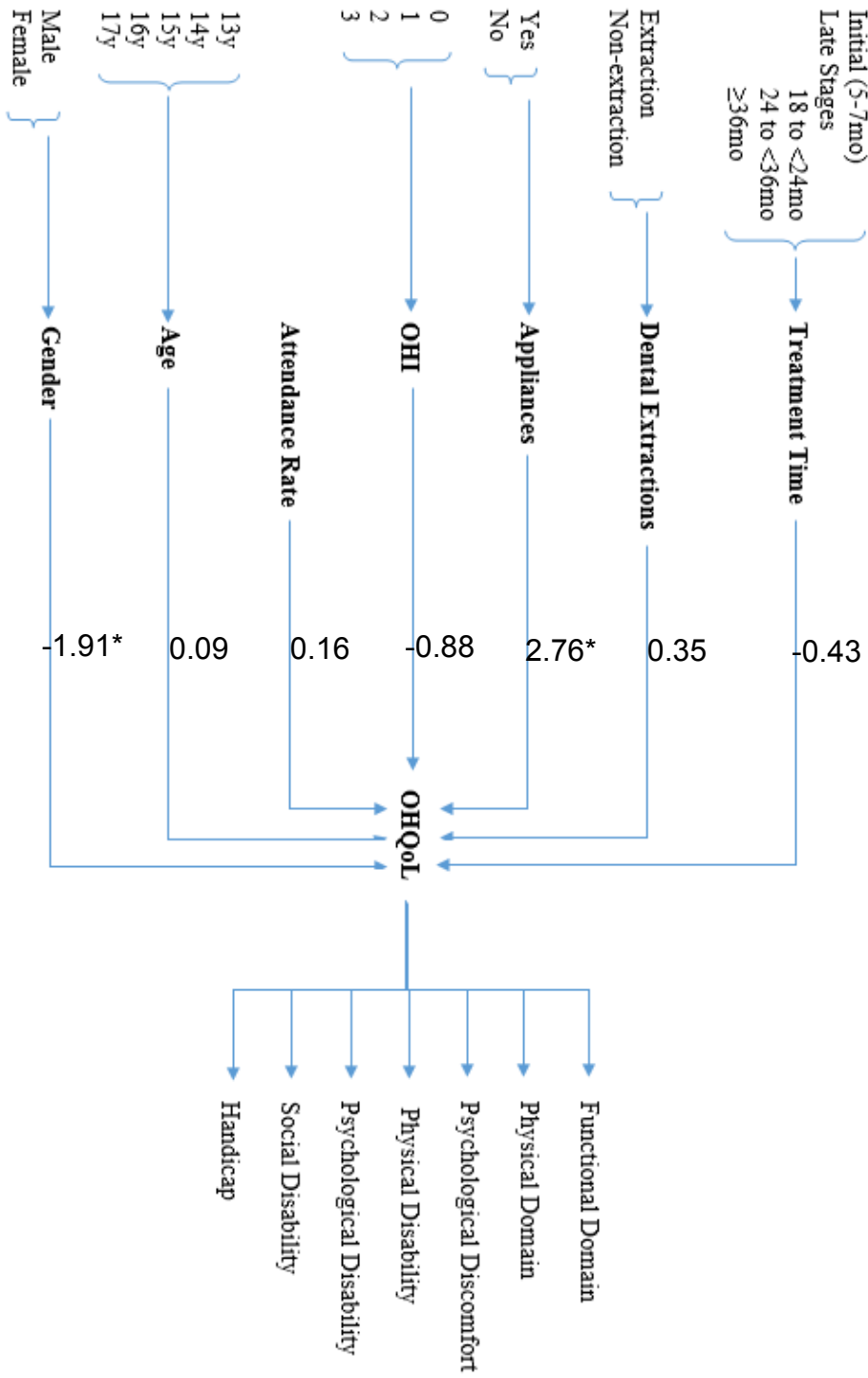
*Structural equation modeling. Significant at the level *P*<0.05.

4.2.1. Stage of Treatment

The main insignificant finding examined is the lack of association between timing during orthodontic treatment and OHQoL (Figure 8). This study divided timing into two stages: initial and late. The initial stage included subjects within 5-7 months of comprehensive fixed orthodontics. The late stage of treatment included patients at or beyond 18 months of comprehensive fixed orthodontics. It was predicted that OHQoL would improve with time since patients should adjust to the physical pain and teeth become visibly aligned. Since we were unable to find a significant difference between the stages, we failed to reject our null hypothesis, specifically: there is no difference in OHQoL between the initial and late stage of orthodontic treatment in adolescents.

The few studies that focus on this late stage of treatment and OHQoL are inconclusive. One questionnaire using the United Kingdom oral health-related quality of life (OHQoL-UK) resulted in an improvement, while another questionnaire using the OHIP-14 showed a deterioration[6]. A separate study using the OHIP-14 questionnaire found an improvement in OHQoL after 2 years of orthodontic treatment[21]. Our results refute the previous studies, unable to find any difference in OHQoL between 6 months and beyond 18 months of orthodontic treatment.

To better understand why our findings did not support the current literature, the progression of OHQoL during fixed orthodontics must be examined. The first few months of orthodontic treatment play a dramatic role in subjects' OHQoL[3,4,28]. When fixed orthodontic appliances are first delivered, patients suffer the most with the lowest level of OHQoL after one week. A slight improvement occurs after one month and at one and a half months, but the overall levels are still significantly worse than baseline scores prior to bonding. After 3 months, the trend continues with improvements approaching pre-treatment baselines. Similar scores occur between pre-treatment and after 6 months of treatment, nullifying the deterioration initially experienced. Most of this fluctuation in OHQoL is due to the diminished levels of subjects' physical pain, functional limitations, or negative oral symptoms and improvements in emotional well-being[3-6,28,49]. These results represent a physical and psychological impact that is altered during fixed orthodontic treatment. More details on these two impacts are discussed below.

Overall, this study's results suggest that extended duration of treatment does not have a positive or negative impact on adolescents' OHQoL. Although it may appear that teeth become straighter after 18

months of orthodontic treatment, there is not enough of a positive psychological impact to improve OHQoL. Conversely, physical pain from fixed orthodontic appliances does not worsen OHQoL after 18 months of treatment nor is the pain diminished enough to improve OHQoL. Although we grouped all subjects into the late stage if they were in treatment at or over 18 months, the range varied from 18 months to 74 months. Even with the possibility of outliers, there was no significant difference found, suggesting that OHQoL levels do not fluctuate after a given number of months of comprehensive fixed orthodontics. Ideally, orthodontic treatment should be kept as short as possible while achieving treatment goals. This study shows that in the cases where treatment duration was unforeseeably extended, the patient's OHQoL is not negatively impacted.

4.2.2. Extractions

This study found no difference in OHQoL between subjects treated with dental extractions and those without (Figure 6 and 7). We failed to reject our null hypothesis, specifically: there is no difference in OHQoL in patients treated non-extraction compared to those treated with dental extractions. Dental extractions do have an effect on OHQoL with subjects experiencing significant deterioration during the first 3 days postoperatively. The average healing is complete after 2 weeks whether a single tooth or multiple teeth are extracted simultaneously[35,36]. Our results support that sufficient healing from dental extractions occur thereby not impacting patients' OHQoL long after healing has completed. There is currently no literature that examines the long term effect dental extractions may have on patients' OHQoL to compare our results to. Clinically, since quality of life is not dramatically affected, the decision to extract teeth should be up to the orthodontists' discretion based upon the health of the periodontium and obtaining an esthetic outcome.

4.2.3. Patient Compliance: OHI-S and Attendance Rate

This study had two measurements for patient compliance. To identify the level of oral hygiene, the Simplified Oral Hygiene Index (OHI-S) score was determined from subjects' initial orthodontic records. Attendance rate was based off of the number of failed or cancelled appointments, and emergency

appointments compared to the total number of appointments that patient had. The results show that neither oral hygiene status nor attendance rate for appointments have an effect on OHQoL. We failed to reject our null hypothesis, specifically: there is no difference in OHQoL in patients based on their oral hygiene index score during orthodontic treatment.

A review of the literature suggests that patient compliance and OHQoL are directly associated. Patient compliance includes coming to their dental appointments regularly as scheduled, both to their orthodontic appointments and for their recall appointments with the general dentist. Those with good compliance who kept up with their recall appointments reported feeling that their oral health enhanced their quality of life[39]. Similarly, the group of children with oral cleft had poor quality of life as well as poor oral hygiene when compared to the control group[40]. Our results were not able to support a correlation between level of compliance and OHQoL. Although children who report poorer OHQoL were found to be more concerned about the arrangement of their teeth, it is not possible to assume these individuals would have better compliance when treatment was rendered[41]. A pleasing dental appearance is an important factor for psychological well-being[50], yet the value children place on their teeth does not indicate they will have good oral hygiene or be more likely to come to their orthodontic appointments.

Construct validity may be a reason why this study did not find an association between patient compliance and OHQoL. Although patients' dental appearance and their OHQoL are related, OHI-S scores recorded prior to orthodontic treatment may not necessarily be a valid measure for dental esthetics. Similarly, attendance rate may not be an accurate measure for valued oral health. Despite that patients who kept up with their recall appointments were likely to have better OHQoL, there may be multiple confounding factors that were not controlled for in this study like parent's opinion on dental health and socioeconomic background. Maternal opinions do not match their children, they tend to overestimate the emotional impact of the dental malocclusion[51]. The population studied here were adolescents, therefore these patients rely on their parent or guardian to take them to their dental appointments, for both recalls and orthodontic adjustments. Without an accurate measurement of patient compliance, it is not possible to predict patients' OHQoL appropriately.

4.2.4. Age

This study's sample age ranged from 13 to 17 years of age. No significant differences in OHQoL were found between the ages (Figure 6 and 7). This supports that all subjects in this study are a good representation of a single population of adolescents. We chose to focus on adolescence due the high prevalence of orthodontic patients within this age group. Additionally, there is no literature on adolescents which focus on the late stages of orthodontic treatment and OHQoL. Important considerations must be given to this population as they are changing physically and psychologically. Younger patients are better able to adapt to new oral environments and suffer from the less detrimental effects[43]. Adolescents are at a stage in their life where they are more vulnerable to undesirable social and emotional issues related to orthodontic treatment[52,53]. It may be suggested that this critical period of physical and psychological development causes more difficulty adjusting to fixed orthodontic appliances. Without a significant difference between ages, we were able to apply our findings to the adolescent population despite their possible heightened sensitivity.

4.3. Significant Direct Findings

4.3.1. Appliances

A significant finding from this study was that subjects with an adjunctive appliance used in conjunction with their comprehensive fixed orthodontic treatment achieved higher scores on the OHIP-14, suggesting that orthodontic appliances has a considerable negative impact on OHQoL (Figure 5 and 8). Those with additional intraoral or extraoral appliances are likely to score 3 points higher even when the other factors examined in this study are taken into consideration. This finding confirms our hypothesis that additional appliances have an effect on OHQoL, specifically causing deterioration. This effect is due to both a physical impact from painful fixed appliances as well a psychological impact experienced with treating dental malocclusion. We were able to reject our null hypothesis.

4.3.1.1. Physical Impact

According to the literature, the main reason why the presence of adjunctive appliances may cause deterioration of OHQoL is due to the physical discomfort and pain experienced with fixed orthodontic appliances[3-6,28,49]. OHQoL fluctuates throughout treatment with negative oral symptoms contributing the most to the deterioration. As more appliances are used, the more negative impact would be expected. There is currently no literature that differentiates basic orthodontic fixed appliances composed of brackets, bands and arch wires with the use of additional extraoral or intraoral appliances. Our finding are in agreement with the existing literature which compare untreated controls to subjects undergoing comprehensive orthodontic treatment[3,49]. Due to the negative impact, it may be suggested that orthodontic treatment is not without potentially harmful effects on OHQoL. It is not until fixed orthodontic appliances are removed at the completion of treatment when OHQoL is shown to significantly improve in all domains[20,28].

Interestingly, patients with appliances had poorer OHQoL, yet we found no significant difference in OHQoL after 18 months of treatment. A reason for this discrepancy is that even though patients feel discomfort with adjunctive appliances, they are able to adapt to it over time. Our results do corroborate findings with individual adjunctive appliances where discomfort was felt initially but diminished with time[49]. A study evaluating OHQoL with the use of various palatal expanders including hyrax, Haas, bonded and quad-helix found that patients experienced problems with speech, chewing and discomfort. These side effects decreased after the first week of cementation[43]. Another study investigating the use of the Forsus fatigue resistant device, a Class II corrector appliance, demonstrated similar findings where patients grew accustomed within 4 weeks[42]. Even though more severe discomfort was reported with fixed appliances than with removable appliances, both caused pain that resolved within 4-7 days[54]. Overall use of orthodontic fixed appliances have been shown to cause only a temporary deterioration in patients' OHQoL compared to untreated controls with no appliances. Patients should be aware of transitory pain when fixed orthodontic appliances are delivered. Certain precautions to help minimize oral symptoms should be taken including but not limited to prophylactic analgesics and providing dental wax with home care instructions.

4.3.1.2. Psychological Impact

A further explanation for the discrepancy between appliance wear and OHQoL over time may stem from adolescent's psychological impact. Treatment of malocclusion has a large psychosocial component[55,56]. The physical pain and discomfort experienced is present but these inconveniences are outweighed by the motivation and desire for straight teeth. Studies that determined reasons for why adolescents seek treatment dealt more with issue with their dental appearance rather than problems with chewing. Adolescents benefit psychologically from orthodontic treatment by obtaining a more esthetic facial and dental appearance. The literature supports the positive correlation between this improvement in dentofacial morphology and heightened self-confidence and self-esteem[50,57,58]. Specific dentofacial characteristics, including extreme overjet, overbite, incisor relationship and overall Class II division 1 dental appearance, were most associated with self-esteem as opposed to generalized malocclusion[59]. With the mouth and eyes as the major contributor to identifying facial attractiveness, such improvement to these dentofacial characteristics may be critical in developing interpersonal relationships[20]. Orthodontic treatment has the potential to dramatically improve facial esthetics thereby boosting self-esteem which may benefit adolescents psychologically deep into their future.

The psychological impact helps improve OHQoL, but this study found no significant difference between OHQoL in the initial and late stages of comprehensive orthodontic treatment. Although our study supports the existing literature, it seems counterintuitive. The visible alignment of teeth, even after 1 month of orthodontic treatment, has been shown to improve levels of patients' emotional well-being[3,4]. It would be assumed that the appearance of visibly straight teeth during the late stage of orthodontic treatment should overcome any feeling of embarrassment due to poor malocclusion[25,56]. Especially when the most severe dental characteristics such as extreme overjet have been corrected for by that point in treatment, there is no overall improvement in OHQoL. This suggests that the self-esteem boost that orthodontics may provide are limited to the initial stage of treatment and do not progress as treatment continues.

Based off of recent trends, it appears that the presence of fixed orthodontic appliances in itself, whether teeth are well-aligned or crooked, provides a status that enhances self-esteem[67]. Orthodontic treatment is often treated as elective and therefore is seen as a symbol of status, wealth and style.

Particularly in Southeast Asia, teenagers have gone to the extent of purchasing faux oral appliances which do not even require an orthodontist or dentist to place on teeth. Unfortunately, the negligence of unmonitored fixed appliances led to at least two deaths, permitting the sale of appliances punishable up to a year in jail. Even within the United States, society is becoming increasingly dependent upon dental appearance. As described by writer Malcolm Gladwell, "teeth are becoming the new benchmark of inequality" to the point that individuals with poor dental esthetics are being discriminated against[68]. The psychological and social impact may be limited to cultures and certain geographic areas of the world which help explain why our study was unable to differentiate levels of OHQoL over time.

It is important to recognize how crucial a role orthodontists play in adolescents' lives. These patients are at an age where they are more vulnerable to the psychological effects that wearing appliances may bring, both positive and negative. At the consultation prior to bonding appliances, practitioners should evaluate patients' emotional and social well-being as well as understand their expectations with treatment. Especially if additional adjunctive appliances are planned, patients should be informed of the deterioration in OHQoL they may experience during treatment.

4.3.2. Females

The second significant finding from this studies' structural equation modeling analysis was that females scored higher on the OHIP-14 than males, suggesting that females suffer from poorer OHQoL during comprehensive fixed orthodontics (Figure 5). On average, females scored 2 points higher than males when contributing factors including dental extractions, age, attendance rate and oral hygiene were considered. Our results supports the findings of another cross-sectional study which also found that females recorded higher scores on the quality of life questionnaires compared to males when fixed orthodontic appliances were worn[49].

4.3.2.1. Physical Impact

The perception of pain has been found to differ between males and females. The results of this study show that females had a greater oral health impact compared to males when treated with fixed

orthodontic appliances. Our findings corroborate with a few studies on gender variations and its effect on OHQoL. The perception of general pain intensity, analgesic consumption, pain while eating and the influence of discomfort on daily life were all significantly greater in adolescent females[53]. Females were 1.76 times more likely to have poorer OHQoL compared to other adolescent males wearing fixed orthodontic appliances[49]. Conversely, there are studies found that gender did not have an impact on OHQoL nor change the perception of discomfort experienced[21,60-62]. Pain sensitivity varies for each individual, so even though our study shows females as more susceptible, it is important clinically to help reduce pain for all patients. To help minimize the physical impact of fixed orthodontic appliances and corresponding OHQoL, proper patient education, discussion of patient expectations, review of home care instructions, as well as good orthodontic mechanics should be completed.

4.3.2.2. Psychological Impact

According to our findings, gender stereotype where females tend to be more emotional and sensitive than their counterparts may hold some level of validity. Our study found that females reporter higher oral health impact suggesting poorer OHQoL than males. The psychological predisposition of enhanced sensitivity both positively and negatively is supported by our results as well as other existing literature. Improved appearance, mood and general well-being contributed to the enhanced quality of life[63]. The greater negative impact was exhibited as being more irritable with other people, feeling tense, having difficulty relaxing and heightened self-consciousness[64]. This intensified self-consciousness in females is associated with an exaggerated emotional response[50,65]. Women are more critical of their physical appearances, thus in combination feel more shame about one's body. Additionally, satisfaction in appearance includes dental esthetics, such that more severe malocclusion was correlated with poorer self-esteem in females only[50,57,66]. The discrepancy may be due to the different standards for attractiveness between males and females. Clinically, it is important to consider the patient's expectations, particularly females, to help address the lower levels of psychological well-being and to prioritize orthodontic treatment needs.

4.4. No Indirect Effects

The possible factors of quality of life examined in this study were stage, extractions, adjunctive appliances, patient compliance, age and gender. The structural equation modeling found three significant indirect effects of treatment timing on OHQoL, but after further examination, the impact reflected the inclusion criteria. The significant results do not accurately represent indirect effects on OHQoL. Simplified oral hygiene index scores were recorded from the initial pre-treatment records therefore are directly correlated with the early stage versus the late stage of treatment. Adjunctive appliances if used were cemented at the beginning of orthodontic treatment to assist with the mechanics during the initial and middle stages of treatment. Finally, if extractions were utilized for tooth size arch length discrepancies, they were completed early in treatment to allow proper leveling and aligning of the dentition. These associations were selected for rather than a result of impact on OHQoL.

4.5. Clinical Significance

This study helps orthodontists better understand the oral health impact of fixed appliances on adolescent patients' OHQoL. Patient education has become the keystone to developing a patient-oriented treatment plan. With the shift towards an autonomous approach, it is up to the orthodontist to discuss with the patient their treatment options so they can make an informed decision. Patients' psychological response may be significantly improved with this anticipatory guidance, allowing them to better adapt to the new oral environment[43]. The advantages and disadvantages for each option are best supported by evidence-based information which research like this study provides.

Our findings show that the use of adjunctive appliances and females are more likely to have poorer OHQoL. Prior to such adjunctive appliance delivery, patients should be counseled about the negative impact they will likely experience, although transitory. The adolescent population is more sensitive to the psychological effects of fixed orthodontics, but females in particular are even more self-conscious. Dissatisfaction with physical appearance may lead to submissive roles in social interactions, unassertiveness, and even depression[50,52,59]. It is important to understand patients' expectations and address them accordingly when prioritizing treatment needs. Additionally, when treatment duration is

extended far beyond 18 months, understanding that adolescents' OHQoL does not deteriorate helps the orthodontist focus on obtaining their treatment goals. The decision for dental extractions should not be based upon adolescents' OHQoL as it does not deteriorate long after healing has completed. We recommend orthodontists include a psychological dimension during data collection and records for a comprehensive assessment.

4.6. Limitations

Our case-control study includes some limitations that must be considered when interpreting results. A factor that may potentially have significant influence was the individual diagnostic and technical ability of the practitioner[31]. Lack of clinical experience may contribute to extended treatment time which was not controlled for. In this study's sample, there were a combination of patients being treated by residents as well as those by faculty members with years of practice experience. Without controlling for the level of experience and technical ability of the provider, it is difficult to accurately compare treatment duration across the multiple variables examined.

It may be difficult to directly compare extraction versus non-extraction cases due to confounding factors such as treatment complexity and tooth size arch length discrepancy. Although there is literature stating that extraction cases tend to take longer to treat orthodontically, extractions may be an indication of more complex cases[29-31]. These types of cases may be associated with significant tooth size arch length discrepancies which require intricate tooth movements and control in all three planes of space. A limitation of this study was that treatment difficulty or severity of the malocclusion was not controlled for across the selected subjects. It may only be speculated that if the treatment difficulties were similar, extractions tend to increase treatment time, thereby potentially OHQoL. Our results did not support the treatment duration affecting OHQoL nor indirectly through extractions.

Possible parental influence may have skewed results on the OHIP-14 questionnaire[51]. When the adolescents were asked to complete the questionnaire, some were in the presence of their parent guardian while others were isolated in the dental chair. Although subjects were instructed to ask the proctor if they had any questions or reading difficulties, those with parents nearby may have been influenced to answer a certain way which was not controlled for in this study. It has been shown that

parental expectation may differ from adolescent's confounding the questionnaire responses[52].

Additionally, the OHIP-14 may not be considered appropriate for 13 year olds. The level of

comprehension of 13 and 14 year olds are likely to be similar and therefore the same instrument was

used for all subjects in this study. No issues were raised by these subjects while completing the

questionnaire.

4.7. Future Studies

A structural equation modeling statistical analysis was used in this study to examine the possible

pathways relating all the factors that may affect OHQoL. It would be more relevant for future studies to

also include the traditional analysis of the OHIP-14 questionnaire. Without complete analysis of this

survey, we were not able to determine how each domain contributed to subject's overall OHQoL. We

were not able to make direct comparisons that either support or refute existing literature that uses the

OHIP-14 or other similar instruments.

Future studies should include a larger sample size to better confirm the relationships found.

Larger sample sizes would also allow more groups rather than consolidating subjects into early and late

stage of treatment. More subjects would have helped us achieve our initial research goal on analyzing

how successive months beyond 18 months would affect OHQoL.

Chapter 5: Conclusions

Treatment time did not have a significant effect on adolescents' OHQoL during comprehensive fixed orthodontic treatment as manifested by the OHIP-14 scores between initial and late stages of treatment suggesting that extended treatment time beyond 18 months neither improves nor deteriorates OHQoL. Extractions, patient compliance and age did not show significant impacts on adolescents' OHQoL at the late stage of orthodontic treatment. However, the use of adjunctive appliances and female gender were found to be a negative predictor. Clinically, orthodontists should assess these impact factors on patients to comprehensively determine a treatment option that best suits the individual.

Extractions did not directly affect patients' OHQoL over time, therefore the decision to extract teeth should be based upon obtaining a stable, functional and esthetic outcome. The physical pain from additional extraoral or intraoral appliances exert discomfort dominating any psychological improvement patients may gain from visibly aligning teeth. Gender differences including varying standards of attractiveness and heightened emotional and social impact may contribute to this discrepancy. Poorer levels of quality of life are linked with psychological complications including depression. Clinically, orthodontist should include a psychologically assessment on patients to comprehensively determine a treatment options that best suit the individual.

Bibliography

Journal Articles

1. Palomares NB, Celeste RK, Oliveira BH, Miguel JA. How does orthodontic treatment affect young adults' oral health-related quality of life? Am J Orthod Dentofacial Orthop 2012;141:751-758.
2. Silvola AS, Varimo M, Tolvanen M, Rusanen J, Lahti S, Pirttiniemi P. Dental esthetics and quality of life in adults with severe malocclusion before and after treatment. Angle Orthod 2013.
3. Zhang M, McGrath C, Hagg U. Changes in oral health-related quality of life during fixed orthodontic appliance therapy. Am J Orthod Dentofacial Orthop 2008;133:25-29.
4. Abreu LG, Lages EM, Abreu MH, Pereira LJ, Paiva SM. Preadolescent's oral health-related quality of life during the first month of fixed orthodontic appliance therapy. J Orthod 2013;40:218-224.
5. Johal A, Fleming PS, Al Jawad FA. A prospective longitudinal controlled assessment of pain experience and oral health-related quality of life in adolescents undergoing fixed appliance treatment. Orthod Craniofac Res 2014.
6. Liu Z, McGrath C, Hagg U. Changes in oral health-related quality of life during fixed orthodontic appliance therapy: an 18-month prospective longitudinal study. Am J Orthod Dentofacial Orthop 2011;139:214-219.
7. Hendry F, McVittie C. Is quality of life a healthy concept? Measuring and understanding life experiences of older people. Qual Health Res 2004;14:961-975.
8. Sischo L, Broder HL. Oral health-related quality of life: what, why, how, and future implications. J Dent Res 2011;90:1264-1270.
9. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med 1995;41:1403-1409.
10. Gupta M, Chaturvedi R, Jain A. Role of cardiovascular disease markers in periodontal infection: Understanding the risk. Indian J Dent Res 2015;26:231-236.
11. Kiyak HA. Does orthodontic treatment affect patients' quality of life? J Dent Educ 2008;72:886-894.
12. McGrath C, Bedi R. An evaluation of a new measure of oral health related quality of life--OHQoL-UK(W). Community Dent Health 2001;18:138-143.
13. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health 1994;11:3-11.
14. Slade GD. Assessing change in quality of life using the Oral Health Impact Profile. Community Dent Oral Epidemiol 1998;26:52-61.
15. Allison P, Locker D, Jokovic A, Slade G. A cross-cultural study of oral health values. J Dent Res 1999;78:643-649.
16. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol 1997;25:284-290.
17. Soe KK, Gelbier S, Robinson PG. Reliability and validity of two oral health related quality of life measures in Myanmar adolescents. Community Dent Health 2004;21:306-311.
18. Oziegbe EO, Esan TA, Adesina BA. Impact of oral conditions on the quality of life of secondary schoolchildren in Nigeria. J Dent Child (Chic) 2012;79:159-164.
19. Ravaghi V, Ardakan MM, Shahriari S, Mokhtari N, Underwood M. Comparison of the COHIP and OHIP-14 as measures of the oral health-related quality of life of adolescents. Community Dent Health 2011;28:82-88.
20. de Oliveira CM, Sheiham A. Orthodontic treatment and its impact on oral health-related quality of life in Brazilian adolescents. J Orthod 2004;31:20-27; discussion 15.
21. Feu D, Miguel JA, Celeste RK, Oliveira BH. Effect of orthodontic treatment on oral health-related quality of life. Angle Orthod 2013;83:892-898.
22. Cunningham SJ, Hunt NP. Quality of life and its importance in orthodontics. J Orthod 2001;28:152-158.
23. Navabi N, Farnudi H, Rafiei H, Arashlow MT. Orthodontic treatment and the oral health-related quality of life of patients. J Dent (Tehran) 2012;9:247-254.
24. Olsen JA, Inglehart MR. Malocclusions and perceptions of attractiveness, intelligence, and personality, and behavioral intentions. Am J Orthod Dentofacial Orthop 2011;140:669-679.

25. Masood Y, Masood M, Zainul NN, Araby NB, Hussain SF, Newton T. Impact of malocclusion on oral health related quality of life in young people. Health Qual Life Outcomes 2013;11:25.
26. Liu Z, McGrath C, Hagg U. The impact of malocclusion/orthodontic treatment need on the quality of life. A systematic review. Angle Orthod 2009;79:585-591.
27. Heravi F, Farzanegan F, Tabatabaee M, Sadeghi M. Do malocclusions affect the oral health-related quality of life? Oral Health Prev Dent 2011;9:229-233.
28. Chen M, Wang DW, Wu LP. Fixed orthodontic appliance therapy and its impact on oral health-related quality of life in Chinese patients. Angle Orthod 2010;80:49-53.
29. Fink DF, Smith RJ. The duration of orthodontic treatment. Am J Orthod Dentofacial Orthop 1992;102:45-51.
30. Skidmore KJ, Brook KJ, Thomson WM, Harding WJ. Factors influencing treatment time in orthodontic patients. Am J Orthod Dentofacial Orthop 2006;129:230-238.
31. Turbill EA, Richmond S, Wright JL. The time-factor in orthodontics: what influences the duration of treatments in National Health Service practices? Community Dent Oral Epidemiol 2001;29:62-72.
32. Kerr WJ. Appliance breakages. Br J Orthod 1984;11:137-142.
33. Janson G, Maria FR, Bombonatti R. Frequency evaluation of different extraction protocols in orthodontic treatment during 35 years. Prog Orthod 2014;15:51.
34. Proffit WR. Forty-year review of extraction frequencies at a university orthodontic clinic. Angle Orthod 1994;64:407-414.
35. Adeyemo WL, Taiwo OA, Oderinu OH, Adeyemi MF, Ladeinde AL, Ogunlewe MO. Oral health-related quality of life following non-surgical (routine) tooth extraction: A pilot study. Contemp Clin Dent 2012;3:427-432.
36. Chaushu G, Becker A, Zeltser R, Vasker N, Branski S, Chaushu S. Patients' perceptions of recovery after routine extraction of healthy premolars. Am J Orthod Dentofacial Orthop 2007;131:170-175.
37. Melo AC, Carneiro LO, Pontes LF, Cecim RL, de Mattos JN, Normando D. Factors related to orthodontic treatment time in adult patients. Dental Press J Orthod 2013;18:59-63.
38. Beckwith FR, Ackerman RJ, Jr., Cobb CM, Tira DE. An evaluation of factors affecting duration of orthodontic treatment. Am J Orthod Dentofacial Orthop 1999;115:439-447.
39. McGrath C, Bedi R. Can dental attendance improve quality of life? Br Dent J 2001;190:262-265.
40. Pisek A, Pitiphat W, Chowchuen B, Pradubwong S. Oral health status and oral impacts on quality of life in early adolescent cleft patients. J Med Assoc Thai 2014;97 Suppl 10:S7-16.
41. Mandall NA, Matthew S, Fox D, Wright J, Conboy FM, O'Brien KD. Prediction of compliance and completion of orthodontic treatment: are quality of life measures important? Eur J Orthod 2008;30:40-45.
42. Bowman AC, Saltaji H, Flores-Mir C, Preston B, Tabbaa S. Patient experiences with the Forsus Fatigue Resistant Device. Angle Orthod 2013;83:437-446.
43. De Felippe NL, Da Silveira AC, Viana G, Smith B. Influence of palatal expanders on oral comfort, speech, and mastication. Am J Orthod Dentofacial Orthop 2010;137:48-53.
44. Kadkhoda S, Nedjat S, Shirazi M. Comparison of oral-health-related quality of life during treatment with headgear and functional appliances. Int J Paediatr Dent 2011;21:369-373.
45. Sachan A, Chaturvedi TP. Emergency orthodontic care. Int J Orthod Milwaukee 2011;22:21-25.
46. Rodrigues CR, Ando T, Guimaraes LO. [Simplified oral hygiene index for ages 4 to 6 and 7 to 10 (deciduous and mixed dentition)]. Rev Odontol Univ Sao Paulo 1990;4:20-24.
47. MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. Psychol Methods 2002;7:83-104.
48. Shrout PE, Bolger N. Mediation in experimental and nonexperimental studies: new procedures and recommendations. Psychol Methods 2002;7:422-445.
49. Costa A, Ferreira MC, Serra-Negra JM, Pordeus IA, Paiva SM. Impact of wearing fixed orthodontic appliances on oral health-related quality of life among Brazilian children. J Orthod 2011;38:275-281.
50. Peres KG, Barros AJ, Anselmi L, Peres MA, Barros FC. Does malocclusion influence the adolescent's satisfaction with appearance? A cross-sectional study nested in a Brazilian birth cohort. Community Dent Oral Epidemiol 2008;36:137-143.
51. Benson P, O'Brien C, Marshman Z. Agreement between mothers and children with malocclusion in rating children's oral health-related quality of life. Am J Orthod Dentofacial Orthop 2010;137:631-638.

52. Brown DF, Moerenhout RG. The pain experience and psychological adjustment to orthodontic treatment of preadolescents, adolescents, and adults. Am J Orthod Dentofacial Orthop 1991;100:349-356.
53. Scheurer PA, Firestone AR, Burgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. Eur J Orthod 1996;18:349-357.
54. Stewart FN, Kerr WJ, Taylor PJ. Appliance wear: the patient's point of view. Eur J Orthod 1997;19:377-382.
55. Tuominen ML, Tuominen RJ. Factors associated with subjective need for orthodontic treatment among Finnish university applicants. Acta Odontol Scand 1994;52:106-110.
56. Manjith CM, Karnam SK, Manglam S, Praveen MN, Mathur A. Oral Health-Related Quality of Life (OHQoL) among adolescents seeking orthodontic treatment. J Contemp Dent Pract 2012;13:294-298.
57. Jung MH. Evaluation of the effects of malocclusion and orthodontic treatment on self-esteem in an adolescent population. Am J Orthod Dentofacial Orthop 2010;138:160-166.
58. Vaida L, Pirte A, Corega C, Slavescu D, Mutiu G. Correlations between the changes in patients' dental-facial morphology at the end of the orthodontic treatment and the psychological variables. Rom J Morphol Embryol 2009;50:625-629.
59. Seehra J, Fleming PS, Newton T, DiBiase AT. Bullying in orthodontic patients and its relationship to malocclusion,self-esteem and oral health-related quality of life. J Orthod 2011;38:247-256; quiz 294.
60. Abdelrahman RS, Al-Nimri KS, Al Maaitah EF. Pain experience during initial alignment with three types of nickel-titanium archwires: A prospective clinical trial. Angle Orthod 2015.
61. Lahti S, Suominen-Taipale L, Hausen H. Oral health impacts among adults in Finland: competing effects of age, number of teeth, and removable dentures. Eur J Oral Sci 2008;116:260-266.
62. Erdinc AM, Dincer B. Perception of pain during orthodontic treatment with fixed appliances. Eur J Orthod 2004;26:79-85.
63. Mc Grath C, Bedi R. Gender variations in the social impact of oral health. J Ir Dent Assoc 2000;46:87-91.
64. Rusanen J, Lahti S, Tolvanen M, Pirttiniemi P. Quality of life in patients with severe malocclusion before treatment. Eur J Orthod 2010;32:43-48.
65. Else-Quest NM, Higgins A, Allison C, Morton LC. Gender differences in self-conscious emotional experience: a meta-analysis. Psychol Bull 2012;138:947-981.
66. Helm S, Kreiborg S, Solow B. Psychosocial implications of malocclusion: a 15-year follow-up study in 30-year-old Danes. Am J Orthod 1985;87:110-118.

Web Reference
67. De Lacey, M. (2013, Jan 3). Brace yourself: Asian teenagers are wearing FAKE dental train tracks as a status symbol, but could they KILL their wearers? [Web log post]. Retrieved Oct 28, 2015, from http://www.dailymail.co.uk/femail/article-2256608/Fake-braces-trend-new-status-symbol-Asian-teenagers-KILL-wearers.html?ito=feeds-newsxml

Book Reference
68. Gladwell, M. (2013). *David and Goliath*. New York, NY: Little, Brown and Company.