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Long term patient and orthodontist satisfaction with non surgical correction of severe class II division 1 malocclusions

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LONG TERM PATIENT AND ORTHODONTIST SATISFACTION WITH NON SURGICAL CORRECTION OF SEVERE CLASS II DIVISION 1 MALOCCLUSIONS

by

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CERTIFICATE OF APPROVAL

MASTER'S THESIS

This is to certify that the Master's thesis of

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ABSTRACT

Background: The correction of Class II malocclusions is one of the most common treatments performed in the United States. Despite Class II malocclusions being one the most commonly presented problems for orthodontists, there is no consensus of which non-surgical treatment modality best impacts a patient's quality of life long term.

Purpose: This study examines the different non-surgical treatment approaches for patients with severe Class II division 1 and the impact of treatment outcomes on patient satisfaction and quality of life long term.

Study Design: This study retrospectively analyzed the different treatment approaches and outcomes of class II division 1 with severe overjet, while prospectively assessing patient satisfaction and quality of life long term. Initial and final cephalometric and clinical variables for 83 patients (38 at Harvard School of Dental Medicine, 30 at the University of Iowa, and 15 in private practice in Iowa) treated non-surgically were recorded and analyzed. A retention clinical exam, at least 6 months post-debond, was done for final measurements, assessment of practitioner and patient satisfaction, and patient quality of life questionnaires.

Results: Non-surgical treatment of severe Class II division 1 malocclusions yielded 5.54 mm overjet reduction and 0.51 mm of relapse in retention on average. Patients with more overjet at their long term retention check demonstrated significantly poorer satisfaction scores with the appearance of their bite ($p<0.001$), the appearance of their face ($p<0.001$),

and with their overall orthodontic treatment ($p<0.001$). Extraction treatment was associated with significantly lower patient satisfaction scores of overall orthodontic treatment ($p=0.023$) and appearance of bite ($p=0.018$) but not facial appearance. Patients treated with extractions also showed higher QOL scores on the OHIP-14 ($p=0.022$) and CPQ ($p=0.002$) surveys, indicating that extraction therapy of severe Class II division 1 patients led to a significantly poorer quality of life.

Conclusion: Non-surgical treatment of severe Class II division 1 malocclusions can yield excellent results and stability long term. Overjet can be dramatically reduced with non-surgical treatment but there is a tendency for overjet to relapse in retention. While treatment outcomes yielded high results of patient satisfaction, patients with more overjet in retention displayed significantly less satisfaction of the appearance of their bite, appearance of their face, and with their overall orthodontic treatment. Extraction treatment was associated with significantly lower patient satisfaction scores of overall orthodontic treatment and appearance of bite but not facial appearance. Patients treated with extractions showed poorer quality of life scores in retention compared to those treated nonextraction.

PUBLIC ABSTRACT

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This study examines the different non-surgical treatment approaches for patients with severe Class II division 1 and the impact of treatment outcomes on patient's quality of life long term.

This study retrospectively analyzed the different treatment approaches and outcomes of class II division 1 with severe overjet, while prospectively assessing patient satisfaction and quality of life long term. Initial and final cephalometric and clinical variables for 83 patients (38 at Harvard School of Dental Medicine, 30 at the University of Iowa, and 15 in private practice in Iowa) treated non-surgically were recorded and analyzed. A retention clinical exam, at least 6 months post-debond, was done for final measurements, assessment for practitioner and patient satisfaction, and patient quality of life questionnaires.

Non-surgical treatment of severe Class II division 1 malocclusions yielded 5.54 mm overjet reduction and 0.51 mm of relapse in retention on average. Patients with more overjet at their long term retention check demonstrated significantly poorer satisfaction scores with the appearance of their bite ($p<0.001$), the appearance of their face ($p<0.001$), and with their overall orthodontic treatment ($p<0.001$). Extraction treatment was associated with significantly lower patient satisfaction scores of overall orthodontic treatment ($p=0.023$) and appearance of bite ($p=0.018$) but not facial appearance. Patients

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INTRODUCTION

In 1899, Dr. Edward H. Angle classified dental malocclusions into four classes: normal occlusion, Class I malocclusion, Class II malocclusion, and Class III malocclusion. Class II malocclusion was defined as the lower molar being distally positioned relative to the upper molar; furthermore, Class II division 1 was characterized by the maxillary anterior teeth being protrusive (Angle, 1899).

From the National Health and Nutrition Estimates Survey III (NHANES III) conducted in the United States from 1989-1994, it was observed that 30% of American children and youths have Angle's normal occlusion, ~55% have Class I malocclusion, ~15% have Class II malocclusion, and less than 1% have Class III malocclusion. Specifically looking into Class II division 1 prevalence, it was estimated that 23% of children, 15% of youths, and 13% of adults have an overjet of 5 mm or greater (Proffit, Fields, & Sarver, 2007).

Class II malocclusion is usually the result of an underlying skeletal problem in the basal bones, yielding an apical base discrepancy of either a prognathtic maxilla, a retrognathic mandible, or a combination of both; however, there is inherently a dental component as well (Southard, Marshall, & Bonner, 2015). The complexity of the clinical manifestation of this malocclusion allows for a variety of different treatment modalities. Generally, treatment modalities of Class II malocclusions include: maxillary distalizing mechanics to move the maxilla and/or maxillary dentition, functional appliances to promote mandibular growth and mesialization of mandibular teeth while distalizing the maxilla and maxillary dentition, inter-arch mechanics to solely shift the dentition leaving the skeleton unaffected, and orthodontic treatment in conjunction with orthognathic

surgery. All of the above treatments can be supplemented with tooth extraction and/or the use of temporary anchorage devices (TADs). Tooth extractions are sometimes necessary depending on occlusion, crowding, and incisor proclination while TADs allow for maximum, skeletal anchorage for tooth movement.

In many Class II division I cases with severe overjet the most ideal treatment option would include orthognathic surgery yet many of these patients reject surgical treatment due to the associated risks and/or cost (Tucker, 1995). Non-surgical Class II division I treatment can result in excellent treatment outcomes; however, sometimes correction is incomplete and there may have been compromises to skeletal, dental, and esthetic outcomes. All Class II treatment options have their compromises and the long term effects on patients' quality of life has yet to be qualified.

It is generally accepted that malocclusion can affect physical, social, and psychological health. Physical effects include pain, speech, and mastication while psychological and social effects include self-confidence, perceived attractiveness, and perceived intelligence. The main reasons for why orthodontic care is sought is due to physical, social, and psychological effects; thus, it can be reasoned that the best measure of orthodontic results is in the improvement of patients' physical, social, and psychological health. Furthermore, these physical, social, and psychological aspects of oral health encompass what is known as the oral-health-related quality of life, OHRQoL, and give insight into how oral health affects quality of life and how oral health care, including orthodontic treatment, can improve life quality (Zhang, McGrath, & Hägg, 2006). Youths with any degree of malocclusion, but specifically those with >6 mm of overjet, report worse OHRQoL scores than those with acceptable or ideal occlusion

making treatment of Class II division 1 immensely important for quality of life (Kiyak, 2008).

The correction of Class II malocclusions is one of the most common treatments performed in the United States (Huang, 2005). Despite Class II malocclusions being one the most commonly presented problems for orthodontists, there is no consensus of which non-surgical treatment modality best impacts a patient's quality of life long term. There are few studies analyzing Class II division 1 malocclusion treatment outcomes in regards to quality of life and many Class II treatment outcomes studies yield questionable results due to a high risk of bias (Millett, Cunningham, O'Brien, Benson, & de Oliveira, 2012). This study tests the hypothesis that patient demographics, extraction treatment plan, and overjet with Class II division 1 orthodontic treatment are associated with long term patient satisfaction and quality of life.

LITERATURE REVIEW

Class II malocclusion is defined by the lower molar being distally positioned relative to the upper molar and is subdivided into 2 categories: division 1 where the maxillary anterior teeth are proclined and division 2 where the maxillary anterior teeth are retroclined (Angle, 1899; English, Akyalcin, Peltomaki, & Litschel, 2014). The predominant etiologic factor of Class II division 1 anomalies is complex but believed to be predominantly hereditary but can also be a result of a thumb-sucking habit (Padure, Negru, & Stanciu, 2012).

Class II malocclusion is a complex, clinical manifestation that is caused from a variety of skeletal and dental components. There are a multitude of treatment approaches in treating Class II occlusal relationships and it is common to find that multiple treatment modalities are applied to each case. Each treatment option differs in its effects on the craniofacial skeletal structures, growth modification, and changes in dentition but shares the same aim of correcting hard and soft tissue problems to result in a normal relationship (McNamara, 1981). The individualized treatment of each patient is dependent on the severity of the anteroposterior discrepancy, age, and patient compliance (Guilherme Janson, Brambilla, Henriques, De Freitas, & Neves, 2004).

The three different ways to treat this malocclusion include: orthopedics, masking (camouflage), and surgery. Orthopedic treatment involves modifying jaw growth in younger patients when growth is still remaining. Masking, or camouflage, treatment involves treatment that is aimed to solely correct the dental relationship without addressing the underlying skeletal problems and is considered when patients are done growing and have a mild to moderate discrepancy. Surgical treatment involves the

surgical skeletal movement of the maxilla and/or the mandible and is considered when the discrepancy is too severe to be adequately corrected by orthopedics or masking (English et al., 2014; Southard et al., 2015).

As previously mentioned, there are multiple different treatment modalities to correct Class II malocclusions. The goal of Class II orthopedic treatment is to modify skeletal anteroposterior growth in younger, growing patients. One common orthopedic treatment is extraoral maxillary traction via headgear and can be done with three slightly different force vectors: cervical pull, high pull, or a combination. The general treatment objective of headgear is to restrict maxillary growth and distalize maxillary dentition. Henriques et al. conducted a systematic review and concluded that cervical headgear treatment is effective in correcting the maxillomandibular relationship in Class II division 1 malocclusions. Resulting effects included: restricting maxillary anterior growth, distalizing and extruding maxillary molars, and slight maxillary expansion (Henriques, Janson, Henriques, & Pupulim, 2015). Firouz et al. examined the effects of high pull headgear therapy in Class II division 1 patients and found dental changes of maxillary molar distalization and intrusion with skeletal changes of restricted maxillary anterior and vertical growth compared to controls. It was further noted that the resultant force vector passes through the maxillary molar center of resistance and causes less unstable molar distal tipping (Firouz, Zernik, & Nanda, 1992). However, it was noted by both Henriques et al. and Firouz et al. that the benefits of headgear treatment are dependent on patient compliance and motivation.

Another approach for orthopedic treatment is via functional appliances. The general treatment objective of functional appliance therapy is to reposition the mandible

anteriorly thus promoting mandibular growth and mandibular teeth mesialization while having a slight headgear effect on the maxilla. There are two basic types of functional appliances commonly used: tissue-borne and tooth-borne. The only tissue-borne appliance is the Frankel II while common tooth-borne appliances include the Herbst, mandibular anterior repositioning appliance (MARA), Twin Block, and Bionator (English et al., 2014). Marscio et al. conducted a systematic review regarding the effectiveness of functional appliance treatment on mandibular growth and found a statistically significant difference of 1.79 mm annual growth compared to controls. Cephalometric evaluation used condylion (ex. condylion-gnathion, Co-Gn) and excluded studies using articulare as condylion led to more accurate measurements of mandibular length due to articulare being determined by the mandibular position that can be altered by posture leading to a false interpretation of increased mandibular length. It must be noted that this study only evaluated the effects in the short term and noted that, although statistically significant, the results may not be very clinically significant (Marsico, Gatto, Burrascano, Matarese, & Cordasco, 2011). In 2005, The Council on Scientific Affairs, COSA, specifically addressed the effects of functional appliances long term. They concluded that current literature suggests functional appliance therapy might have effects on the maxilla, glenoid fossa, dentoalveolar structures, and might have a minor effect on mandibular growth but not statistically significant enough to claim increased horizontal mandibular growth (Huang, 2005). Therefore, it seems reasonable to argue that functional appliance therapy accelerates mandibular growth short term but does not increase horizontal growth long term.

Deviating from orthopedic treatment, masking or camouflage treatment options most commonly include inter-arch mechanics (Forsus, elastics) and tooth extractions (usually either maxillary first premolars and mandibular second premolars or maxillary first premolars only) and do not majorly modify skeletal growth (English et al., 2014). Janson et al. concluded in a systematic review that inter-arch mechanics, Class II elastics and Forsus, are an effective treatment in correcting Class II malocclusions and that the effects are primarily dentoalveolar: lingual tipping, retrusion, and extrusion of maxillary incisors with labial tipping and intrusion of mandibular incisors. Similar to Huang, the systematic review states that the effects of Class II elastics compared to functional appliances are similar long term thus deeming the two treatment modalities close to each other in evaluating treatment effectiveness (G. Janson, Sathler, Fernandes, Branco, & Freitas, 2013).

Extraction treatment for Class II malocclusions can involve 2 maxillary premolars or 2 maxillary and 2 mandibular premolars. Two maxillary premolar extraction therapy is indicated when no crowding or cephalometric discrepancy is present in the mandibular arch whereas 4 premolar extraction therapy is indicated when mandibular crowding and/or a cephalometric discrepancy is observed. Janson et al. (2004) noted that in a complete Class II malocclusion anchorage is a major concern when treating with extractions thus making patient compliance or the use of TADs essential. A study of primarily complete Class II division 1 with severe overjet patients showed that 2 maxillary premolar extraction therapy is superior to 4 premolar extractions in terms of better occlusal success rate; occlusal success rate being defined by Grainger's treatment priority index (TPI), Class I canine relationship, ideal overbite, and ideal overjet

(Guilherme Janson et al., 2004). The common assumption of extraction treatment is excessive retrusion and impaired facial profile and esthetics; however, Janson et al. (2007) analyzed soft-tissue treatment changes in Class II division 1 malocclusion with and without maxillary premolar extractions and found similar soft-tissue results in both treatment groups (Guilherme Janson, Fuziy, De Freitas, Castanha Henriques, & De Almeida, 2007). On the contrary, Kizinger et al. found that Class II division 1 young adult patients treated with maxillary premolar extractions demonstrated no soft-tissue profile improvement and demonstrated an enlarged nasiolabial angle which decreased profile attractiveness; however, this decreased attractiveness is deemed by the authors and not necessarily representative of patient opinions (Kinzinger, Frye, & Diedrich, 2009). Another study investigated the esthetic effects of extraction and nonextraction treatment on Class I and Class II Caucasian patients using a panel of 58 laypersons and 42 dentists and concluded extraction treatment produces improved facial esthetics for patients with a pretreatment combination of crowding and lip protrusion that extended more than 2-3 mm behind the Ricketts' E-plane (Bowman & Johnston, 2000). Additionally, Paquette et al. investigated the long-term (10-20 years post-treatment) comparison of nonextraction and premolar extraction in "borderline" extraction or nonextraction Class II division 1 malocclusions. The study concluded that a 2 mm "fuller," more convex, profile was noted at the end of treatment and long term for nonextraction patients but despite a significantly "flatter" profile, extraction patients were just as likely to view their outcome as an improvement (Paquette, Beattie, & Johnston, 1992).

The importance of facial esthetics is one of the main motivating factors for patients to pursue orthodontic treatment. Tucker (1995) described that a significant

percentage of females, 53%, and males, 43%, list esthetic improvement in facial appearance as a major factor and goal for seeking treatment. He notes that patients have a variety of chief complaints and goals for treatment outcomes, such as: enhanced dental esthetics, improved dental function, better facial esthetics, resolution/improvement of temporomandibular joint or muscle pain, and improved long term maintenance of dentition (Tucker, 1995). Zhang et al. argues that greater understanding of physical, social, and psychological effects of malocclusion is important as it provides health care providers insight into the consequences of malocclusion on people's lives. Furthermore, the study argues that best measure of success for treatment outcomes is in the improvement to physical, social, and physiological health as they encompass a patient's oral-health-related quality of life, OHRQoL (Zhang et al., 2006). Furthermore, Bernabe et al. supports the findings that malocclusions have physical, psychological and social consequences on quality of life and specifically adolescents with Class II division 1 show a higher prevalence of psychological and social condition-specific impacts (CSIs) regarding smiling, laughing, and embarrassment showing teeth (Bernabé, Sheiham, & De Oliveira, 2008). Kiyak explains that a desired enhancement of appearance and social acceptance are driving motivational factors to seek orthodontic care. This desired improvement to OHRQoL is specifically noted in children who had >6 mm of overjet (Kiyak, 2008).

Assessing quality of life is inherently difficult and challenging to adequately quantify. Growing recognition that quality of life is an important factor in dental care has generated the need for instruments to measure oral health related quality of life. One measure is the Oral Health Impact Profile (OHIP) that was developed in 1994 with the

aim of providing a comprehensive measure of self-reported dysfunction, discomfort, and disability attributed to oral health and is concerned with the impairment and three function status dimensions: physical, social, and psychological. The original OHIP-49, a 49 item questionnaire used to quantify patients' perception of the impact of oral conditions on their well-being, was adapted to an alternative 14 item questionnaire, OHIP-14. Both the OHIP-49 and OHIP-14 assessment were shown to have good reliability, validity, and precision (G. D. Slade, 1997; Gary D Slade, 1997). Another instrument for measuring oral-health related quality of life is the Child Perceptions Questionnaire, CPQ. The CPQ was designed as a specific measure of the impact of oral and oro-facial conditions on children. The questionnaire was formulated from an item pool generated from interviews with health professionals, parents, and pediatric patients, as well as a literature review, to include the most frequent and bothersome items. The CPQ demonstrated significant associations between global ratings of oral health and overall well-being and was deemed a valid and reliable instrument (Jokovic et al., 2002).

Andiappan et al. conducted a systematic review and meta analysis in 2015 on the impact of malocclusion and orthodontic treatment on people's quality of life. With the inclusion of 25 citations, the study concluded that OHIP-14 scores were significantly lower (indicative of improved quality of life) in individuals without malocclusion and after patients received treatment for malocclusions compared to those with untreated malocclusions (Andiappan, Gao, Bernabe, Kandala, & Donaldson, 2015). Abreu et al. conducted a study assessing oral health related quality of life via CPQ evaluation within the first year of treatment with fixed appliances on adolescents aged 11 and 12 years and found treatment yielded a positive effect on oral health related quality of life (lower CPQ

scores) due to improvements in emotional and social well-being subscales (Abreu, Melgaco, Lages, Abreu, & Paiva, 2014). Both aforementioned studies show the absence of malocclusion and the orthodontic treatment to resolve malocclusion positively impacts people's quality of life; however, details in severity and type of malocclusion and the associated differing treatment modalities were not specifically addressed.

This study aims to supplement the current literature in characterizing different non-surgical treatment modalities for Class II division 1 malocclusions with severe overjet and analyze their long term impacts on patient satisfaction and quality of life.

MATERIALS AND METHODS

Institutional Review Board (IRB) Approval: The study was approved to be conducted by the Office of Human Subjects Protection of the University of Iowa (IRB protocol # is 201604815). Informed consent and assent was obtained from study participants and their parents when appropriate.

This study included a retrospective examination of patient records and a prospective examination of long term (6+ month post debond/in retention) patient satisfaction and quality of life. Patient records were obtained from the database at the University of Iowa orthodontic clinic, the Harvard School of Dental Medicine, and three private practice orthodontists in Iowa. Patients were selected based on the following criteria: 1) Class II division 1 malocclusion in at least one molar, 2) At least 6 mm of overjet, 3) Debanded between the ages of 13-18, and 4) Debanded between 2014-September 2017 5) Follow up with a 6+ month retention check. Patient record analysis included initial and final lateral cephalometric radiograph measurements, treatment plans offered, treatment plan chosen, various clinical findings, and demographics. Initial and final lateral cephalometric radiographs were traced by each patient practitioner and analyzed in Dolphin Imaging using the landmarks shown in figure 1 and planes/angles in figure 2. The cephalometric measurements noted for this study were the following: Sella-Nasion-A point (SNA), Sella-Nasion-B point (SNB), and A point-Nasion-B point (ANB) angles, mandibular plane angle (MPA), angulation of maxillary incisors to SN plane (U1-SN), angulation of mandibular incisors to mandibular plane (IMPA), Frankfort horizontal to mandibular incisor angle (FMIA), and lower anterior face height (LAFH). Each patient's treatment options and treatment plan chosen was noted, specifically noting

which treatment approach was used: headgear, functional appliance, extraction vs. nonextraction, the use of temporary anchoring devices (TADs), etc. The following information regarding patient demographics was collected: gender, race, age and date at start of treatment and end of treatment. Overall treatment time and retention protocol was also noted for every patient. The various clinical findings collected included: antero-posterior relationship of molars and canines in millimeters (based on Angle's classification), upper dental midline (UDML) relationship to the midline of the face, lower dental midline (LDML) in relation to upper dental midline, overjet (OJ) in millimeters, overbite (OB) as a percentage of overlap of lower incisors, and incisor crowding in millimeters.

In the prospective aspect of this study, we primarily assessed the long term patient satisfaction and quality of life while also recording stability of outcomes and practitioner satisfaction and how they might have changed their treatment in hindsight. The long term stability was assessed by the practitioner during the post deband/retention follow up visit. During this retention clinical examination, the orthodontist assessed the various clinical findings noted previously as well as noting if the patient was compliant with their recommended retention protocol. Following completion of the clinical examination, the orthodontist completed a questionnaire that assessed their satisfaction with stability of occlusion and facial esthetics. The following items were assessed:

1. How satisfied are you with the facial esthetics? (scored on a Likert scale from most satisfied to least satisfied)
2. How satisfied are you with the stability of the occlusion? (scored on a Likert scale from most satisfied to least satisfied)

3. Considering the current occlusion, would you have treated the patient any differently? (open ended question)

At the retention appointment, patients were asked to complete quality of life (QOL) and patient satisfaction questionnaires to assess impacts of their orthodontic treatment. Quality of life was assessed by two QOL instruments: The Oral Health Impact Profile (OHIP-14) and short form Child Perceptions Questionnaire (CPQ). The OHIP-14 was used to assess functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, and social disability, and handicap domains. The following questions were used as part of the OHIP-14 and were scored on a Likert scale from "Never" (0) to "Very Often" (4):

1. Have you had any trouble pronouncing any words?
2. Have you felt that your sense of taste has worsened?
3. Have you had pain in your mouth?
4. Have you found it uncomfortable to eat any foods?
5. Have you been self conscious?
6. Have you felt tense?
7. Has your diet been unsatisfactory?
8. Have you had to interrupt meals?
9. Have you found it difficult to relax?
10. Have you been a bit embarrassed?
11. Have you been a bit irritable with other people?
12. Have you had difficulty doing your usual jobs?
13. Have you felt that life in general was less satisfying?

14. Have you been totally unable to function?

The CPQ was used to assess oral symptoms, functional limitations, emotional well-being, and social well-being domains. The following questions were used as part of the short form CPQ scored on a Likert scale from "Never" (0) to "Everyday or Almost Every Day" (4), posed as "In the past three months how often have you (had/been)…because of your teeth/mouth?":

1. Pain in teeth/mouth
2. Bad breath
3. Mouth sores
4. Food caught between teeth
5. Difficulty eating/drinking hot/cold foods
6. Difficulty Chewing firm foods
7. Difficulty saying words
8. Takes longer to eat a meal
9. Trouble sleeping
10. Upset
11. Feel irritable/frustrated
12. Feel shy
13. Concerned about what people think about teeth/mouth
14. Teased/called names
15. Avoid smiling/laughing
16. Argue with children/family
17. Not want to speak/read loud in class

Patient satisfaction was assessed using the "patient satisfaction with orthodontic treatment" questionnaire. The following questions were used to assess patient satisfaction with orthodontic treatment:

1. How satisfied are you with your overall orthodontic treatment? (scored on a Likert scale from most satisfied (5) to least satisfied (1))
2. How satisfied are you with the appearance of your face? (scored on a Likert scale from most satisfied (5) to least satisfied (1))
3. Do you feel that the appearance of your face has changed following orthodontic treatment (Yes, No, or Unsure)
4. How satisfied are you with the appearance of your teeth? (scored on a Likert scale from most satisfied (5) to least satisfied (1))
5. Are you happy with the way your bite fits? (Yes, No, or Unsure)
6. Has your bite changed since your braces were removed? (Yes, No, or Unsure)
7. If yes, has your bite gotten better or worse?
8. Do you wear your retainers regularly as per the recommendation of your orthodontist? (Yes or No)

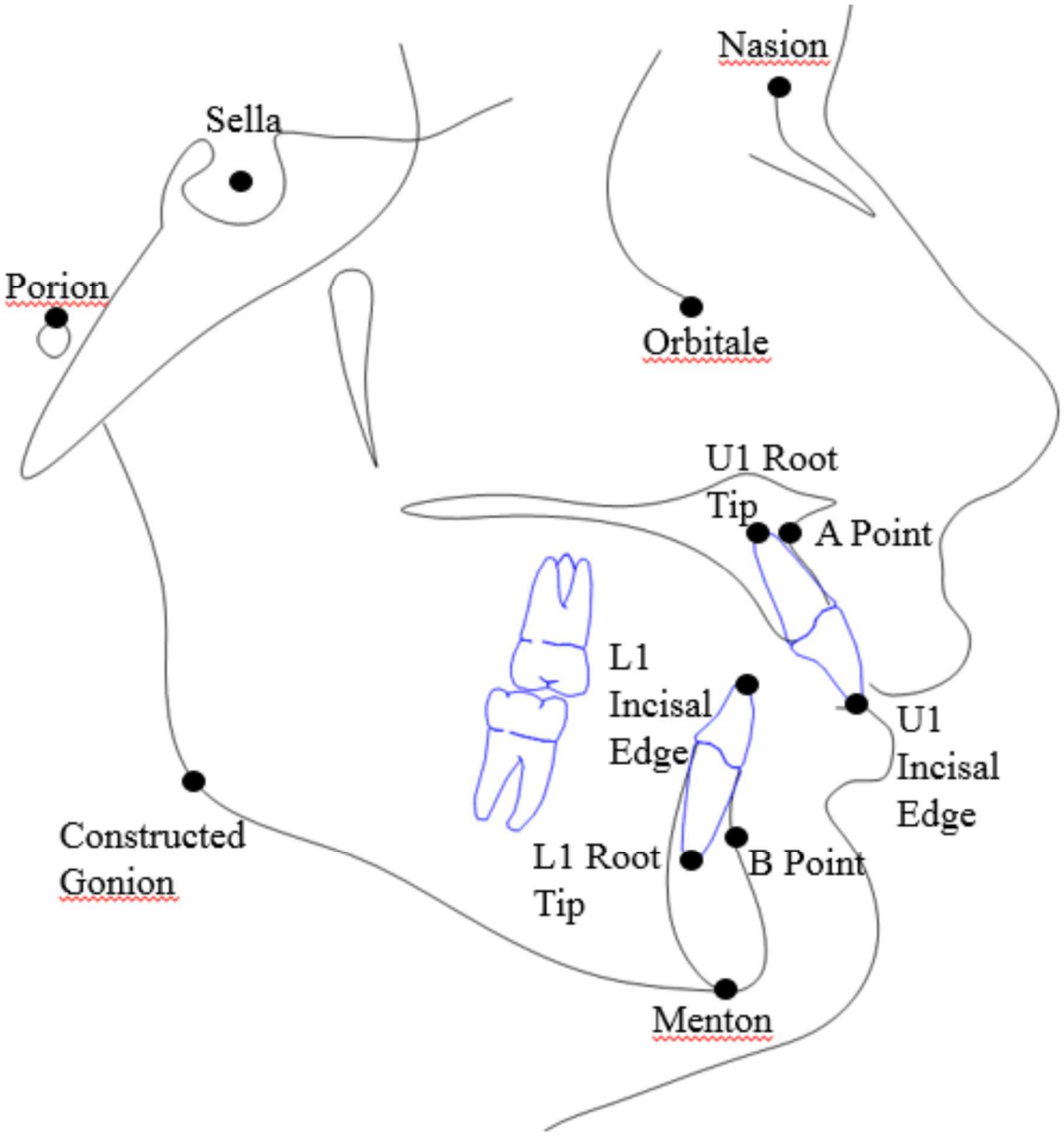

Figure 1 Cephalometric landmarks.

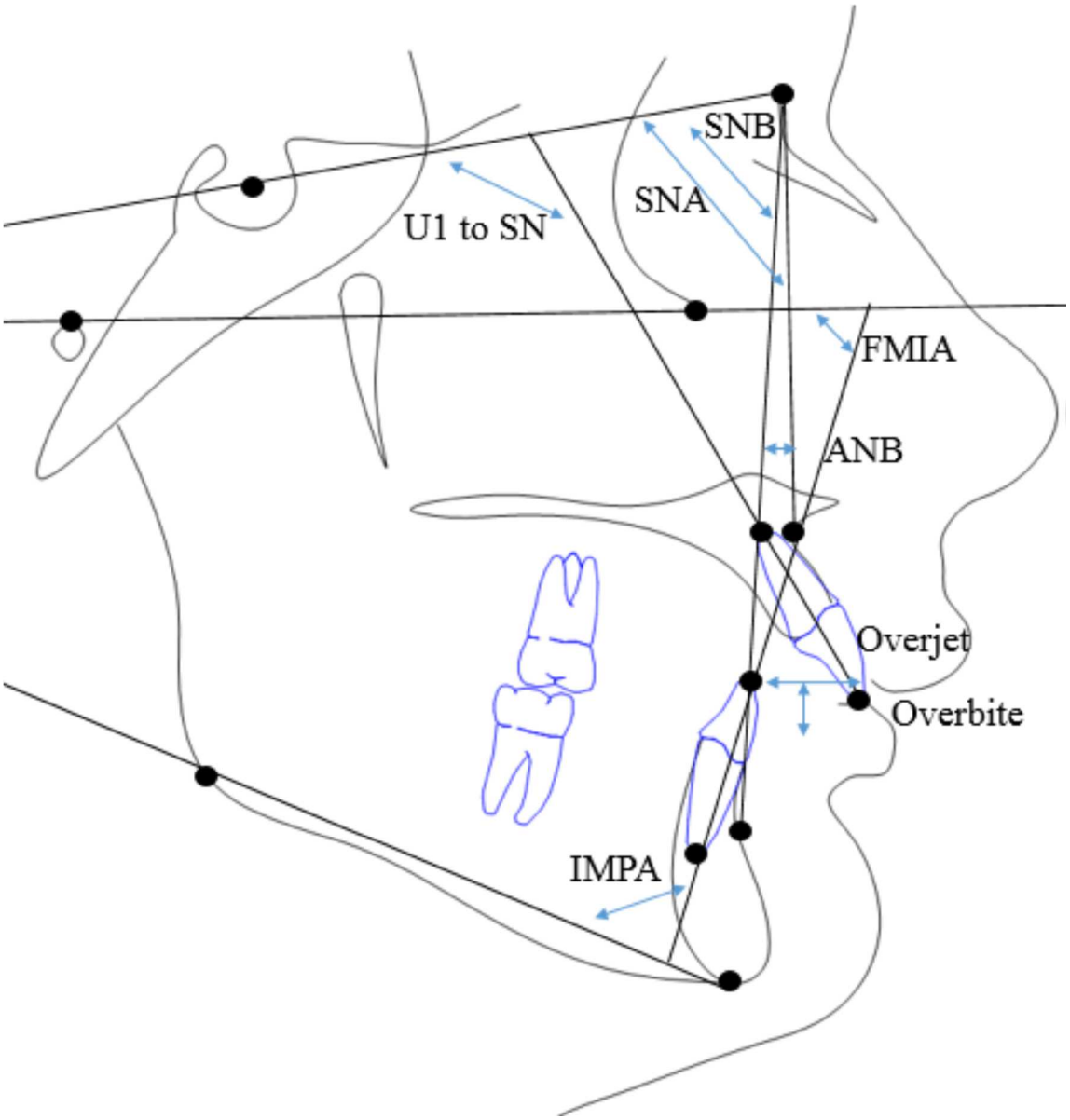

Figure 2 Cephalometric angular and linear measurements traced.

RESULTS

Eighty-three subject were included in this study, using only subjects that fit the qualifications and were able to come back for retention examination. Of the 83 subjects, 38 (45.8%) were treated at Harvard School of Dental Medicine, 30 (36.1%) were treated at The University of Iowa, and 15 (18.1%) were treated in private practice in Iowa. Fifty-two (62.7%) patients were female and 31 (37.3%) were male. The race/ethnicity of the patients included: 57 (68.7%) Caucasian, 17 (20.5%) Hispanic, 8 (9.6%) Asian, and 1 (1.2%) African. The average age of patients at the start of treatment was 12.7 years old and the average age at the end of treatment was 14.9 leading to an average treatment duration of 26 months (Table 1). Initial cephalometric findings are listed in table 2.

		Age at start of Treatment	**Age at End of Treatment**
Mean		12.7	14.9
Std. Deviation		1.1	1.1
Percentiles	25	11.8	14.1
	50	12.5	14.7
	75	13.5	15.7

Table 1 Age of patients. This table represents the mean, standard deviation, and quartiles of age (years) at the the beginning and end of treatment for the 83 patients.

		SNA	**SNB**	**ANB**	**MPA**	**U1-SN**	**IMPA**	**FMIA**	**LAFH**
Mean		81.3	76.3	5.0	28.2	106.3	95.3	61.0	55.9
Std. Deviation		4.2	4.0	2.1	7.0	8.7	6.6	7.4	2.2
Minimum		74.0	68.9	-1.0	10.0	87.7	72.0	44.0	50.0
Maximum		95.0	92.0	8.2	43.5	130.0	111.0	88.2	63.0
Percentiles	25	78.4	73.0	3.9	24.0	101.1	90.2	57.2	54.9
	50	81.0	76.0	5.1	27.1	105.0	96.0	61.0	56.0
	75	84.2	79.0	6.3	32.4	110.0	99.8	64.0	57.0

Table 2 Initial cephalometric variables. This table represents the mean, standard deviation, minimum, maximum, and quartiles of the initial cephalometric variables for the 83 patients. All cephalometric variables are angles and units are in degrees (°).

The five main treatments analyzed for patients included one or more of the following: extractions, headgear, functional appliance, TADs, and accelerated tooth movement. Of the 83 patients treated, 0 patients were treated with accelerated tooth movement. Figure 3 presents the frequency at which different treatment approaches were offered to patients at the case presentation.

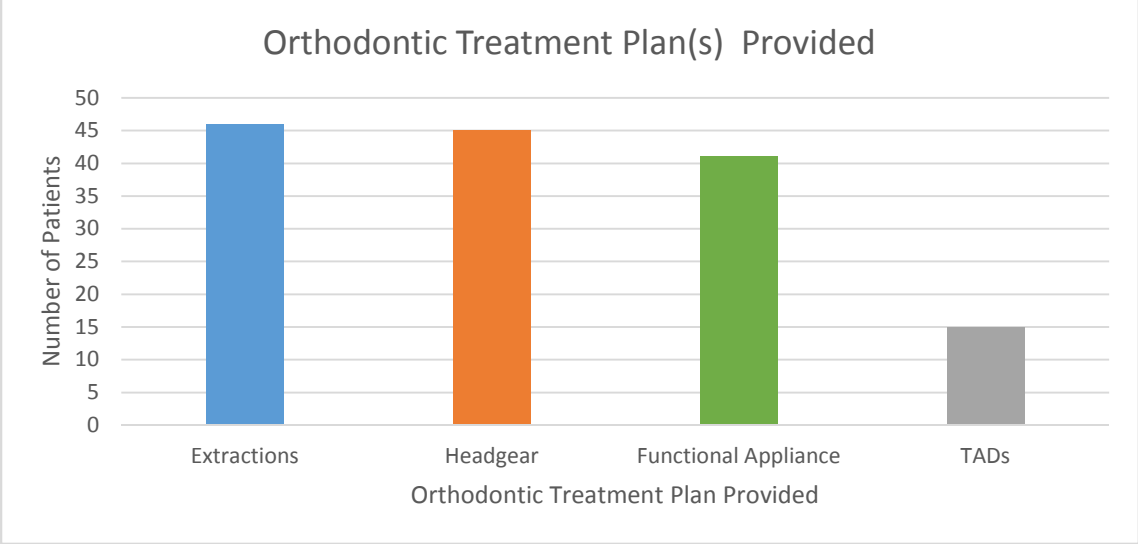

Figure 3 Orthodontic treatment plan(s) provided at case presentation. This chart represents the frequency at which different treatment approaches were offered to patients at the case presentation including: extractions, headgear, functional appliance, or temporary anchorage devices (TADs).

Of the 46 patients offered an extraction treatment plan, 34 (41%) ultimately elected an extraction treatment plan leaving 49 (59%) patients treated without extraction(s). Of the 34 extraction patients, 30 were treated with the extraction of maxillary first premolars. For the remaining 49 patients treated nonextraction, 24 (28.9%) had functional appliance treatment, 18 (21.7%) had headgear treatment, and 11 (13.3%) had other Class II correctors. Figure 4 presents the frequency at which different treatment approaches were chosen by patients.

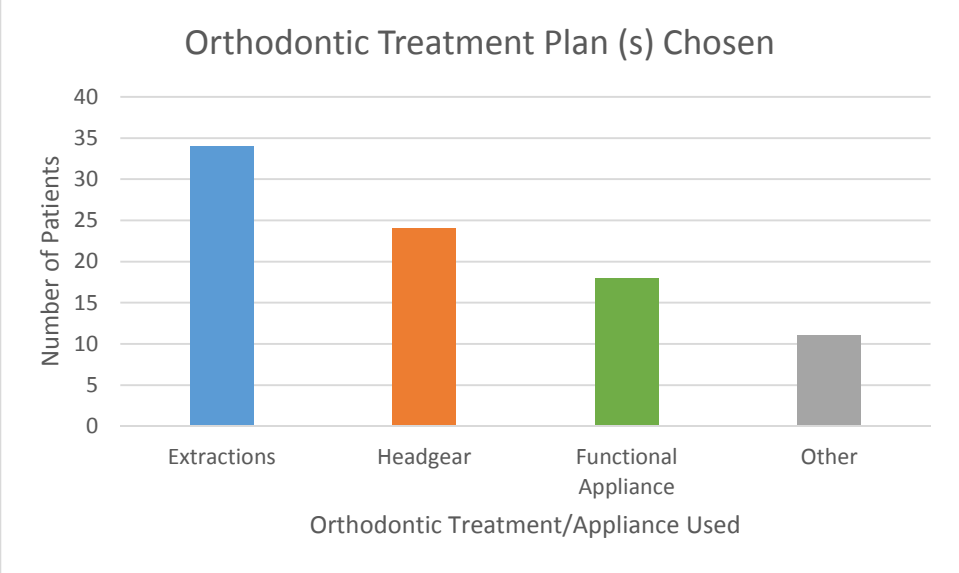

Figure 4 Orthodontic treatment plan(s) chosen. This chart represents the frequency at which different treatment approaches were chosen by patients including: extractions, headgear, functional appliance, and/or other Class II correctors.

Final measurements were taken and compared to initial findings. Table 3 displays the cephalometric findings at the end of treatment.

		SNA	SNB	ANB	MPA	U1-SN	IMPA	FMIA	LAFH
Mean		80.9	78.1	2.8	27.4	105.7	98.5	58.2	56.2
Std. Deviation		4.0	3.7	1.7	6.9	7.1	7.4	8.7	2.2
Minimum		73.0	70.0	-2.0	9.0	93.0	66.0	32.0	51.0
Maximum		92.0	87.0	7.0	44.5	124.0	117.1	89.0	61.0
Percentiles	25	78.7	75.6	1.9	23.1	100.0	94.0	53.1	54.5
	50	81.0	78.6	3.0	26.0	105.2	98.4	59.0	56.0
	75	84.0	80.3	3.9	32.0	110.2	103.9	62.5	58.0

Table 1 Final cephalometric variables. This table represents the mean, standard deviation, minimum, maximum, and quartiles of the final cephalometric variables for the 83 patients. All cephalometric variables are angles and units are in degrees (°).

In addition to cephalometric variables, one key clinical variable measured was overjet. Overjet was measured by the clinician at initial, final, and long term time points. Figures 5-7 and Table 4 report the clinical findings of overjet in this study.

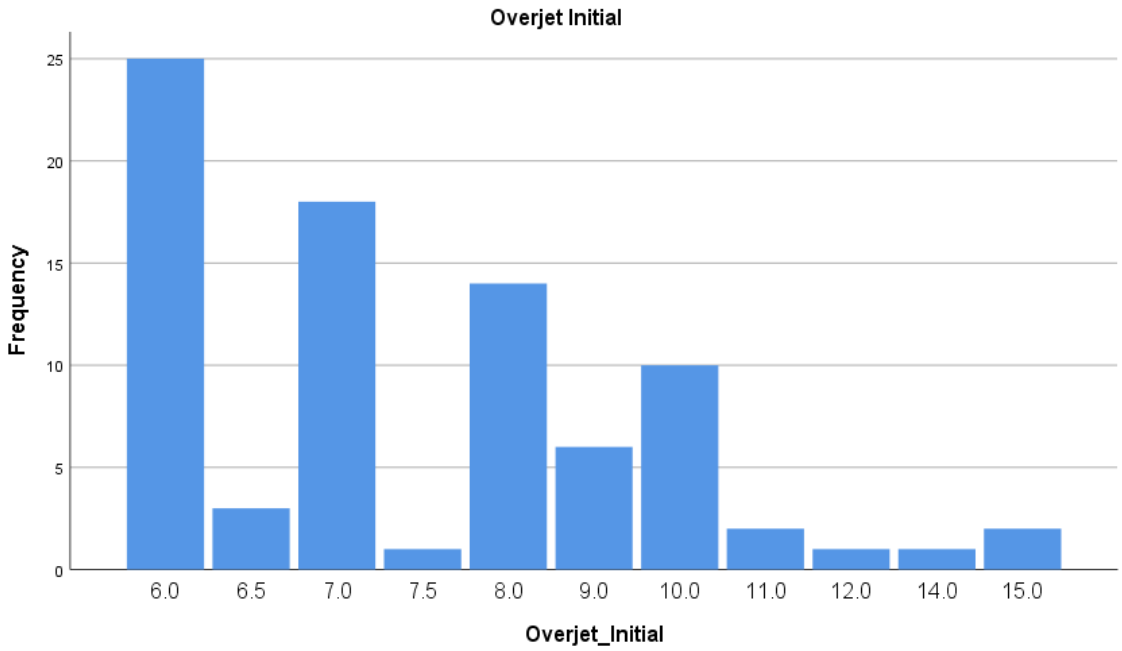

Figure 5 Initial overjet. This figure represents the frequency and severity of patients' overjet (mm) at the initial clinical time point.

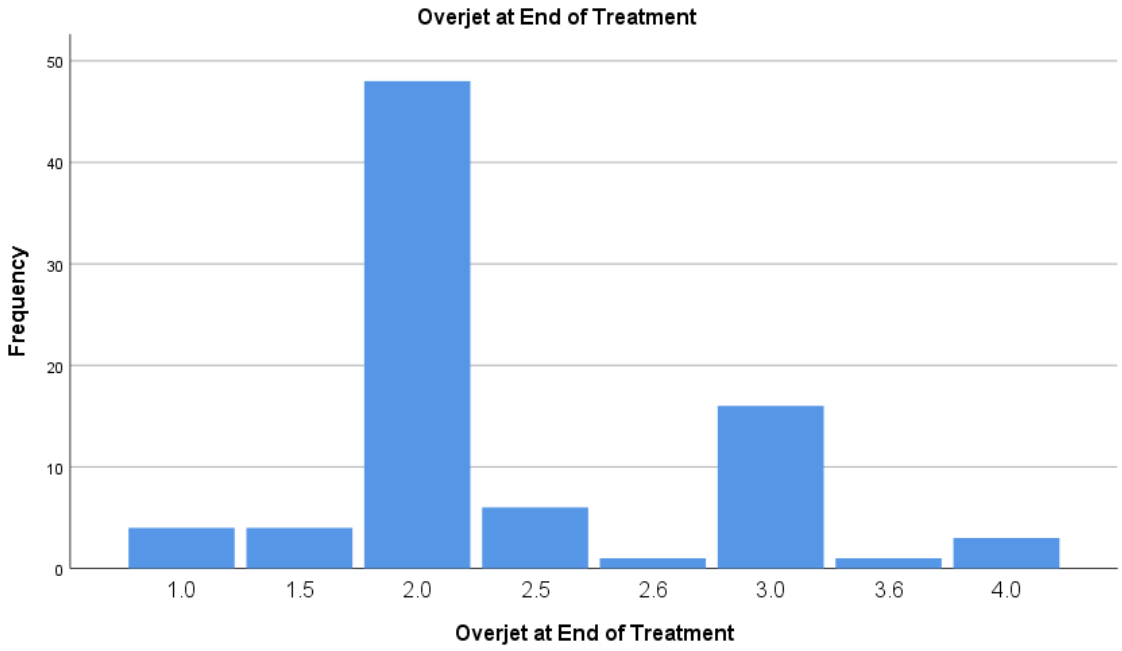

Figure 6 Final overjet. This figure represents the frequency and severity of patients' overjet (mm) at the final, end of treatment, clinical time point.

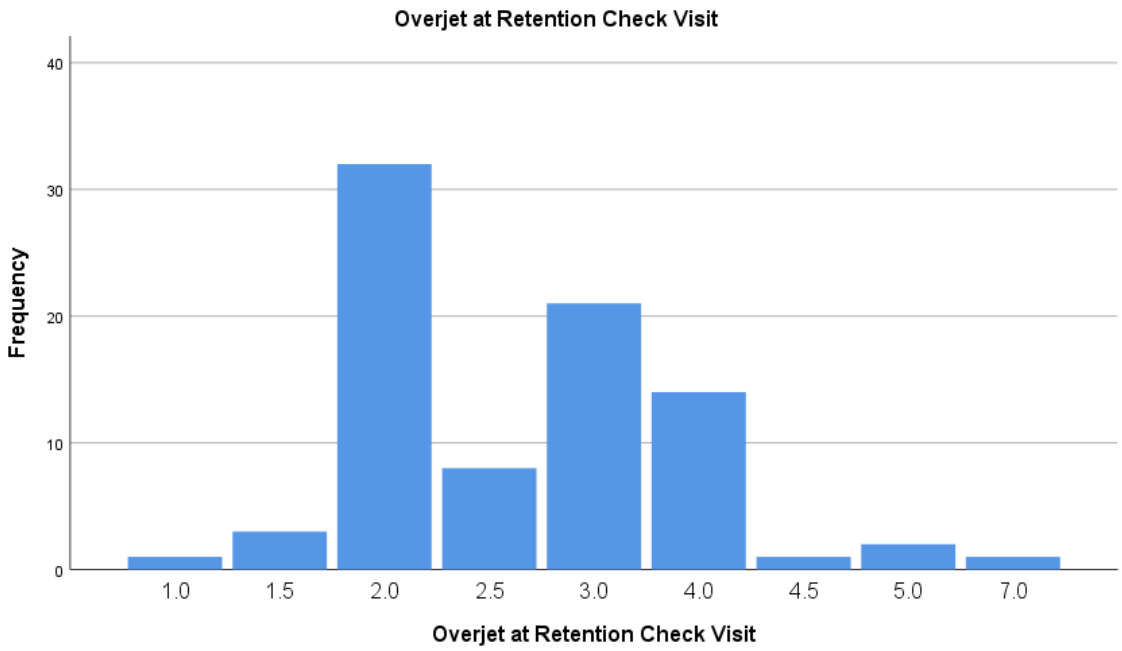

Figure 7 Long term overjet. This figure represents the frequency and severity of patients' overjet (mm) at the long term, retention check, clinical time point.

		Overjet Initial	Overjet at End of Treatment	Overjet at Retention Check Visit
Mean		7.795	2.255	2.771
Std. Deviation		2.0228	.6247	.9917
Minimum		6.0	1.0	1.0
Maximum		15.0	4.0	7.0
Percentiles	25	6.000	2.000	2.000
	50	7.000	2.000	2.500
	75	9.000	2.600	3.000

Table 4 Change in overjet. This table represents the mean, standard deviation, minimum, maximum, and quartiles of the initial, final, and long term overjet (mm) for the 83 patients.

Patient satisfaction of orthodontic treatment at least 6 months post-deband (in retention) was taken on a Likert scale of 1-5, 1 being the least satisfied and 5 being the most satisfied. Results are summarized on Tables 5, 7, and 9 and Figures 8-10. In addition, the satisfaction questionnaire asked patients if they were compliant with retainers and if they are happy with their bite. Seventy-four percent of patients claimed

they wear their retainers and only 2.5% of patients responded that they are not happy with their bite with 78.8% responding that they are happy with their bite (18.8% unsure).

The average satisfaction of overall orthodontic treatment was 4.60 with the median being 5 on the 5-point scale. Sex, race, practice location, and lateral cephalometric measurements at end of treatment were not significantly associated with "overall satisfaction with orthodontic treatment." Extractions of permanent teeth were associated with significantly lower patient satisfaction scores. Those who had extractions of permanent teeth had 0.414 points less than those who did not have extractions of permanent teeth ($p=0.023$). Each 1-unit increase in overjet at retention check visit was associated with 0.325 less points in patient satisfaction with orthodontic treatment scores ($p<0.001$). The multivariable linear regression model explained 39.1% of the variance in outcome ($R^2 = 0.391$). The multivariable linear regression model is illustrated in Table 6.

Patient Satisfaction of Overall Orthodontic Treatment		
Value on Scale (1-5)	Frequency	Percentage
1	2	2.4
2	0	0
3	3	3.6
4	19	22.9
5	59	71.1
Average: 4.60		

Table 5 Patient satisfaction with overall orthodontic treatment. Responses are valued on a Likert scale of 1-5 (l = least satisfied; 5 = most satisfied) and the results were summarized as a frequency and percentage of the 83 patients.

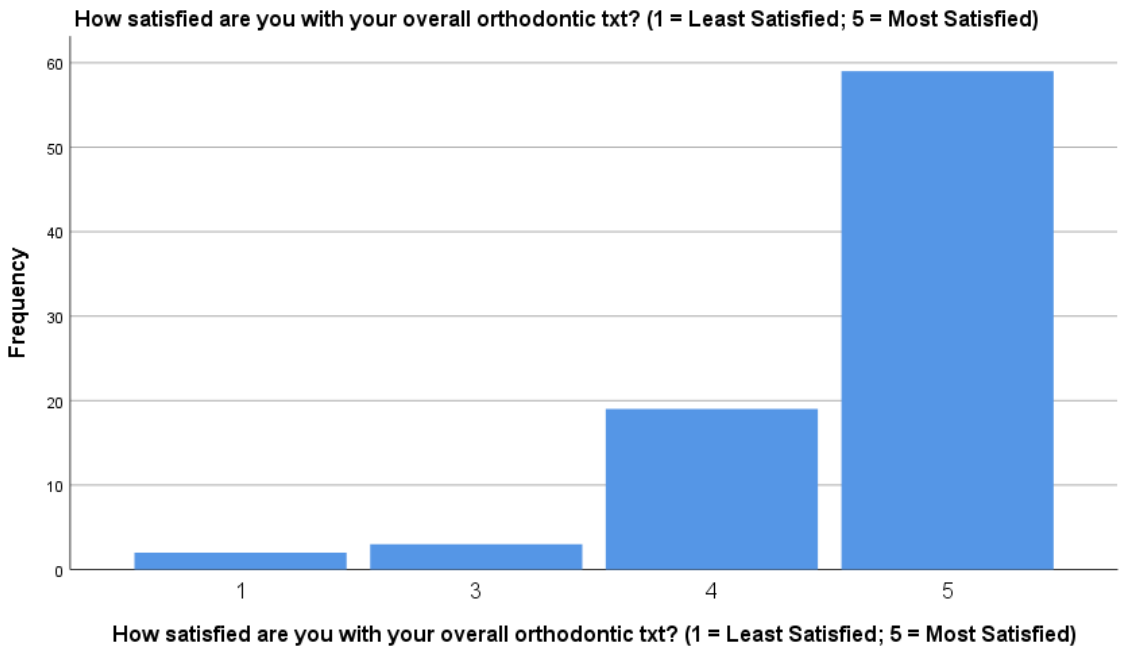

Figure 8 Patient satisfaction with overall orthodontic treatment. This figure presents the frequency of patient responses to the question "How satisfied are you with your overall orthodontic treatment?" Responses are valued on a Likert scale of 1-5 (1 = least satisfied; 5 = most satisfied).

Independent Variables		Unstandardized Coefficients		p-value	95% Confidence Interval for Parameter Estimates	
		Parameter Estimates	Std. Error		Lower Bound	Upper Bound
A*	(Constant)	-1.990	4.793	.679	-11.566	7.586
	Sex	-.199	.165	.232	-.528	.130
	Caucasian Race	-.135	.217	.538	-.568	.299
	UIOWA**	.359	.301	.237	-.243	.961
	Private Practice**	.105	.320	.743	-.533	.744
	Extractions Done As Treatment Plan	-.414	.177	.023	-.767	-.060
	Lower FH Final	.067	.041	.105	-.014	.148
	FMIA angle Final	.020	.018	.266	-.016	.056
	Mand Incisors to mand plane Final	.026	.023	.267	-.020	.072
	Max Incisor to SN Final	.009	.013	.492	-.017	.035
	Mand. Plane Angle Final	.001	.020	.945	-.039	.042
	ANB angle Final	.097	.062	.120	-.026	.220
	Overjet at Retention Check Visit	-.415	.101	**.000**	-.616	-.214
	Overjet at End of Treatment	-.325	.173	.065	-.671	.020

A*. Dependent Variable: How satisfied are you with your overall orthodontic txt? (1 = Least Satisfied; 5 = Most Satisfied)

**. Reference for UIOWA and Private Practice is Harvard School of Dental Medicine

Table 6 Multivariable linear regression model of patient satisfaction with overall orthodontic treatment.

The average satisfaction of facial appearance was 4.41 with the median being 5 on the 5-point scale. Sex, practice location, extraction vs. nonextraction treatment, and lateral cephalometric measurements at end of treatment were not significantly associated with "appearance of face at retention check visit." Caucasians were associated with significantly lower patient satisfaction scores compared to non-Caucasians. Caucasians had 0.488 points less than non-Caucasians ($p=0.039$). Each 1-unit increase in overjet at retention check visit was associated with 0.405 less points in patient satisfaction with appearance of face at retention check visit scores ($p<0.001$). The multivariable linear regression model explained 38% of the variance in outcome ($R^2 = 0.380$). The multivariable linear regression model is illustrated in Table 8.

Patient Satisfaction with Facial Appearance		
Value on Scale (1-5)	Frequency	Percentage
1	2	2.4
2	0	0
3	5	6
4	31	37.3
5	45	54.2
Average: 4.41		

Table 7 Patient satisfaction with facial appearance. Responses are valued on a Likert scale of 1-5 (l = least satisfied; 5 = most satisfied) and the results were summarized as a frequency and percentage of the 83 patients.

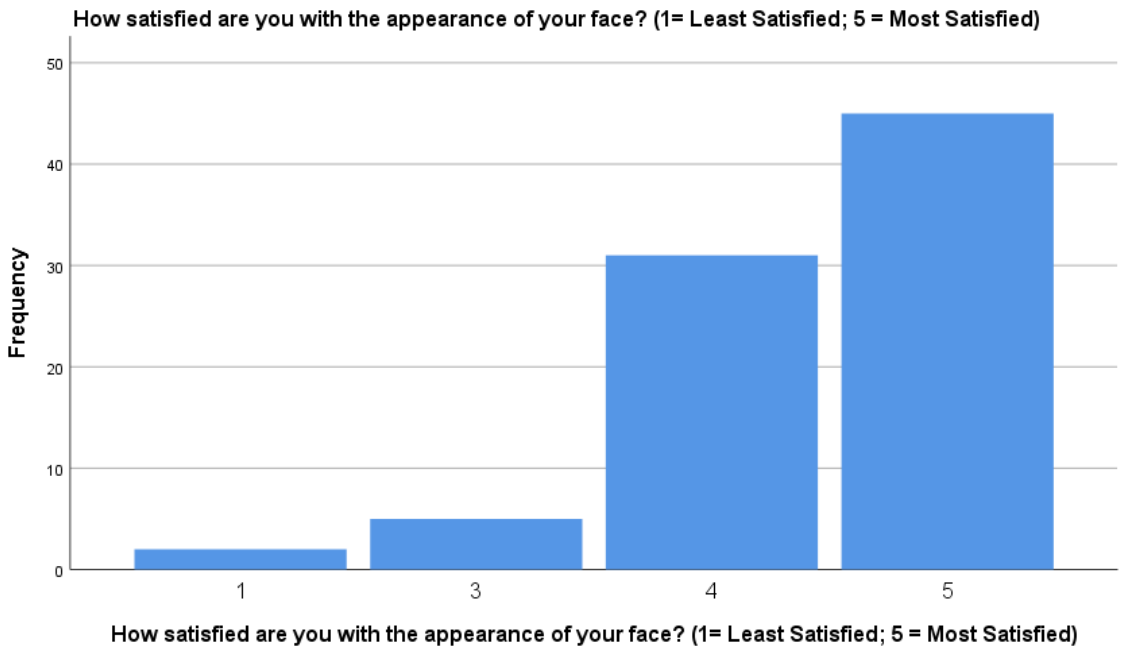

Figure 9 Patient satisfaction with facial appearance. This figure presents the frequency of patient responses to the question "How satisfied are you with the appearance of your face?" Responses are valued on a Likert scale of 1-5 (l = least satisfied; 5 = most satisfied).

Model		Unstandardized Coefficients		p-value	95% Confidence Interval for Parameter Estimates	
		Parameter Estimates	Std. Error		Lower Bound	Upper Bound
A*	(Constant)	4.335	5.103	.399	-5.859	14.529
	Sex	-.184	.175	.299	-.534	.167
	Caucasian Race	-.488	.231	**.039**	-.950	-.026
	UIOWA	.446	.321	.170	-.195	1.086
	PrivatePractice	.489	.340	.156	-.191	1.169
	Extractions Done As Treatment Plan	-.353	.188	.066	-.729	.024
	Lower FH Final	.012	.043	.779	-.074	.099
	FMIA angle Final	.016	.019	.410	-.022	.054
	Mand Incisors to mand plane Final	.011	.024	.651	-.038	.060
	Max Incisor to SN Final	-.010	.014	.489	-.037	.018
	Mand. Plane Angle Final	.008	.021	.712	-.035	.051
	ANB angle Final	.070	.066	.289	-.061	.201
	Overjet at Retention Check Visit	-.405	.107	**.000**	-.618	-.191
	Overjet at End of Treatment	-.258	.184	.166	-.626	.110

A*. Dependent Variable: How satisfied are you with the appearance of your face? (1= Least Satisfied; 5 = Most Satisfied)

**. Reference for UIOWA and Private Practice is Harvard School of Dental Medicine

Table 8 Multivariable linear regression model of patient satisfaction with facial appearance.

The average satisfaction with appearance of bite was 4.51 with the median being 5 on the 5-point scale. Sex, race, practice location, and lateral cephalometric measurements at end of treatment were not significantly associated with "appearance of bite at retention check visit." Extractions of permanent teeth were associated with significantly lower patient satisfaction scores. Those who had extractions of permanent teeth had 0.457 points less than those who did not have extractions of permanent teeth (p=0.018). Each 1-unit increase in overjet at retention check visit was associated with

0.493 less points in patient satisfaction with appearance of bite at retention check visit scores ($p<0.001$). The multivariable linear regression model explained 38.7% of the variance in outcome ($R^2 = 0.387$). The multivariable linear regression model is illustrated in Table 10.

Patient Satisfaction with Appearance of Bite		
Value on Scale (1-5)	Frequency	Percentage
1	2	2.4
2	0	0
3	5	6
4	23	27.7
5	53	63.9
Average: 4.51		

Table 9 Patient satisfaction with appearance of bite. Responses are valued on a Likert scale of 1-5 (l = least satisfied; 5 = most satisfied) and the results were summarized as a frequency and percentage of the 83 patients.

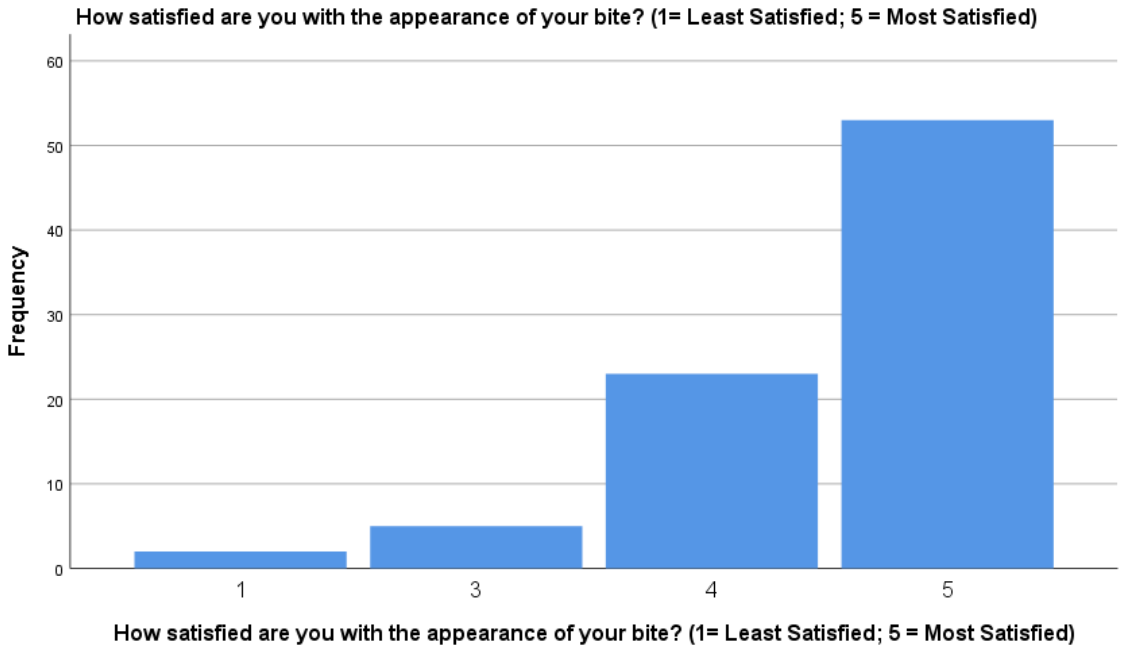

Figure 10 Patient satisfaction with appearance of bite. This figure presents the frequency of patient responses to the question "How satisfied are you with the appearance of your bite?" Responses are valued on a Likert scale of 1-5 (l = least satisfied; 5 = most satisfied).

Model		Unstandardized Coefficients		p-value	95% Confidence Interval for Parameter Estimates	
		Parameter Estimates	Std. Error		Lower Bound	Upper Bound
A*	(Constant)	1.956	5.083	.702	-8.198	12.110
	Sex	-.213	.175	.228	-.562	.137
	Caucasian Race	-.221	.230	.341	-.681	.239
	UIOWA	.235	.320	.465	-.403	.873
	Private Practice	.026	.339	.940	-.652	.703
	Extractions Done As Treatment Pplan	-.457	.188	**.018**	-.832	-.083
	Lower FH Final	.024	.043	.578	-.062	.110
	FMIA angle Final	.008	.019	.674	-.030	.046
	Mand Incisors to mand plane Final	.001	.024	.975	-.048	.050
	Max Incisor to SN Final	.022	.014	.108	-.005	.049
	Mand. Plane Angle Final	.002	.021	.933	-.041	.045
	ANB angle Final	.141	.065	.034	.011	.272
	Overjet at Retention Check Visit	-.493	.107	**.000**	-.706	-.280
	Overjet at End of Treatment	-.182	.184	.324	-.549	.184

A*. Dependent Variable: How satisfied are you with the appearance of your bite? (1= Least Satisfied; 5 = Most Satisfied)

**. Reference for UIOWA and Private Practice is Harvard School of Dental Medicine

Table 10 Multivariable linear regression model of patient satisfaction with appearance of bite.

The results of the oral health impact profile (OHIP-14) and child perceptions questionnaire (CPQ) surveys are summarized in Figures 11 and 12, respectively, with items being oriented from least applicable (left) to most applicable (right). The OHIP-14 and CPQ instrument showed that patients who had a nonextraction treatment plan reported significantly ($p=0.022$ and $p=0.002$, respectively) lower QOL scores (indicative of better quality of life) when compared to those who had an extraction treatment plan according to multivariable linear regression models. Table 12 illustrates OHIP-14 and CPQ QOL scores for extractions vs nonextraction treatment plans.

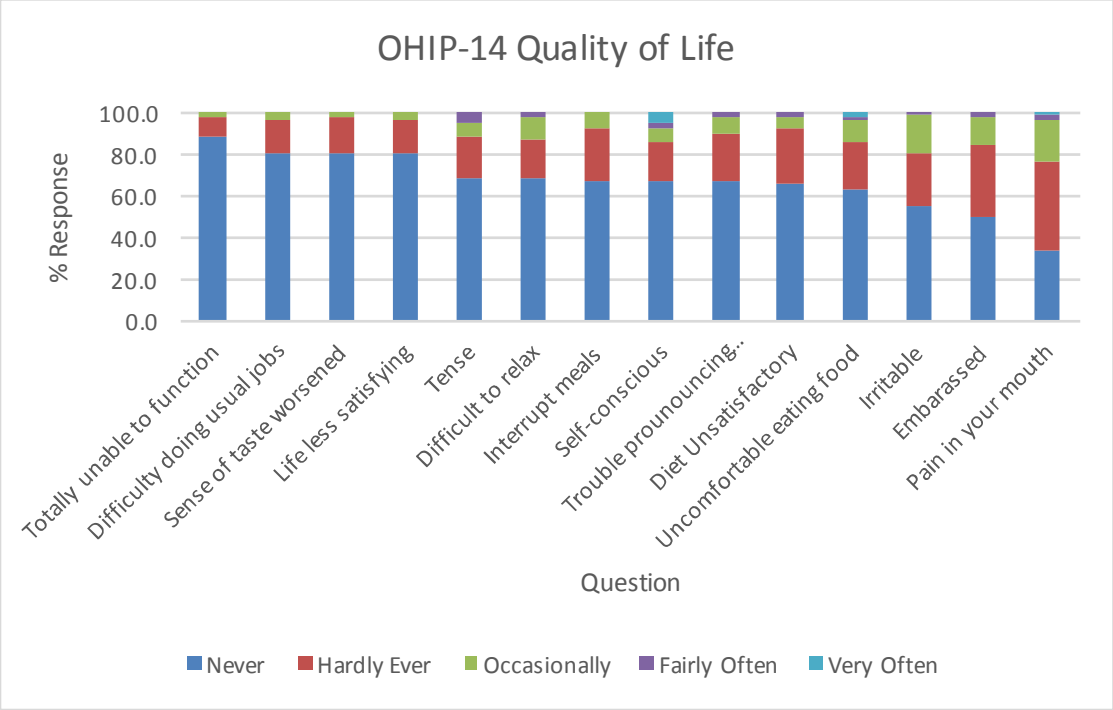

Figure 11 OHIP-14 results summary. Oral health impact profile-14 questionnaire results as percentages of patients who answered the labeled responses, in order of least applicable to most applicable attribute.

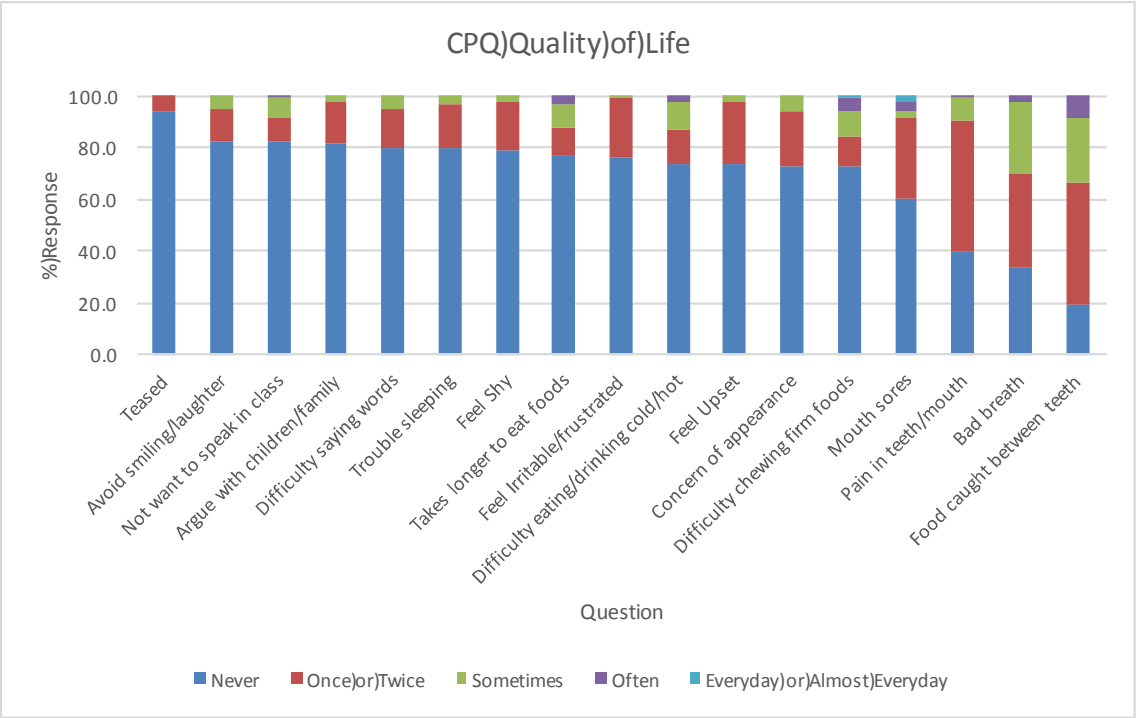

Figure 12 CPQ results summary. Percentages of patients who answered the listed responses, in order of least applicable to most applicable attribute.

Extractions Done As Treatment Plan		N	Mean	Std. Deviation	Std. Error Mean
OHIP-14 Total QOL Score	Extractions Done	34	21.79	6.696	1.148
	Nonextraction	49	19.73	5.310	0.759
CPQ Total QOL Score	Extractions Done	34	26.24	6.453	1.107
	Nonextraction	49	22.94	4.584	0.669

Table 11 OHIP-14 and CPQ QOL scores of extraction vs nonextraction treatment. This table shows the N, mean, standard deviation, and standard error mean for OHIP-14 and CPQ QOL scores.

DISCUSSION

The intent of this study was to examine the different non-surgical treatment approaches for patients with severe Class II division 1 and to analyze the impact of treatment outcomes on patient satisfaction and quality of life.

One main goal of Class II division 1 treatment is the reduction of overjet. The pre-treatment average overjet of the 83 patients was 7.80 mm and post-treatment average was 2.26 mm, an average of 5.54 mm of reduction. The long term retention (6 months to 3 years post deband) average overjet was 2.77 showing 0.51 mm of relapse towards pre-treatment.

Our results are in perfect agreement with the findings of Fidler et al. who demonstrated an average relapse of 0.51 mm of overjet 14 years in retention for 78 patients successfully treated with extraction and nonextraction treatment of severe Class II division 1; however, they claim the relapse was not significant and correlation coefficients were so small that clinical relevance was minimal. (Fidler, Artun, Joondeph, & Little, 1995). A study by Paquette et al. supports the tendency of long term relapse of overjet as they found an average of 1-2mm of relapse over 14.5 years post-treatment and noted no significant differences between extraction and nonextraction treatment in Class II division 1 patients that were “borderline” extraction cases (Paquette et al., 1992). It is reasonable to argue that non-surgical correction of overjet can be successful and that relapse long term will occur but the overall prognosis for stability in overjet correction is excellent, which is in agreement with several previous studies (Blake & Bibby, 1998; Dyer, Vaden, & Harris, 2012; Fidler et al., 1995).

The primary finding of our study was that patients with more overjet at their long term retention check demonstrated poorer satisfaction scores. Final regression models showed that those with more overjet at the retention check reported statistically significantly lower satisfaction with the appearance of their bite ($p<0.001$), the appearance of their face ($p<0.001$), and with their overall orthodontic treatment ($p<0.001$).

A systematic review addressing long term stability of orthodontic treatment and patient satisfaction conducted in 2007 was unable to derive evidence-based conclusions on patient satisfaction as very few high level studies are available (Bondemark et al., 2007). This is a testament to the aim of our pilot study. Our results are in agreement with Bennett et al. who found post-treatment overjet was inversely related to parental satisfaction with orthodontic treatment and treatment outcomes for their children; however, this study analyzed satisfaction at the time of deband and not in retention (Bennett, Camilla Tulloch, Vlg, & Phillips, 2001). In accordance with our results, O'Brien et al. demonstrated that early treatment of 8-10 year old Class II division 1 patients reduced overjet by 6.6 mm on average and yielded higher patient self-concept scores (based on Piers-Harris Children's Self-Concept Scale) and fewer negative social experiences (based on CPQ) than controls (O'Brien et al., 2003). Furthermore, Graber et al. analyzed dental esthetic self-evaluation and satisfaction of four hundred eighty-one 10-13 year old untreated children and concluded a correlation between increased overjet and incisor crowding and negative responses on self-evaluation of straightness and attractiveness (Graber & Lucker, 1980). Conversely, Espeland et al. found that young adults are more aware of moderate spacing/crowding than overjet and that overjet was

not correctly reported by patients in their perception of dental appearance (Espeland, Odont, Stenvik, & Odont, 1991). Also in disagreement with our results, Feldmann found no correlation between overjet and patient satisfaction 6 weeks post treatment and demonstrated patient satisfaction is mainly derived from patients' perception of how well they had been informed and cared for during treatment (Feldmann, 2014). In agreement with Feldmann, Keles et al. argues that the doctor-patient relationship is the most important factor contributing to patient satisfaction (Keles & Bos, 2012).

The secondary finding of our study was that patients treated with extractions showed higher QOL scores on the OHIP-14 and CPQ surveys, indicating that extraction therapy of severe Class II division 1 patients led to a poorer quality of life. Multivariable linear regression models showed that those treated with extraction therapy had statistically significantly higher OHIP-14 scores ($p=0.022$) and CPQ scores ($p=0.002$), with a higher score representing a greater negative impact on quality of life. Furthermore, extraction treatment was associated with significantly lower patient satisfaction scores of overall orthodontic treatment ($p=0.023$) and appearance of bite ($p=0.018$) but not facial appearance

Very little data exists comparing long term perceptions, satisfaction, and quality of life between patients treated extraction vs. nonextraction, even fewer data when specifically looking at non-surgical Class II division 1 treatment. One of the only other studies looking at extraction vs. nonextraction treatment and the impact on patient satisfaction, Al-Omiri et al., found that patients treated nonextraction showed significantly more dissatisfaction with their dentition ($p<0.05$) 6-12 months in retention. This result is the opposite finding of our current study. Furthermore, Al-Omiri et al.

concludes patients treated as nonextraction expressed significantly more (p=0.048) dissatisfaction in the oral comfort dimension but that satisfaction scores of appearance, pain, general performance, and eating/chewing were similar to those treated with extractions. The Dental Impact on Daily Living (DIDL) questionnaire was used in this study for assessment of satisfaction and it must be noted that the type of malocclusion treated was not classified (Al-Omiri & Abu Alhaija, 2006).

Although not specifically addressed in this study, it is important not to forget that surgery is an option for treating severe Class II division 1 malocclusion. In response to if the orthodontist would treat the patient differently knowing the result, several practitioners answered in our questionnaire that they would have treated the patient surgically. Mihalik et al. agrees with our assessment that although many Class II patient perceptions publications are available for surgical treatment, more research is needed focused on non-surgical correction. Furthermore, Mihalik et al. examined surgical vs non-surgical Class II treatment looking at occlusal stability and patient satisfaction with treatment outcomes one year in retention. The study noted patients' perception of outcomes were highly positive in both orthodontic only (all treated with extractions) and surgical groups with similar reports of satisfaction with treatment. Surgical patients with a mandibular advancement were significantly more positive with their dentofacial image, notably chin projection; however, it must be noted they found surgery patients were nearly twice as likely to have a long term increase in overjet (Mihalik, Proffit, & Phillips, 2003). Although not concluded by Mihalik et al, our current study would suggest an increase in long term overjet would indeed lead to dissatisfaction in patients' appearance of bite, appearance of their face, and overall orthodontic treatment.

CONCLUSION

There a multiple different treatment approaches for treating severe Class II division 1 malocclusions and they all fall into one of the following categories: orthopedics, masking/camouflage, or surgery. Treatments can include headgear, functional appliances, inter-arch mechanics, tooth extractions, temporary anchorage devices, surgery, or a combination.

Non-surgical treatment of severe Class II division 1 malocclusions can yield excellent results and stability long term. While overjet can be dramatically reduced with non-surgical treatment there is a tendency for overjet to relapse in retention. Patients with more overjet at their long term retention check demonstrated significantly poorer satisfaction scores with the appearance of their bite, the appearance of their face, and with their overall orthodontic treatment. Furthermore, extraction treatment was associated with significantly lower patient satisfaction scores of overall orthodontic treatment and appearance of bite but not facial appearance. Patients treated with extractions also showed higher QOL scores on the OHIP-14 and CPQ surveys, indicating that extraction therapy of severe Class II division 1 patients led to a significantly poorer quality of life.

While our study supports the claim that overjet is inversely related with patient satisfaction quality of life long term, the current literature appears to be mixed on the issue and few long term studies are available to definitely make a claim. Additionally, very little data exists comparing long term perceptions, satisfaction, and quality of life between patients treated with extraction vs. nonextraction. Future research analyzing long term satisfaction and quality of life in regards to overjet and extraction vs

nonextraction therapy in non-surgical Class II division 1 malocclusions is desperately needed to assist clinicians in proper treatment.

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