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Effect of Attending Doctor Changes on Orthodontic Treatment Times and Results

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The Effect of Attending Doctor Changes on Orthodontic Treatment Times and Results

by

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A thesis submitted in partial satisfaction of
the requirements for the degree
Master of Science in Orthodontics and Dentofacial Orthopedics

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Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Science.

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ABBREVIATIONS AND TERMS

DI	Discrepancy Index
PAR	Peer Assessment Rating
T1	Time point 1 (start of active orthodontic treatment)
T2	Time point 2 (end of active orthodontic treatment)
ANOVA	Analysis of Variance
LLU	Loma Linda University
PA	Primary Attending
OA	Original Attending

ABSTRACT OF THE THESIS

The Effect of Attending Doctor Changes on Orthodontic Treatment Times and Results

by

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Master of Science, Graduate Program in Orthodontics
Loma Linda University, September 2013
Dr. V. Leroy Leggitt, Chairperson

Introduction: The objective of this study was to determine if there was any significant difference in treatment time or results due to varying levels of attending doctor coverage in the Loma Linda University (LLU) graduate orthodontics clinic.

Methods and Materials: The main study group of 191 subjects was split into high, medium and low coverage groups by primary attending doctor coverage and then by original attending doctor coverage. Treatment times, treatment results, and other variables were evaluated for each of the groups. Treatment results were evaluated using UK Peer Assessment Rating (PAR) scores. A second study group (289 subjects) included an additional 98 subjects who met all of the inclusion criteria but lacked PAR scores. Statistical tests included one-way ANOVA and Pearson Correlation.

Results: No statistically significant differences were found in treatment time ($P \geq 0.128$) or results ($P \geq 0.052$). There were no statistically significant differences in the mean scores for T1 PAR ($P \geq 0.056$), T2 PAR ($P \geq 0.602$), patient age at T1 ($P \geq 0.747$), total appointments ($P \geq 0.128$), missed appointments ($P \geq 0.050$), or cancelled appointments ($P \geq 0.183$).

When the main subject group was divided into thirds by T1 PAR (low, medium, and high T1 PAR), there were statistically significant differences in percent change in PAR (P =0.000), treatment time (P =0.008), and the percent of primary attending coverage (P =0.001) between the low T1 PAR and the medium T1 PAR groups as well as between the low T1 PAR and high T1 PAR groups.

In the second study group (n =289), T1 PAR was weakly correlated with treatment time (r=0.280) and with appointment number (r =0.248). Treatment time was strongly correlated with the number of appointments (r =0.822), and moderately correlated with missed appointments (r =0.333). Subjects who had treatment involving the extraction of permanent teeth had longer treatment times (P =0.003), but had no statistically significant differences in results (as measured by percent change in PAR score) (P =0.454).

Conclusions: This study shows that variation in attending doctor coverage in the LLU graduate orthodontic clinic does not lengthen time of orthodontic treatment or reduce the quality of treatment results.

CHAPTER ONE

EXPANDED REVIEW OF THE LITERATURE

One of the goals in orthodontic treatment is to accomplish what needs to be done for a patient as efficiently as possible. Unnecessarily prolonged treatment time, in addition to being a poor use of the doctor's resources and potentially frustrating for the patient, can have substantial untoward effects. It has been shown that caries risk may increase with prolonged treatment time. Reichter et al., found that patients developed approximately 3 white spot lesions for treatment times under 22 months, but this increased to over five lesions per patient when treatment times exceeded 33 months.[1] The average number of cavitated lesions formed during treatment also increased for longer treatment times, but the increase was not statistically significant.[1]

Another problem associated with orthodontic treatment is root resorption. Although root resorption may occur in the absence of orthodontic treatment, research has shown that orthodontic treatment routinely causes minor root resorption and can cause significant root resorption. A recent cone beam computed tomography study found that 94% of orthodontic patients will have at least one tooth with more than 1 mm of resorption during treatment.[2] One of the factors associated with significant resorption is prolonged treatment time.[3] A literature review of over 100 publications concluded that "treatment duration and mechanical factors definitely influence root resorption."[4]

An agreed upon standard or average treatment time for satisfactory comprehensive orthodontic treatment is difficult to find in the literature. This is understandable, as there are so many variables that can affect what amount of time an orthodontic case will take to complete.

Recent research cited in the American Journal of Orthodontics and Dentofacial Orthopedics in 2010 has reported the typical orthodontic treatment time with fixed appliances to be 15-24 months.[5] A study done in the United Kingdom and published in 2011 noted that time spent in space closure in extraction cases may significantly increase treatment duration.[6]

A recent study of 400 patients reported on several important pre-treatment characteristics that affect treatment time.[7] This study showed a mean treatment time of 25.3 months. It defined "short treatment" as 20 months or less and "long treatment" as 30 months or more. Patients were two to three times more likely to have short treatments if they were non-extraction cases, had no primary teeth at T1, had less than 80% overbite, had less than 6 mm maxillary crowding, and had good oral hygiene. Patients were two to three times more likely to have long treatment duration if they had extraction treatment, more than 80% overbite, more than 6 mm maxillary crowding, excessive overjet, primary teeth present at T1, short lower face height, or poor academic performance.[7]

Case difficulty is certainly one of the most important variables in determining treatment time. In one recent study performed in the graduate clinic at Indiana University, researchers showed a significant relationship between the American Board of Orthodontics Difficulty Index (DI) and treatment time. Over 700 cases were analyzed, and a significant relationship was found between the DI and treatment time.

Demographic variables such as race and gender were not found to significantly affect treatment times. The average DI score for the group was 15.7, and average treatment time was 31.2 months The average increase in treatment time per 1 point in DI score was 11 days. The researches found that following treatment time increases per 1 DI point scored in the categories listed: tooth transposition 199 days, crowding 30 days, overbite 27 days, overjet 25 days, occlusion 21 days, and lateral open bite 14 days.[8]

It is interesting to note that in the Indiana University study, there was a significant bivariate correlation between impacted canines and treatment time, but the correlation was found to be insignificant in their multiple variable model.[8] In contrast, another study found that a unilateral impacted canine may be expected to add 72 days to treatment and bilateral impacted canines may be expected to add 297 days.[9]

Orthognathic surgery is another factor that may have a significant impact on orthodontic treatment time. A research project in Sweden looked at patients who underwent surgery combined with orthodontic treatment. They found an average pre-surgical treatment time of 19.2 months, and an average post-treatment time of 4.6 months. The average total time was 27.8 months.[10] This is a longer treatment time than the average of 15-24 months reported by Fleming, et al., in 2010.[5]

A related study in the United Kingdom (UK) reported on duration of treatment for orthodontic cases treated with orthognathic surgery for the maxilla, the mandible, and bimaxillary sugery. Average treatment time for all cases was 30.6 months.[11] Maxilla-only surgical cases had the shortest treatment time, but no statistically significant differences were found in time or treatment results among the three groups.[11]

Patient compliance can have a significant impact on treatment time. It has been estimated that each appointment missed by a patient will add about 1 month to treatment time. One broken bracket or band will add two weeks to treatment. Patients with poor oral hygiene have been estimated to have treatment 0.67 months longer per time that poor hygiene was noted in the patient's chart.[12]

An important variable that could affect treatment time which may not exist in private orthodontic offices is variability in the patients' treatment provider. This might apply to graduate schools or other clinic settings where patients see more than one doctor during their treatment. One might expect that seeing multiple doctors could result in greater treatment duration compared to seeing the same doctor at every appointment.

A study conducted in Ireland and the UK looked to address this possibility using 183 patients from postgraduate teaching programs.[13] The researchers evaluated cases treated by one operator and by multiple operators. Peer Assessment Rating (PAR) scores were used to evaluate the quality of the orthodontic treatment provided. The was an average reduction in PAR of 70.85% for the one-operator group and 79.95% for the multiple-operator group, but these differences were not found to be significant. As such, it was concluded that quality of treatment outcomes was not affected by number of operators. However, the researchers found an average treatment time of 17.67 months for patients who had been treated by one operator, and 26.1 months for patients treated by multiple operators. These values were found to be very significant, and it was concluded that changes in the operator have a profound effect on total treatment time.[13]

We must also recognize that predictions and estimates of treatment times are very important to our patients. In a publication on patients' most common recommendations

for orthodontists, "true and accurate timing estimates" was ranked second only to "reduction in treatment fees."[14] Patients who are given accurate information regarding predicted treatment times are more likely to be satisfied with treatment overall, and will have more realistic expectations about the outcomes of their treatment.[15] In addition, satisfied patients are more likely to refer other patients to the office where they were treated.[16]

A 2009 survey of Dutch and English parents and children evaluated expectations of orthodontic treatment prior to any orthodontic consultation.[17] Interestingly, the only question where a significant difference between patients and parents was shown was the one regarding treatment times. The patients, children with an average age of 11.4, expected treatment to take less time than their parents did. Looking at all respondents, 19% said treatment would take 12 to 18 months, 24% said 18 to 24 months, and 19% said 25 to 36 months. 30% said they "don't know", and only a small percentage answered less than 12 months or greater than 36 months. Another question in the same study asked about expected frequency of orthodontic appointments, a factor which can have a significant effect on overall treatment time. In response to this survey, 53% of respondents expected appointments every 1-2 months, 15% expected visits to be in the range of 3 to 6 months apart, and 25% answered that they did not know. The study concluded that these, among other important expectations, should be discussed early on with patients and parents to avoid disappointments regarding time commitment and improve the orthodontic treatment experience.[17]

Although we know treatment times are very important to our patients, the importance seems to fade after several years of being finished with orthodontic treatment.

A recent survey of patients who were five or more years post-treatment found that reported satisfaction with orthodontic treatment was not related to duration of treatment.[18] Nor was satisfaction related to severity of T1 malocclusion, final result (as measured with PAR), total improvement from T1 to T2, age at T1, gender, or whether teeth were extracted. The only variable that had an effect on long-term satisfaction was the long-term PAR score. That is, it seems that post-retention patients report satisfaction with orthodontic care when they are satisfied with the current status of their dentition. The benefits of the other factors, which certainly are noted to be important to the patient during orthodontic treatment, appear to be diminished or lost as time advances after debanding.[18]

The literature reviewed here confirms that orthodontic treatment times can vary widely, and it is beneficial to the patient and the orthodontist to provide reliable information about the duration of treatment.

The PAR index can be used to evaluate orthodontic cases before and after treatment, and can be used to evaluate the amount of change achieved during treatment. This index assigns numerical values to the traits that comprise a malocclusion. The score increases as the malocclusion severity increases. This scoring system originated in the United Kingdom, and has been used with some frequency in orthodontic practice and in studies performed there. It was validated in the UK by a panel of 74 dentists (including 22 orthodontic specialists) in 1991.[13,19,20]

The PAR index has been adapted for use in North America. In a study performed in England and Pennsylvania in 1995, a panel of American orthodontists evaluated casts for malocclusion. Their findings were compared to the UK PAR index. The study concluded

"...the PAR index may be considered to represent a good approximation of malocclusion severity and treatment difficulty, and may be used as an outcome measure for the assessment of dento-occlusal change, in studies investigating the effectiveness of orthodontic treatment that are based in the United States."[21] A more recent study from Ohio and California confirmed that: "... the US and UK PAR scores were excellent predictors of orthodontic treatment need as determined by a panel of orthodontists."[22]

As computer-based imaging and modeling has become more widespread in dentistry and orthodontics, many studies have been done on the use of digital dental models and their comparison to stone models. The current literature supports the use of PAR scoring on digital as well as on stone models. A 2005 study published in the American Journal of Orthodontics and Dentofacial Orthodpedics concluded that "The PAR index scores derived from digital, computer-based models are valid and reliable measures of malocclusion."[23] In a 2010 systematic review of 17 related studies, it was found that there were no significant differences between PAR measurements on plaster models compared to digital models. It was concluded that "measurements with digital models were comparable to those derived from plaster models. The use of digital models as an alternative to conventional measurement on plaster models may be recommended."[24]

PAR may be used to measure treatment outcomes in several ways: the total point reduction in the PAR score, the T2 PAR score only, or the percentage reduction in the PAR score. Previous literature has accepted that a 22 point reduction in score may be considered a "great improvement" provided by treatment, a reduction less than this but more than 30% of the T1 score may be considered an "improved" condition, and a less

than 30% reduction indicated “no improvement” provided by treatment.[25,26] In a 2007 article, it was stated that a “posttreatment PAR score of 5 or less is considered an excellent outcome, and a posttreatment PAR score above 10 indicates a residual malocclusion.”[27] When looking at percentage reduction in PAR score only, the following categories are generally recognized for evaluation of PAR reduction: 70-100% = great improvement, 69-50% = improvement, 49-30% = little improvement, less than 30% = no improvement.[28,29]

CHAPTER TWO

THE EFFECT OF ATTENDING DOCTOR CHANGES ON ORTHODONTIC TREATMENT TIMES AND RESULTS

Introduction

Statement of the Problem

One of the questions orthodontic patients frequently ask before and during their orthodontic treatment is, "how long is this going to take?" This is an important question, not only because of its significance to the patient, but because of the negative effects associated with prolonged time in orthodontic appliances that include: patient difficulty with oral hygiene, dental root resorption, decalcification, and chronic gingivitis. It is also an inefficient use of the treating doctors' time and resources to keep patients in treatment longer than necessary.

Statement of Purpose

The purpose of this study was to survey a large number of digital patient records via Ortho2 and Dolphin Imaging, to evaluate treatment results using the PAR scores of the corresponding dental models, and to evaluate average treatment times for comprehensive orthodontic treatment in a graduate orthodontic clinic. The primary aims were: (1) to compare treatment time to the consistency of attending doctor coverage on each case, and (2) to compare results using PAR scores to consistency of attending doctor coverage on each case. This was done by evaluating the percentage of visits when

patients were seen by a “primary” attending doctor and by the “original” attending doctor. The primary attending doctor was the doctor whose name was “signed” most often on the patient's chart. The original attending doctor was the doctor whose name appeared on the original treatment plan.

Null Hypothesis

Increasing frequency of attending doctor supervision of resident orthodontic cases has no effect on treatment times or results.

Significance of the Study

This study provides data regarding treatment times and results that has not yet been available for the finished cases produced by a graduate orthodontic clinic. This study differs from previous studies in that no published literature has examined the effect of attending doctor variability on orthodontic treatment times and results in a graduate clinic environment. This information may be of value when discussing expectations and goals for patient treatment times and outcomes in graduate teaching institutions.

Review of the Literature

One of the goals in orthodontic treatment is to accomplish what needs to be done for a patient as efficiently as possible. Unnecessarily prolonged treatment time, in addition to being a poor use of the doctor’s resources and potentially frustrating for the patient, may have substantial untoward effects including increased caries risk and increased risk of root resorption.[1, 2, 3, 4]

An agreed upon standard or average treatment time for satisfactory phase two orthodontic treatment is difficult to find in the literature. Recent research has reported the typical orthodontic treatment time with fixed appliances to be 15-24 months.[5]

Claims that certain types of fixed appliances are superior to others in their ability to expedite treatment time or improve results remain unsubstantiated by research.[5,6]

It has been noted that time spent in space closure in extraction cases may have an effect on treatment duration.[6,7] Impacted canines may also be a factor that leads to prolonged treatment times.[8,9]

Case difficulty is certainly one of the most important variables in determining treatment time. In one recent study performed in the graduate clinic at Indiana University, researchers showed a significant relationship between the American Board of Orthodontics Difficulty Index (DI) and treatment time in analysis of over 700 cases were analyzed, and a significant relationship was found between the DI and treatment time.[8]

Orthognathic surgery is another factor that can have a significant impact on orthodontic treatment time. A research project in Sweden looked at patients who underwent surgery combined and orthodontic treatment, and found an average total time of 27.8 months.[10] A related study in the UK reported on duration of treatment for orthodontic cases treated with orthognathic surgery, and found an average treatment time of 30.6 months.[11]

Patient compliance with home care instructions and oral hygiene instructions can also have a significant impact on treatment time. Less compliant patients tend to have longer treatment times.[12]

Another important variable that could affect treatment time which may not exist in private orthodontic offices is variability in the patients' treatment provider. This might apply to graduate schools or other clinic settings where patients see more than one doctor during their treatment. One might expect that seeing multiple doctors could result in greater treatment duration compared to seeing the same doctor at every appointment.

A study conducted in Ireland and the UK looked to address this possibility using 183 patients from postgraduate teaching programs. The researchers evaluated cases treated by one operator and by multiple operators. Peer Assessment Rating scores were used to evaluate the quality of the orthodontic treatment provided. The study concluded that quality of treatment outcomes was not affected by number of operators. However, it was found that changes in the operator did have a significant effect on total treatment time.[13]

We must also recognize that predictions and estimates of treatment times are very important to our patients. In a publication on patients' most common recommendations for orthodontists, "true and accurate timing estimates" was ranked second only to "reduction in treatment fees."[14] Patients who are given accurate information regarding predicted treatment times are more likely to be satisfied with treatment overall, and will have more realistic expectations about the outcomes of their treatment.[15] In addition, satisfied patients are more likely to refer other patients to the office where they were treated.[16]

A 2009 survey of Dutch and English parents and children evaluated expectations of orthodontic treatment prior to any orthodontic consultation, and they concluded that treatment times, among other important expectations, must be discussed early on with

patients and parents to avoid disappointments regarding time commitment and improve the orthodontic treatment experience.[17]

Although we know treatment times are very important to our patients, the importance seems to fade after several years of being finished with orthodontic treatment. A recent survey of patients who were five or more years post-treatment found that the only variable that had an effect on long-term satisfaction was the long-term PAR score. That is, it seems that post-retention patients report satisfaction with orthodontic care when they are satisfied with the current status of their dentition.[18]

The literature reviewed here confirms that orthodontic treatment times can vary widely, and it is beneficial to the patient and the orthodontist to provide reliable information about the duration of treatment.

The PAR index evaluates orthodontic cases before and after treatment, and evaluates at the amount of change achieved during treatment. This index assigns numerical values to the traits that comprise a malocclusion. The score increases as the malocclusion severity increases. This scoring system originated in the United Kingdom, and has been used with some frequency in orthodontic practice and in studies performed there. It was validated in the UK by a panel of 74 dentists (including 22 orthodontic specialists) in 1991.[13,19,20]

The PAR index has been adapted for use in North America, and has been affirmed as a good and appropriate measure of treatment difficulty and treatment results.[21,22]

As computer-based imaging and modeling has become more widespread in dentistry and orthodontics, many studies have been done on the use of digital dental models and their comparison to stone models. Generally, and for PAR scoring in

particular, digital models have been found to be an acceptable alternative to stone models.[23,24]

PAR may be used to measure treatment outcomes in several ways: the total point reduction in the PAR score, the T2 PAR score only, or the percentage reduction in the PAR score (Table 1).

Table 1. Evaluation of case outcomes using PAR scores.

Point Reduction in PAR Score	Interpretation of Outcome
≥ 22 points	Great improvement
< 22 points but ≥ 30%	Improvement
< 30%	No improvement
T2 PAR Score	**Interpretation of Outcome**
≤ 5	Excellent
> 5 and <10	Acceptable
≥ 10	Residual malocclusion
Percent Reduction in PAR Score	**Interpretation of Outcome**
70-100%	Great improvement
50-69%	Improvement
30-49%	Little improvement
< 30%	No improvement

The literature has accepted that a 22 point reduction in score may be considered a "great improvement" provided by treatment. A reduction less than this but more than 30% of the T1 score may be considered an "improved" condition, and a less than 30% reduction indicated "no improvement" provided by treatment.[25,26] Another way to evaluate outcomes would be with T2 PAR score only. In a 2007 article, it was stated that a "posttreatment PAR score of 5 or less is considered an excellent outcome, between 5 and 10 points is considered an acceptable result, and a posttreatment PAR score above 10

indicates a residual malocclusion."[27] When looking at percentage reduction in PAR score only, the following categories are generally recognized for evaluation of PAR reduction: 70-100% = great improvement, 69-50% = improvement, 49-30% = little improvement, less than 30% = no improvement.[28,29]

Methods and Materials

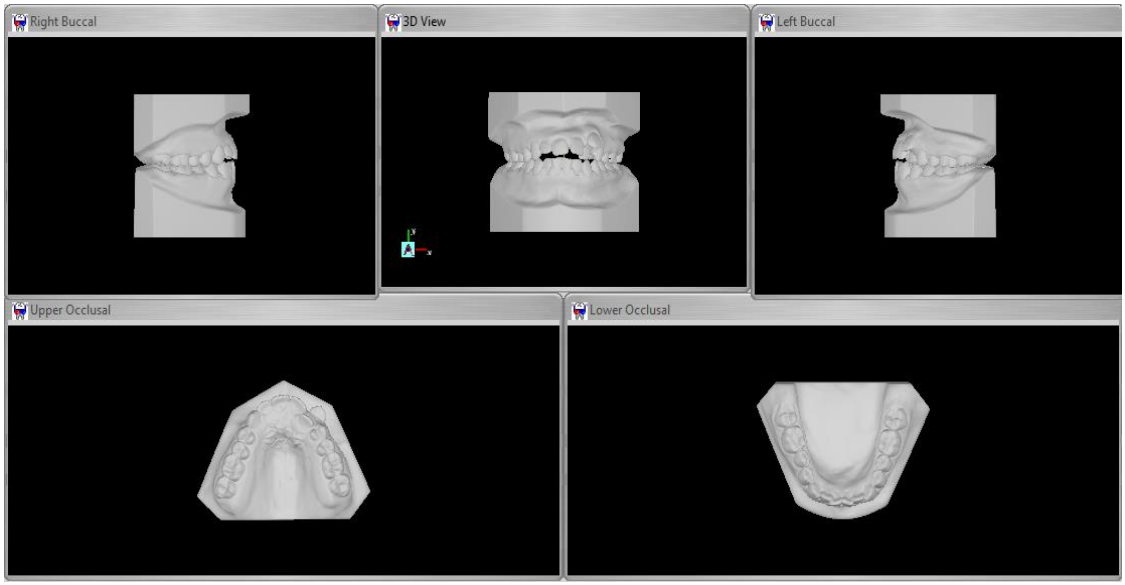
This study was reviewed and approved by the Institutional Review Board at Loma Linda University. Patient records were collected randomly from a list of all recently debanded orthodontic cases (cases in "active retention" status) in the Loma Linda University Graduate Orthodontic Clinic. The majority of these were less than two years out of active treatment. Ortho2 (v. View Point 9) and Dolphin Imaging (v. 11.5 Premium) were the digital charting systems. All cases had been approved for deband by the attending doctor and the patient, parent, or legal guardian.

Exclusion criteria for this study included the following: (1) phase one or limited treatments, (2) complex inter-disciplinary/integrative cases (for example, patients who were being set up for partial dentures or patients who had experienced significant periodontal disease), (3) orthognathic surgical cases, (4) craniofacial anomalies (for example, cleft lip/palate cases) (5) patients who were debanded prior to completing treatment, (6) patients whose charts did not contain all of the desired information were excluded.

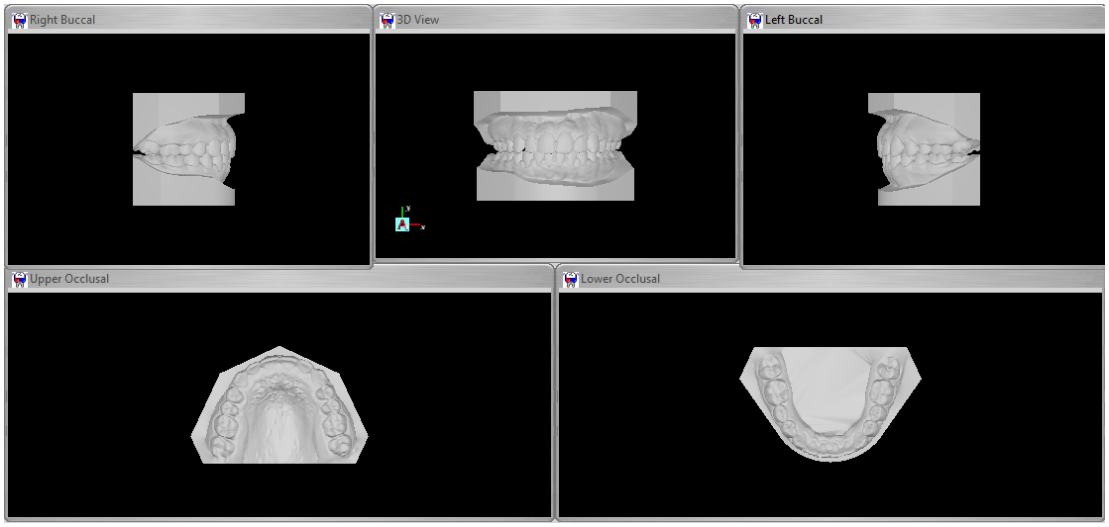
Data collected from each chart via Dolphin Imaging or Ortho2 included: (1) age at start of treatment, rounded to the nearest tenth of a year, (2) gender, (3) total treatment time from delivery of first appliances (fixed or removable) to deband appointments, in

months, (4) number of total appointments from delivery of appliances to deband, (5) number of missed and cancelled appointments, as recorded in Ortho2, (6) whether the patient had bicuspid extraction(s) in conjunction with treatment, (7) number of appointments covered by the primary attending doctor (the primary attending doctor was defined as the doctor who signed the most patient visits during active treatment), (8) number of appointments covered by the original attending (which was the attending who signed the original treatment plan and may or may not have been the same as the "primary" attending), (9) number of times that the original treatment plan was officially changed, (10) any unusual treatment situation or complication that did not fall in the exclusion criteria was noted, especially if the treatment time for the case appeared unusually long or short.

Stone models were scanned into digital format using an Ortho Insight 3D scanner (Fig 1). PAR index at T1 and T2 was collected (Fig 2). To provide the most accurate and unbiased values possible for PAR, these scores were measured from anonymized digital models by a rater who was calibrated in PAR scoring. The UK PAR scoring system was used.



T1 Digital Models



T2 Digital Models

Fig 1. An example of T1 and T2 digital models displayed in Ortho Insight 3D.

PAR SCORING SHEET

Name

CASE NUMBER		Pre-Treatment		Date										UN-WEIGHTED TOTAL	WEIGHTED TOTAL
PAR COMPONENTS	RIGHT												LEFT		
Upper anterior segments	3-2		2-1		1-1		1-2		2-3						X1
Lower anterior segments	3-2		2-1		1-1		1-2		2-3						X1
Buccal occlusion	Antero-posterior				Right		Left								X1
	Transverse				Right		Left								X1
	Vertical				Right		Left								X1
Overjet	Positive				Negative										X6
Overbite	Overbite				Openbite										X2
Centre line															X4
													TOTAL		

CASE NUMBER		Post-Treatment		Date										UN-WEIGHTED TOTAL	WEIGHTED TOTAL
PAR COMPONENTS	RIGHT												LEFT		
Upper anterior segments	3-2		2-1		1-1		1-2		2-3						X1
Lower anterior segments	3-2		2-1		1-1		1-2		2-3						X1
Buccal occlusion	Antero-posterior				Right		Left								X1
	Transverse				Right		Left								X1
	Vertical				Right		Left								X1
Overjet	Positive				Negative										X6
Overbite	Overbite				Openbite										X2
Centre line															X4
													TOTAL		

ASSESSMENT OF OUTCOME

PAR SCORE		IMPROVEMENT	
Change in PAR score		Greatly improved	
% change in PAR score		Improved	
		Worse or no different	

Fig 2. An example of a PAR scoring sheet, showing the components of the PAR score, obtained from the British Orthodontic Society, originally published by Stephen Richmond.[30,31]

There were 364 patients found to be "in active retention" (patients being seen regularly at the clinic for retainer checks) at the time this study was initiated. After applying the exclusion criteria to this group, our sample size was reduced to 191 subjects. In addition, we were able to collect all the desired data except PAR scores on 98 subjects, giving us a total of 289 subjects for which we collected and recorded data in this study (Table 2).

Table 2. Sample Divisions.

Sample Divisions	PAR Scores	Number (n)
Main Group Sample	Yes	191
Non-PAR Group Sample	No	98
Total Group Sample	Yes + No	289

First, the main group sample was divided into three groups based on percentage of primary attending (PA) coverage (Table 3). The low PA coverage group included primary attending coverage of 18-50%. There were 65 subjects in the low PA coverage group. The medium PA coverage group included primary attending coverage of over 50% and less than 65%. The high PA coverage group included primary attending coverage of 65% and above. The medium and high PA coverage groups both had 63 subjects.

Table 3. Primary Attending Coverage Groups.

Primary Attending (PA) Coverage Group	Coverage Percentage	Number (n)
Low PA Coverage	18-50%	65
Medium PA Coverage	50-65%	63
High PA Coverage	>65%	63

These PA coverage groups were compared with respect to: T1 PAR scores, T2 PAR scores, change in PAR scores (PAR chg), percent change in PAR scores (PAR % chg), treatment time (Tx Time), age at T1 (Start Age), total number of appointments (Total Appts), missed appointments (Missed Ap), and cancelled appointments (Cancelled Ap).

The main group sample was divided a second time based on percentage of original attending (OA) coverage (Table 4). These groups were also split into low OA Coverage, medium OA coverage, and high OA coverage designations as well, and the splits were: 0 to 47.6%, over 47.6 up to 64.3%, and over 64.3 up to 96.7%. The low, medium, and high coverage groups had 64, 65, and 62 subjects, respectively.

Table 4. Original Attending Coverage Groups.

Original Attending (OA) Coverage Group	Coverage Percentage	Number (n)
Low OA Coverage	<47.6%	64
Medium OA Coverage	47.6-64.3%	65
High OA Coverage	>64.3%	62

These OA coverage groups were compared with respect to: T1 PAR scores, T2 PAR scores, change in PAR scores (PAR chg), percent change in PAR scores (PAR % chg), treatment time (Tx Time), age at T1 (Start Age), total number of appointments (Total Appts), missed appointments (Missed Ap), and cancelled appointments (Cancelled Ap).

In the interest of looking at T1 PAR effect on other variables, the 191 subjects were also divided into three groups by T1 PAR scores (Table 5). The groups were designated “low”, “medium”, and “high T1 PAR”. The T1 PAR scores comprising the groups were

3-17 (low), 18-29 (medium), and 30-54 (high). There were no T1 PAR scores lower than 3 or higher than 54. The groups contained 66, 65, and 60 subjects, respectively.

Table 5. T1 PAR Score Groups.

T1 PAR Score Group	T1 Score Range	Number (n)
Low T1 PAR Score	3 to 17	66
Medium T1 PAR Score	18 to 29	65
High T1 PAR Score	30 to 54	60

These T1 PAR groups were compared with respect to: percentage change in PAR scores (PAR % chg), percentage primary attending appointments (%PA Appts), and treatment time (Tx Time).

Statistical Analysis

One-way Analysis of Variance testing (ANOVA) was used as the main statistical test. Further analysis was done using Pearson Correlation Tests and Comparisons of Means.

Results

Summaries of the results pertaining to the null hypothesis are presented in Tables 6 and 7. Information regarding other variables recorded and evaluated are presented in chapter three.

Using ANOVA testing, it was found that low, medium, and high PA coverage groups had average treatment times of 24.43, 26.38, and 23.56 months respectively. Average percent changes in PAR for the three groups were 81.83, 83.79, and 86.43%,

respectively. These treatment times and PAR results were not statistically significantly different among the three groups (P = 0.128 and 0.234, respectively) (Table 6).

Table 6. Summary of Findings for Primary Attending Groups. This table shows the summary of findings based on the percentage of visits a patient had with their primary attending doctor.

Factor	%PA Appts	N	Mean	Std. Deviation	Std. Error	Mean Lower Bound	Mean Upper Bound	P-Value
T1 PAR	Low	65	21.18	10.53	1.31	18.58	23.79	0.056
	Medium	63	24.90	11.65	1.47	21.97	27.84	
	High	63	25.62	11.27	1.42	22.78	28.46	
T2 PAR	Low	65	2.89	1.92	0.24	2.42	3.37	0.602
	Medium	63	3.11	2.17	0.27	2.56	3.66	
	High	63	2.76	1.78	0.22	2.31	3.21	
PAR Chg	Low	65	18.29	10.46	1.30	15.70	20.89	0.052
	Medium	63	21.79	11.55	1.45	18.89	24.70	
	High	63	22.86	11.16	1.41	20.05	25.67	
PAR % Chg	Low	65	81.83	16.49	2.04	77.75	85.92	0.234
	Medium	63	83.79	16.40	2.07	79.66	87.92	
	High	63	86.43	12.47	1.57	83.29	89.57	
Tx Time	Low	65	24.43	7.46	0.93	22.58	26.28	0.128
	Medium	63	26.38	8.36	1.05	24.28	28.49	
	High	63	23.56	8.02	1.01	21.54	25.58	
T1 Age	Low	65	16.60	7.82	0.97	14.66	18.54	0.747
	Medium	63	16.85	9.30	1.17	14.51	19.19	
	High	63	15.79	7.32	0.92	13.94	17.63	
Total Appts	Low	65	24.62	7.67	0.95	22.72	26.52	0.128
	Medium	63	26.35	7.88	0.99	24.36	28.33	
	High	63	23.65	7.02	0.88	21.88	25.42	
Missed Appt	Low	65	2.62	2.94	0.36	1.89	3.34	0.177
	Medium	63	2.56	2.67	0.34	1.88	3.23	
	High	63	1.84	2.09	0.26	1.32	2.37	
Cancelled Appt	Low	65	2.00	1.96	0.24	1.51	2.49	0.183
	Medium	63	2.79	2.72	0.34	2.11	3.48	
	High	63	2.54	2.70	0.34	1.86	3.22	

These tests were repeated for the low, medium, and high OA coverage groups. Average treatment times were 23.98, 26.32, and 24.02 months, respectively. Average percent changes in PAR scores were 82.69, 84.28, and 85.05%, respectively. These treatment times and PAR results were also not statistically significantly different among the three groups (P = 0.166 and 0.678, respectively) (Table 7).

Table 7. Summary of Findings for Original Attending Groups. This table shows the summary of findings based on the percentage of visits a patient had with their primary attending doctor.

Factor	%OA Appts	N	Mean	Std. Deviation	Std. Error	Mean Lower Bound	Mean Upper Bound	P-Value
T1 PAR	Low	64	22.13	10.23	1.28	19.57	24.68	0.207
	Medium	65	23.86	11.97	1.48	20.90	26.83	
	High	62	25.69	11.41	1.45	22.79	28.59	
T2 PAR	Low	64	2.84	1.87	0.23	2.38	3.31	0.881
	Medium	65	3.02	2.10	0.26	2.50	3.53	
	High	62	2.90	1.92	0.24	2.42	3.39	
PAR Chg	Low	64	19.28	10.31	1.29	16.71	21.86	0.211
	Medium	65	20.85	11.62	1.44	17.97	23.73	
	High	62	22.79	11.44	1.45	19.88	25.70	
PAR % Chg	Low	64	82.69	16.42	2.05	78.59	86.79	0.678
	Medium	65	84.28	12.85	1.59	81.09	87.46	
	High	62	85.05	16.53	2.10	80.85	89.25	
Tx Time	Low	64	23.98	7.36	0.92	22.15	25.82	0.166
	Medium	65	26.32	8.57	1.06	24.19	28.44	
	High	62	24.02	7.90	1.00	22.01	26.02	
T1 Age	Low	64	16.10	7.72	0.97	14.17	18.03	0.921
	Medium	65	16.45	7.49	0.93	14.60	18.31	
	High	62	16.69	9.31	1.18	14.33	19.06	
Total Appts	Low	64	24.55	7.99	1.00	22.55	26.54	0.332
	Medium	65	25.97	7.71	0.96	24.06	27.88	
	High	62	24.05	6.97	0.88	22.28	25.82	
Missed Appt	Low	64	2.23	2.55	0.32	1.60	2.87	0.050
	Medium	65	2.94	2.99	0.37	2.20	3.68	
	High	62	1.82	2.10	0.27	1.29	2.36	
Cancelled Appt	Low	64	2.47	2.71	0.34	1.79	3.15	0.961
	Medium	65	2.37	2.10	0.26	1.85	2.89	
	High	62	2.48	2.67	0.34	1.81	3.16	

For both of the above sets of groups, there were no significant differences in T1 PAR scores, T2 PAR scores, total appointment number, missed appointments, cancelled appointments, or patient age at the start of treatment (P was greater than 0.050) (Table 6, Table 7).

For the low, medium, and high T1 PAR groups: average percent changes in PAR score were 74.30, 87.17, and 91.22%, respectively. Average percent of appointments covered with the primary attending doctor were 53.29, 61.18, and 60.74%, respectively. Average treatment times were 21.98, 25.30, and 27.33 months, respectively. For all of these categories, there were statistically significant differences in percent change in PAR

(P = 0.000), treatment time (P = 0.008), and the percent of primary attending coverage (P = 0.001) between the low T1 PAR and the medium T1 PAR groups as well as the low T1 PAR and high T1 PAR groups. The medium and high T1 PAR groups were not statistically significantly different from each other (Table 8).

Table 8. Summary of Findings for T1 PAR Groups. This table shows findings based on categories of Low, Medium, and High T1 PAR scores (CI = 95% Confidence Interval).

Factor	T1 PAR Groups	N	Mean	Std Dev	Std Error	CI Lower Bound	CI Upper Bound	P-Value
PAR % Chg*	Low	66	74.30	20.75	2.55	69.20	79.40	0.000
	Medium	65	87.17	8.23	1.02	85.13	89.21	
	High	60	91.22	5.96	0.77	89.68	92.76	
% PA Appts*	Low	66	53.29	16.63	2.05	49.20	57.38	0.008
	Medium	65	61.18	16.99	2.11	56.96	65.39	
	High	60	60.74	14.52	1.87	56.98	64.49	
Tx Time*	Low	66	21.98	7.70	0.95	20.08	23.87	0.001
	Medium	65	25.30	7.08	0.88	23.55	27.05	
	High	60	27.33	8.40	1.09	25.15	29.50	

** All groups are significantly different except for Medium and High.*

Discussion

When the main study group of 191 subjects was split into thirds by primary and original attending coverage, we found that there were no significant differences in T1 PAR scores, T2 PAR scores, total appointments, missed appointments, cancelled appointments, or patient age at the start of treatment between any of the three groups in either case. This would be expected because the distribution of incoming LLU orthodontic clinic patients to the assigned attending doctors is essentially random. This was a useful finding to have confirmed, however, because if any of these factors had not been evenly distributed among the groups, they may have affected treatment times or results.

When looking at the results for the low PA, medium PA, and high PA groups, we see that the mean PAR percent changes were 81.83, 83.79, and 86.43%, respectively. It is interesting to note that the mean tends to increase (a higher number indicates greater improvement in the case) as the attending coverage moves from low to high, even though the differences were not statistically significant (P=0.234). It is also interesting to note that the average of the raw PAR score change increases as the attending coverage moves from low to high. The means were 18.29, 21.79, and 22.86 points, respectively, for the three groups. These differences were also not clinically significant, but the P value was much lower (P=0.052).

Nearly identical outcomes are found for these categories when the OA group is split and evaluated. This similarity is to be expected, due to the fact that the primary attending doctor and the original attending doctor were found to have the same number of appointments for most of the subjects (in fact, the original attending was the primary attending, as defined in our study, for 156 of the 191 cases in the main group, and for 230 of the 289 cases in the total group).

When treatment time is evaluated for both OA and PA groups, it is interesting to note that the medium coverage groups have the highest mean treatment time. However, the range of the means for both instances is between 23.5 and 26.5 months, and the differences in treatment times for low, medium, and high coverage groups in the PA and OA groups were not statistically significant.

These results are slightly different than those of McGuinness, et al., who looked at similar factors for operators (instead of attending doctors) and found that changes in operator did prolong treatment time.[13] In contrast, we found that attending doctor

changes did not significantly prolong treatment time. However, both studies showed that operator/attending changes did not significantly impact the quality of the finished treatment result.

In order to draw conclusions regarding the quality of the finished cases in this study, it is important to look more closely at the PAR values in the data and the meanings pertaining to case difficulty and results that may be inferred from the raw numbers. Of the 191 main study group subjects, two had percent changes in PAR less than 30%, indicating negligible improvement obtained with treatment. The rest of the cases were "improved" or "greatly improved". It was found that 8 subjects showed between 30 and 50% reduction, indicating "little improvement", 16 showed between 50 and 70% reduction, indicating "improvement", and 165 showed 70 to 100% reduction, indicating "great improvement". Using percentage reduction only for the 191 cases evaluated, 1.0% of cases showed no improvement, 4.2% showed little improvement, 8.4% showed improvement, and 86.4% showed great improvement.

Using the 22 point reduction as a cut-off for "great improvement" provided by treatment, 89 patients (or 46.6% of the PAR group) showed great improvement. Removing those that had less than a 22-point T1 PAR (and as such could not obtain "great improvement" using this cut-off), 83% of cases showed "great improvement".

Using only T2 PAR point values to assess outcome: 2 subjects had scores of 10, 17 had scores of 6 to 9, 5 had a score of 5, and the remaining 167 had scores under 5. Using T2 PAR scores only, this indicates that 172 of 191 subjects (or 90% of subjects) had excellent treatment outcomes.

It was an advantage to have the expertise of an outside rater who was calibrated in PAR scoring, thus providing unbiased evaluations of the T1 and T2 scores and degrees of change in treatment. During data analysis, the main study group of 191 patients was also split into thirds by T1 PAR (low, medium, and high). Low T1 PAR scores showed less improvement over the course of treatment than medium or high T1 PAR scores. This is a result that could be expected, since a low T1 PAR score means there is less malocclusion to improve.

While the mean percent changes for the high group were higher than the medium group (91.22 compared to 87.17%), those numbers were not statistically significantly different. Treatment times were also lower on average for the low T1 PAR group at 21.98 months, which was significantly different from the other two groups. The medium and high T1 PAR groups were again not significantly different from each other, at 25.3 and 27.3 months, respectively. What was interesting was that low T1 PAR had less consistency of primary attending coverage (53.29% compared to over 60% in the other two groups), and this difference was statistically significant. One possible explanation for this could be that cases that are less challenging at T1 do not need to be as rigidly scheduled with the same attending doctor.

Based on the results of this study, the null hypothesis cannot be rejected. This is a positive result, because some variation in attending doctor coverage is an often unavoidable situation in clinic environments. Ideally, this should not be disadvantageous for our patients.

Limitations

This study examined general trends in PAR scores, treatment times, and attending doctor changes in a graduate orthodontic clinic. It did not include a detailed evaluation of complexities present in the cases evaluated. There are other extraneous factors that may affect treatment times and results that were not evaluated in this study, including but not limited to resident doctor changes and frequent school breaks and holidays.

Conclusions

This study shows that the variation in attending doctor coverage at the LLU graduate orthodontic clinic does not lengthen time of orthodontic treatment or reduce the quality of treatment results. In addition, the results of this study demonstrate that average treatment times in the LLU graduate clinic are well within accepted published "norms", and that our results (as measured by PAR scores) for the majority of our cases meet or exceed what is considered clinically acceptable.[25,26,27,28]

CHAPTER THREE

EXPANDED DISCUSSION

Additional Results

In addition to the ANOVA tests used for the main questions pertaining to the study, Pearson Correlation was used to look at several other variables, which are discussed below. A correlation score of 0 to 0.3 indicates a weak correlation, 0.31 to 0.5 indicates a moderate correlation, 0.51 to 0.7 indicates a strong correlation, and greater than 0.7 indicates a very strong correlation.

A correlation was found between T1 PAR scores and number of total appointments (r =0.248, P=0.001), as well as T1 PAR scores and total treatment time (r =0.280, P =0.000) (Table 9).

Table 9. Correlations with T1 PAR Score.

		Total Appointments	Treatment Time
T1 PAR	Pearson Correlation	0.248*	0.280*
	Sig. (2-tailed)	0.001	0.000

*Correlation is significant at the 0.05 level (2-tailed).

For the main study group of 191 subjects with PAR scores, average treatment time was 24.79 months, with a standard deviation of 8.00. Average number of appointments was 24.87, with a standard deviation of 7.58 (Table 10).

Table 10. Treatment Time and Appointment Number for the Main Group of 191 Patients.

	Treatment Time	Total Appointments
N	191	191
Mean	24.79	24.87
Std. Deviation	8.00	7.58

For the total group of 289 subjects, average treatment time was 27.17 months, with a standard deviation of 9.31. Average number of appointments was 26.89, with a standard deviation of 8.76 (Table 11).

Table 11. Treatment Time and Appointment Number for the Total Group of 289 Patients.

	Treatment Time	Total Appointments
N	289	289
Mean	27.17	26.89
Std. Deviation	9.31	8.76

For both the main study group and the total group, total appointment number was found to be strongly correlated with total treatment time ($r = 0.822$ and 0.832, $P = 0.000$ and 0.000, respectively). For both groups, missed appointments were found to be weakly correlated with total treatment time. Cancelled appointments were very weakly correlated with treatment time for the total group only (Table 12, Table 13).

Table 12. Correlations with Treatment Time for the Main Group of 191 Patients.

		Treatment Time
Missed Appts	Pearson Correlation Sig. (2-tailed)	0.333* 0.000
Total Appts	Pearson Correlation Sig. (2-tailed)	0.822* 0.000
Cancelled Appts	Pearson Correlation Sig. (2-tailed)	0.119 0.100

*Correlation is significant at the 0.05 level (2-tailed).

Table 13. Correlations with Treatment Time for the Total Group of 289 Patients.

		Treatment Time
Missed Appts	Pearson Correlation Sig. (2-tailed)	0.311* 0.000
Total Appts	Pearson Correlation Sig. (2-tailed)	0.832* 0.000
Cancelled Appts	Pearson Correlation Sig. (2-tailed)	0.145* 0.014

*Correlation is significant at the 0.05 level (2-tailed).

In the total group of 289 subjects, 46 patients were treated with extraction of one or more permanent teeth (not including third molars), and 243 were treated without extraction. Average treatment times were 26.53 months for the non-extraction cases, and 30.53 months for the extraction cases. These treatment times were found to be significantly different (P=0.003). Average percent changes in PAR scores were 83.85% for the non-extraction cases and 86.00% for the extraction cases. The difference in percent change in PAR between the two groups was not statistically significant (P=0.454) (Table 14).

Table 14. Comparison of Means for Extraction and Non-extraction Cases.

	Extraction	N	Mean	Std. Deviation	P-Value
Treatment Time	No	243	26.53	9.48	0.003
	Yes	46	30.53	7.63	
PAR % Chang	No	163	83.65	16.11	0.454
	Yes	28	86.00	9.06	

Additional Discussion

Correlations with T1 PAR

One might expect that as T1 PAR increases (indicating an increase in case difficulty), the treatment times and numbers of appointments would increase. The data analysis confirmed a weak correlation between T1 PAR scores and both treatment time (0.280) and total appointments (0.248) (Table 9). This finding is in agreement with Parrish, et al., who reported that higher ABO DI scores (which also measure complexity in a case at the start of treatment) were predictive of longer treatment times.[8] Total appointments and treatment time were both very strongly correlated with each other in both the main group of 191 subjects and the total group of 289 (correlation was >0.8 in both cases). This would likely be expected to be the case for most orthodontic patients, as most patients are seen at regular intervals throughout treatment, regardless of length of treatment.

Correlations with Treatment Times

Overall mean treatment times for the main group of 191 patients and the total group of 289 patients were 24.79 months and 27.17 months, respectively. Average total appointment numbers were 24.87 and 26.89, respectively (Table 10, Table 11). Treatment

time increases were weakly correlated with missed appointments, but not correlated with cancelled appointments in the main group and very weakly correlated with cancelled appointments in the total group (Table 12, Table 13). From a patient compliance standpoint, this finding makes sense, as the "cancelled" appointments designate an instance where a patient had called to communicate that they were not coming in (and often to reschedule), and the "missed" appointments typically indicate that a patient had failed to show and had not called in. This finding supports the findings of Beckwith, et al., who concluded in their study that poor patient compliance prolonged treatment time.[12]

Extraction and Non-Extraction Cases

Finally, this study evaluated extraction versus non-extraction treatment times and results. Out of 289 subjects, 243 were treated non-extraction (84%), indicating that LLU treats the large majority of its cases without extraction of permanent teeth. There was a significant difference in treatment time for non-extraction compared to extraction cases (mean time 26.53 months compared to 30.53 months) (Table 14, Fig 3).

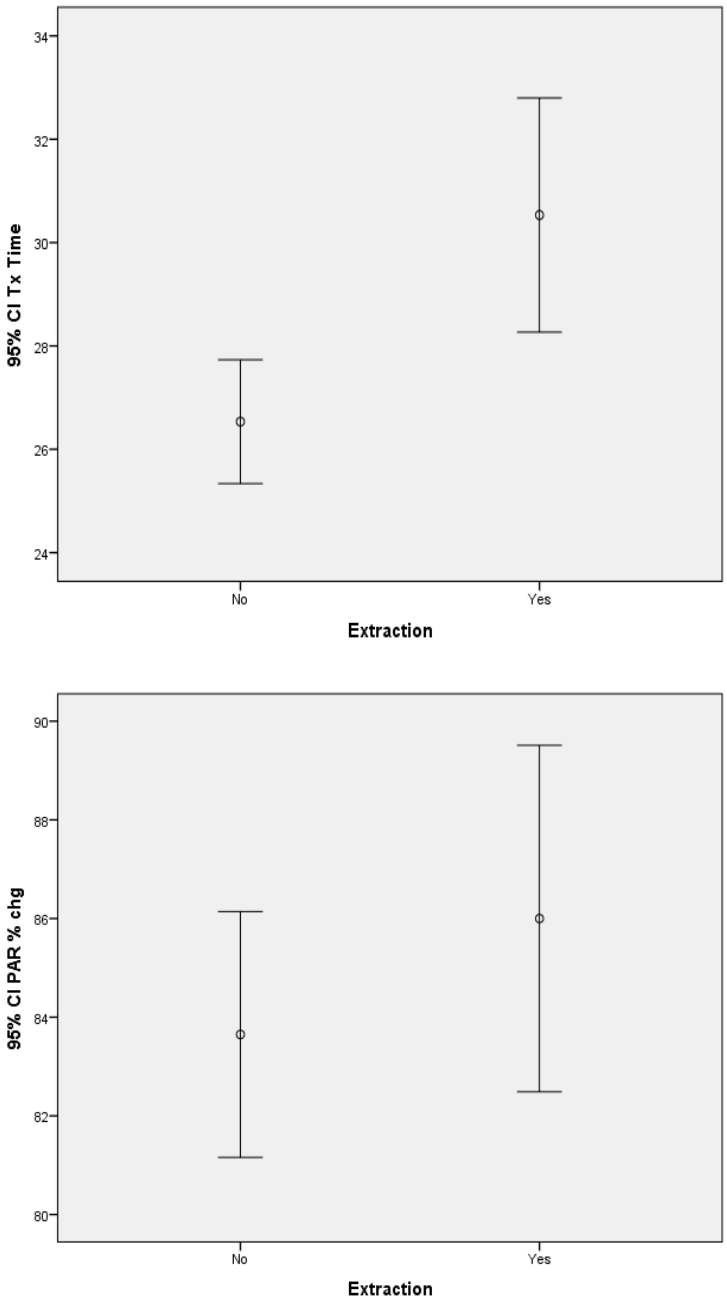


Fig 3. Graphic representation of data regarding treatment times and results for extraction and non-extraction cases.

Of those for whom PAR scores were recorded, there was no significant difference in results as evaluated by percent change in PAR (P=0.454). Regarding extraction cases at LLU, the conclusion may be drawn that they average 4 months longer in treatment than

non-extraction cases, but that the treatment results are similar. This is in agreement with other recent studies, which have found that closing extraction spaces tends to prolong treatment time.[6,7]

Suggestions for Future Research

This group of patients could be compared to a group of patients who were treated with orthognathic surgery in addition to orthodontics in the graduate school clinic environment. It would be interesting to know if treatment times and results show any variation among surgical and non-surgical cases. Extraction versus non-extraction for both surgical and non-surgical cases could also be compared. In addition, to further evaluate the effect of operator changes, it would be interesting to look at resident doctor variability on each case in addition to the variability in attending doctor coverage.

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