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Factors affecting treatment duration in a group of Egyptian Angle class I patients; a retrospective study.

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Abstract:
Introduction: *Pretreatment characteristics can assist orthodontists in accurately estimating treatment duration. The most frequent question asked by neworthodontic patients is: How long will I need to wear my braces? Several factors can influence the answer to this question. The purpose of this retrospective study was to identify some of the factors that influence orthodontic treatmentduration. Few studies have attempted to evaluate these factors*
Methods: *This retrospective study included 276 (66 males and 210 females) finished Angle class I patients. The sample was gathered from 2 private clinics (132 patients) and one dental school, the orthodontic department of Cairo University, (144 patients). Factors that were investigated: Gender, Age, Oral hygiene, Missed appointments , Elastic wear , Broken appliances, Amount of overbite / open bite, ANB angle, Transverse discrepancies, Impacted teeth, Amount of crowding, Extraction versus nonextraction treatment plans, type of clinic (private clinic vs. dental school).*
Results, conclusions and, limitations*,Of all the factors investigated, ANB, Gender, missed appointments, amount of crowding, impactions, and extraction treatment plans , appear to have a statistically significant effect on treatment duration. The quality of the finished cases and the appropriateness of the original diagnosis and treatment plan were not evaluated. Developing an objective assessment to evaluate these areas may be important for increasing our understanding of treatment time variation. Incomplete files was the main problem encountered during the course of this study.*

I. Introduction

Studies that identify relationships between pretreatment characteristicsand orthodontic treatment duration providedata pertinent for evidence-based orthodontics. This isan important topic for orthodontists because ‘‘true andaccurate timing estimates’’ is just as important as ‘‘reductionin treatment fees’’ when it comes to patients’recommendations for orthodontists. Furthermore, orthodontistsusually have a fixed treatment fee, buthave the ability to identify patients who are more likelyto have shorter or longer than average treatment durationswould allow them to adjust fees accordingly.Previous studies assessed the variations in treatmentduration with the following possible variables: extractions,peer assessment rating (PAR) score, oral hygiene during treatment, number of phases of treatment, headgear,age, sex, midline, type of appliances, crowding,Angle classification of molar relationship, pretreatmentoverbite and overjet, impacted canines, missing teeth,orthognathic surgery, various cephalometricmeasurements,number of missed appointments, number of brokenappliances, total number of office visits, timebetween appointments, and type of clinic (privatepracticevs graduate orthodontic clinic). The aim of this retrospective study was to evaluate the effects of a group of factors on the duration of orthodontic therapy of a group of Angle Class I malocclusion patients.

II. Material And Methods

This retrospective study included 276 (66 males and 210 females) finished Angle class I patients. The sample was gathered from 2 private clinics (132 patients), and one dental school, the orthodontic department of Cairo University (144 patients).
Criteria for Selection:

1. Angle Class I cases. All the patients started with a class I molar relationship, regardless of the canine relationship.
2. Single phase fixed appliance therapy, using preadjusted conventional metal brackets. Any cases with more than one phase were dismissed.
3. The 2 private clinics were managed by University professors. While the dental school sample (public clinic) was treated by post graduate students, and supervised by staff members of the department.
4. All cases had to have complete pretreatment records.
5. All the cases were started and finished between the years 2010 and 2013.

Factors that were investigated:

- Gender
- Age
- Oral hygiene
- Missed appointments
- Elastic wear
- Broken appliances
- Amount of overbite / open bite
- ANB
- Transverse discrepancies
- Impacted teeth
- Amount of crowding
- Extraction versus nonextraction
- Type of clinic (private clinic vs. dental school).
- Treatment duration

Methods:

The first factor to be studied was sex, followed by age in years. Then there were the 4 factors related to patient compliance: oral hygiene, missed appointments, elastic wear, and number of broken appliances. Those factors were each given a grade, excellent, good, fair, or poor.

Oral hygiene was determined by the operator himself and was recorded exactly as it was found in the file. Missed appointments were counted from the file, and given a grade according to their number. If the patient missed 2 or less appointments he was given an excellent grade, from 2 to 4 good, from 4 to 6 fair, and more than 6 missed appointments were given a poor grade. Appointments are scheduled every 2-4 weeks, and any missed appointments were recorded in the files.

Elastic wear was either given a grade, or ungraded, according to whether or not elastics were prescribed. If the patient was asked to wear elastics, the grade, from excellent to poor was determined according to the improvement recorded by the operator. Broken or debonded appliances were counted and given a grade. Those repositioned by the operator were not included as they are not a measure of compliance. If the patient debonded 2 or less brackets, he was given an excellent grade, from 2 to 4 good, from 4 to 6 fair, and more than 6 debonded brackets were given a poor grade.

Overbite was recorded as a percentage and was measured on the pretreatment study models. If there was an openbite, it was recorded in mms. ANB, was measured on the pretreatment lateral cephalometric radiograph.

Transverse discrepancies referred to any tooth (teeth) in crossbite and were divided into 3 categories, one tooth, 2 teeth, and a group of teeth (3 or more teeth). Impacted teeth included not only canines, but any impacted tooth (central incisor, lower second premolar).it was divided into 2 groups, one tooth, and more than one tooth. It should be noted that in case of absence of a transverse discrepancy or an impacted tooth, no score was given.Crowdingwas divided into 4 categories, first spacing (amount of space was not specified), then mild crowding(less than 3mm), moderate crowding (3-6 mm), and severe crowding (more than 7 mm)

Whether the treatment plan involved extractions or did not was a major contributing factor. The cases were divided into extraction and nonextraction. The type of clinic was described as either public or private. The public clinic is the Cairo University orthodontic department clinic. The private clinics are both managed by professors from the department.Lastly, the treatment duration, was recorded in months.

Statistical analysis:

Numerical data were presented as mean and standard deviation (SD) values. Treatment duration data showed non-parametric distribution, so Mann-Whitney U test was used to compare between two groups. Kruskal-Wallis test was used to compare between more than two groups. Mann-Whitney U test was used for pair-wise comparisons between the groups when Kruskal-Wallis test was significant.Spearman's correlation coefficient was used to determine significant correlations between treatment duration and different numerical data.The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

Results

Table (I): Results of Spearman's correlation coefficient for the correlation between treatment duration and numerical variables

Table (I): Results of Spearman's correlation coefficient for the correlation between treatment duration and numerical variables		
Variables	***Correlation coefficient***	***P-value***
Treatment duration & Age	-0.085	0.16
Treatment duration & Over bite	-0.016	0.793
Treatment duration & Open bite	-0.295	0.407
Treatment duration & ANB°	0.119	0.048*

**: Significant at P ≤ 0.05*

Table (II): Descriptive statistics and results of Mann-Whitney U test for comparison between treatment duration in males and females

Table (II): Descriptive statistics and results of Mann-Whitney U test for comparison between treatment duration in males and females			
	Male	***Female***	***P-value***
	(n=66)	***(n=210)***	
Treatment duration (Months)	24 ± 8.7	20.9 ± 8.3	0.009*
Mean ± SD			
****: Significant at P ≤ 0.05***			

Table (III): Descriptive statistics and results of Kruskal-Wallis test for comparison between treatment duration with different oral hygiene findings

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	Excellent	***Good***	***Fair***	***Poor***	***P-value***
	(n=50)	***(n=125)***	***(n=61)***	***(n=40)***	
Treatment duration (Months)	21.3 ± 8.9	21.8 ± 8.6	21.1 ± 8.1	22.8 ± 8.3	0.822
Mean ± SD					
****: Significant at P ≤ 0.05***					

Table (IV): Descriptive statistics and results of Kruskal-Wallis test and Mann-Whitney U test for comparison between treatment duration with different missed appointments findings

Table (IV): Descriptive statistics and results of Kruskal-Wallis test and Mann-Whitney U test for comparison between treatment duration with different missed appointments findings						
	Excellent	***Good***	***Fair***	***Poor***	***P-value***	
	(n=135)	***(n=114)***	***(n=20)***	***(n=7)***		
Treatment duration (Months)	19.2 ± 8.1 [d]	22.4 ± 6.9 [c]	28.6 ± 8.2 [b]	38.3 ± 9.7 [a]	<0.001*	
Mean ± SD						
****: Significant at P ≤ 0.05,***						

Different letters are statistically significantly different according to Mann-Whitney U test						

Table (V): Descriptive statistics and results of Kruskal-Wallis test for comparison between treatment duration with different elastic wear findings

Table (V): Descriptive statistics and results of Kruskal-Wallis test for comparison between treatment duration with different elastic wear findings					
	Excellent	***Good***	***Fair***	***Poor***	***P-value***
	(n=70)	***(n=106)***	***(n=11)***	***(n=3)***	
Treatment duration (Months)	21.4 ± 8.9	23 ± 7.8	28.1 ± 8.3	23 ± 6.1	0.051
Mean ± SD					
****: Significant at P ≤ 0.05***					

Table (VI): Descriptive statistics and results of Kruskal-Wallis test for comparison between treatment duration with different broken appliances findings

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duration with different broken appliances findings					
	Excellent	***Good***	***Fair***	***Poor***	***P-value***
	(n=167)	***(n=93)***	***(n=11)***	***(n=5)***	
Treatment duration (Months)	21 ± 8.3	22.4 ± 8.8	24.8 ± 8	25.6 ± 5.6	0.186
Mean ± SD					
****: Significant at P ≤ 0.05***					

Table (VII): Descriptive statistics and results of Mann-Whitney U test for comparison between treatment duration in public and private clinics

Table (VII): Descriptive statistics and results of Mann-Whitney U test for comparison between treatment duration in public and private clinics			
	Public	***Private***	***P-value***
	(n=144)	***(n=132)***	
Treatment duration (Months)	21.6 ± 8.1	21.8 ± 8.9	0.872
Mean ± SD			
****: Significant at P ≤ 0.05***			

Table (VIII): Descriptive statistics and results of Kruskal-Wallis test and Mann-Whitney U test for comparison between treatment duration with different crowding findings

Table (VIII): Descriptive statistics and results of Kruskal-Wallis test and Mann-Whitney U test for comparison between treatment duration with different crowding findings					
	Space	***Mild***	***Moderate***	***Severe***	***P-value***
	(n=28)	***(n=91)***	***(n=101)***	***(n=56)***	
Treatment duration (Months)	21.4 ± 8.8 [c]	19.1 ± 9.3 [d]	22.4 ± 7.8 [b]	24.7 ± 7 [a]	<0.001*
Mean ± SD					

**: Significant at P ≤ 0.05, Different letters are statistically significantly different according to Mann-Whitney U test*

Table (IX): Descriptive statistics and results of Kruskal-Wallis test for comparison between treatment duration with different transverse discrepancy findings

Table (IX): Descriptive statistics and results of Kruskal-Wallis test for comparison between treatment duration with different transverse discrepancy findings					
	No discrepancy	***One tooth***	***Two teeth***	***Group of teeth***	***P-value***
	(n=223)	***(n=19)***	***(n=23)***	***(n=11)***	
Treatment duration (Months)	22 ± 8	18.8 ± 11.2	20.4 ± 9.6	23.6 ± 9.1	0.072
Mean ± SD					
****: Significant at P ≤ 0.05***					

Table (X): Descriptive statistics and results of Kruskal-Wallis test and Mann-Whitney U test for comparison between treatment duration with different numbers of impacted teeth

Table (X): Descriptive statistics and results of Kruskal-Wallis test and Mann-Whitney U test for comparison between treatment duration with different numbers of impacted teeth				
	No impactions	***One tooth***	***More than one tooth***	***P-value***
	(n=254)	***(n=16)***	***(n=6)***	
Treatment duration	21.3 ± 8.5 [c]	24.9 ± 6.9 [b]	29.2 ± 5.4 [a]	0.007*

(Months)				
Mean ± SD				

**: Significant at P ≤ 0.05, Different letters are statistically significantly different according to Mann-Whitney U test*

Table (XI): Descriptive statistics and results of Mann-Whitney U test for comparison between treatment duration in extraction and non-extraction cases

Table (XI): Descriptive statistics and results of Mann-Whitney U test for comparison between treatment duration in extraction and non-extraction cases			
	Extraction	***Non-extraction***	***P-value***
	(n=94)	***(n=182)***	
Treatment duration (Months)	25.2 ± 7.7	19.9 ± 8.3	<0.001*
Mean ± SD			
****: Significant at P ≤ 0.05***			

III. Discussion

The influence of sociodemographic characteristics including age, sex, and socioeconomic status on treatment duration is unclear. Although some studies havereported that chronological age was not significantly associated with treatment duration(1,2),others have found the opposite(3,4), and it has been asserted that stage of dental development, rather than age, at treatment commencement might affect treatment duration.Age is associated with patient cooperation; younger patients may or may not be more cooperative than older ones (5-7)Longer treatment durations for boys have been a common finding (8),if not a consistent one (5,6,9).Controversy exists over the influence of socioeconomic status on cooperation and treatment duration, with no clear consensus on whether a lower socioeconomic status is associated with a shorter or longer treatment duration (10,11)

Malocclusion characteristics have been suggested to influence treatment duration. Vigetal(4)found that not only Class II or Class III malocclusions took longer to treat, but also that there were interactions between malocclusion type and other variables: the effect of missed appointments was twice as great in Class II patients, patient cooperation reduced treatment duration for Class II but not Class I patients; and more experienced clinicians treated Class II cases in less time than Class I cases. Wenger et al (12) observed that treatment duration, for Class I cases, was less than that for Class II or Class III cases. Although differences in anatomy and malocclusion (e.g. high pretreatment ANB angle and low mandibular plane angle (2) large overjet, and buccal occlusion (13)) have been reported to influence treatment duration, the relationship of longer treatment duration and greater difficulty has not been well studied(2).

The treatment method chosen, extraction vs. nonextraction, has been reported to influence treatment duration. Extractions have been linked to longer treatment durations, and premolar extractions appear to be particularly significant (2,3,11,14),although the influence of extraction and nonextraction approaches on treatment duration remain controversial, with some studies reporting no difference(1). Shia et al(15)reported that altering the treatment approach in mid-treatment was a significant cause of time overruns, specifically when nonextraction treatment was started, but extractions were done later during treatment (delayed extractions). Another important treatment variable might be differences among clinicians in the time spent in detailed finishing procedures (2),although this is also controversial(1).

Patient cooperation accounts for much treatment time variation, the major considerations are keeping scheduled appointments(1,2,13,14),cooperation in wearing elastics, refraining from activities that could distort the archwires and remove bonded brackets, leading to appliance breakages or repairs(13),and adequate oral hygiene(1).Patients with good oral hygiene have also been described as more likely to cooperate with other

aspects of treatment(10,16,17).Beckwith et Al(1)reported that thenumber of brackets and bands replaced during treatment was the second largest contributor to treatment time variance.

It has to be noted that the quality of the finished cases and the appropriateness of the original diagnosis and treatment plan were not evaluated. Developing an objective assessment to evaluate these areas may be important for increasing our understanding of treatment time variation.

As explained by table (I), the numerical values (age, overbite/openbite, &ANB) all had no statistically significant correlation with the treatment duration, EXCEPT the ANB. There was a statistically significant positive (direct) correlation between treatment duration and ANB, an increase in ANB was associated with an increase in treatment duration. It has to be noted that for this study, class I molar cases were selected regardless of their skeletal classification.

The results concerning the effect of age on treatment duration are similar to those concluded by Dyer et al(18)andRobb et al(13)who found no statistically significant differences between adult and adolescent groups. Although Vayda et al(19)stated that there was a statistically significant difference between older and younger patients, the older taking less time, which was attributed to better compliance from the older group.

The second factor investigated concerns a vertical aspect of the malocclusion, the overbite, or in some cases openbite. There was no statistically significant correlation between treatment duration and amount of overbite or openbite. Skidmore et al(20)mentioned that an overbite greater than 5 mm increased treatment time by 1.2 months. Fisher et al(21)explained that having at least an 80% overbite was associated with a longer treatment duration. One plausible explanation for this is that, in deep-bite patients, it might be impossible to bond the mandibular arch at the start of treatment. The deep overbite might need to be corrected before placing appliances on the mandibular teeth. Parrish et al(22)correlated the DI (Discrepancy index) score with increased treatment duration. They speculated a 28–30 days increase in treatment duration for each point increase in overbite.

Of all the numerical values measured, the only one having a statistically significant positive (direct) correlation with treatment duration was the ANB i.e. an increase in ANB was associated with an increase in treatment duration as shown in table (1). Vu et al(23), had a similar correlation, they also mentioned that class I, ANB (0^0-4^0), not only required a shorter period of time to be treated, but also showed a better treatment outcome.Fink et al(2), explained by a five-step multiple regression equation the variations in treatment duration among patients. Among the variables entering this equation was pretreatment ANB. There was a direct correlation between increased ANB and longer treatment durations.

Among the sociodemographic characteristics influencing treatment duration in Skidmore et al's(20)retrospective study was sex. The correlation between sex and treatment duration showed that males had longer treatment durations. Their explanatory model indicated that treatment time increased by an additional month if the patient was male.

As shown in table (II), males showed a statistically significant higher mean treatment duration than females. The mean duration for males was 24 ± 8.7 months, and for females 20.9 ± 8.3 months. This constitutes an average of 3 months difference between the treatment duration for both sexes, again probably due to better female compliance. Vu et al(23)concluded that the average treatment duration for males was 1.3 months longer than that for females. However, this difference was not statistically significant(1-3).

When oral hygiene was correlated with treatment duration, table (III), there was no statistically significant difference between mean treatment duration among patients with different oral hygiene findings. Patients having excellent O.H. showed mean treatment duration 21.3 ± 8.9 months, while those having poor O.H. showed mean treatment duration 22.8 ± 8.3 months. It has to be noted that when it came to measuring oral hygiene and elastic wear, the results were purely subjective, depending on the involved orthodontist.

On the other hand, when correlating missed appointments with treatment duration, table (IV), Patients with (Poor) grades showed the statistically significant highest mean treatment duration (38.3 ± 9.7 months). This was followed by (Fair) then (Good) grades. Patients with (Excellent) grades showed the statistically significant lowest mean treatment duration (19.2 ± 8.1 months).According to the orthodontists involved, appointments are usually set every 2-4 weeks, if a patient missed an appointment it was recorded in his file.

Also concerning patient compliance, elastic wear when correlated with treatment duration, table (V), showed no statistically significant difference between mean treatment durations among patients with different elastic wear findings. The same could be said for different broken appliances findings ,table (VI),although, patients who scored excellent had a mean treatment duration of 21 ± 8.3 months as opposed to those who scored poor with an average of 25.6 ± 5.6 months.Those findings support the observations made by Shia (15) After examining 500 consecutively treated cases, he listed the primary causes for treatment overruns in his private practice. Poor patient cooperation, broken appointments, and appliance breakage were the top three items on his list.Beckwith et al(1), concluded that missed appointments, loose brackets and bands, and poor oral hygiene are

all patient cooperation factors that contributed significantly to increase treatment time. The most important variable measured in this study to explain differences among patients in treatment duration was the number of appointments missed during treatment. The results of the multiple regression analysis indicated this variable explained 17.6% of the treatment time variance. Each failed appointment was associated with a little over 1 month additional estimated time in appliances.

Skidmore et al(20),when considering compliance related factors were able to distinguish between the number of brackets rebonded for repositioning reasons which is of clinical importance and those loosening or breaking during treatment.. They considered bands and brackets replaced due to breakages and those replaced for repositioning as 4 separate variables.

Robb et al(13)concluded that the number of missed appointments and appliance repairs explained 46% of the variability in orthodontic treatment duration and 24% of the variability in treatment effectiveness.

Fisher et al(21)assessed pretreatment behavioral factors that are often overlooked when attempting to determine treatment duration. Using multivariable logistic regression modeling,so the other characteristics were constant or equal,they found patients with good pretreatment oral hygienewere over 3 times more likely to have a shorter treatment duration. They also investigated 'sibling appointment history' and school grades, they found no association between goodgrades and short treatment duration, but poor grades were linked to long treatment duration.

When we correlated treatment duration with the type of clinic, private vs. public, we found no statistically significant difference between mean treatment durations in public and private clinics, table (VII). Mascarenhas et al(24), concluded that there was no statistically significant difference in the occlusal outcome between the private practice orthodontists (PPO) and graduate orthodontic clinic (GOC), but there was a significant difference in the treatment duration, which was longer for the PPO.

McGuinness et al(25), tested the influence of operator changes on orthodontictreatment duration and results in a postgraduate teaching environment. Results showed that Change of operator contributes significantly to a lengthening of treatment times in fixed orthodontic appliance therapy, in this study by an average of 8.43 months. Thus, patients who for some reason are treated by more than onepostgraduate student are compromised with respect to treatment duration. The study highlights the fact that patients who are treated by orthodontic postgraduatesshould, as far as possible, be completed by that postgraduate and not transferred to another operator. However, there was no significant difference in the standard of orthodontic treatment results.

Amount of crowding was divided into 4 categories. Patients with severe crowding showed the highest statistically significant mean treatment duration. This was followed by moderate crowding, then patients with spacing. Patients with mild crowding showed the lowest statistically significant mean treatment duration, table (VIII). Most of the previous studies have confirmed a strong correlation between increased amount of crowding and longer treatment durations(20-22).

Table (IX) correlated treatment duration with transverse discrepancy. Patients were divided amongst 4 categories, either having 1, 2, a group of teeth (3 or more), or no discrepancy. The results showed that there was no statistically significant difference between mean treatment durations among patients with different transverse discrepancy findings.

Patients with more than one impacted tooth showed the highest statistically significant mean treatment duration. This was followed by patients with one impacted tooth. Patients with no impactions showed the lowest statistically significant mean treatment duration, table (X).A number of studies were found in the literature that correlated impacted teeth with treatment duration(26-31).To be more specific, they were concerning impacted canines, although in our sample we did not specify that the impacted tooth was necessarily a canine, other teeth were included (central incisor, lower premolar). For the sake of clarity, all impactions were pooled into 2 categories, one impacted tooth, or more than one impacted tooth.

Finally, the last factor investigated is whether the treatment plan involved extractions, or not. Table (XI), shows that treatment plans involving extractions showed a higher statistically significant mean treatment duration than non-extraction treatment plans. The mean treatment duration for extraction cases was 25.2 ± 7.7 months, and 19.9 ± 8.3 months for nonextractioncases (2,14,32).

Beckwith et al(1)concluded that the influence of extraction versus nonextraction treatment on the length of treatment remains controversial. Their study supported the findings by Vig et al(3)that extracting teeth for orthodontic treatment does not significantly influence the duration of treatment. At 29.2 months, the mean treatment time for extraction patients in their study was 1.4 months longer than for those who did not have teeth extracted. This difference was not statistically significant.

Fink et al(2)found extraction of teeth for orthodontic treatment to be the most significant of their 18 variables in the explanation of treatment duration variation. Their analysis concluded that 0.94 months of treatment was added per extracted premolar. Alger et al(32) observed that for patients from whom he extracted

teeth, treatment time averaged 4.6 months longer than for his nonextraction cases. Many other studies associated extraction with longer treatment duration(20,21,23).

Some of the unexplained variation in treatment time observed in this retrospective study might be attributed to 3 variables that were not examined: time spent on detailed finishing procedures and the quality of finish(1,2),patient satisfaction(11),and the appropriateness of the original diagnosis and treatment plan.

IV. Conclusions

1. The numerical values (age, overbite, openbite, &ANB) all had no statistically significant correlation with the treatment duration, EXCEPT the ANB. There was a statistically significant positive (direct) correlation between treatment duration and ANB.
2. Males showed a statistically significant longer mean treatment duration than females.
3. When oral hygiene, elastic wear, and broken appliances were correlated with treatment duration, the results were not statistically significant.
4. When correlating missed appointments with treatment duration, Patients with (Poor) grades showed the statistically significant highest mean treatment duration, this was followed by (Fair) then (Good) grades. Patients with (Excellent) grades showed the statistically significant lowest mean treatment duration.
5. There was no statistically significant difference between mean treatment durations in public and private clinics.
6. Patients with severe crowding showed the highest statistically significant mean treatment duration. This was followed by moderate crowding, then patients with spacing. Patients with mild crowding showed the lowest statistically significant mean treatment duration.
7. There was no statistically significant difference between mean treatment durations among patients with different transverse discrepancy findings.
8. Patients with more than one impacted tooth showed the highest statistically significant mean treatment duration. This was followed by patients with one impacted tooth. Patients with no impactions showed the lowest statistically significant mean treatment duration.
9. Treatment plans involving extractions showed a higher statistically significant mean treatment duration than non-extraction treatment plans.

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