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Factors Affecting the Duration of Fixed Orthodontic Treatment in Patients Treated in a University Department between 2016 and 2020

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ABSTRACT

Objective: *The aim of this study was to assess the effect of possible influential factors on duration of fixed orthodontic treatment.*

Methods: *This cross-sectional retrospective study included 505 female and 183 male orthodontic patients (a total of 688 persons) referring to a university department of orthodontics during 2016-2020. The study population included only those who had undergone fixed orthodontic treatment of both maxillary and mandibular arches. Information including age, gender, total treatment duration, number of missed treatment sessions, incidences of bracket debonding, and type of treatment plan were collected from patient records. Data were analyzed using SPSS software version 21 at 0.05 significance level.*

Results: *The mean duration of orthodontic treatment was significantly longer in men than women (19.09±5.6* versus *18.22±4.56 months, respectively; P=0.040). The treatment duration was also longer in patients with a treatment plan including teeth extraction compared to non-extraction treatment plans (19.85±4.30* versus *17.56±5.02 months, respectively; P<0.001). Duration of treatment in patients with more than one missed treatment appointment was significantly longer than those who had ≤ one missed session (P<0.001). Duration of treatment in patients with bracket debonding was significantly longer*

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(P=0.030). Also, the duration of treatment had a significant correlation with the frequency of both missed sessions (r=0.365, P<0.001) and bracket debonding (r=0.098, P=0.01).

Conclusion: *Based on the results of the present study, missed sessions, treatment plan, and bracket debonding have the greatest effect on the duration of fixed orthodontic treatment.*

Keywords: orthodontic treatment, patient cooperation, treatment duration, treatment plan.

INTRODUCTION

Dental clinicians have to answer a couple of questions regarding the course and particularly duration of treatment. However, the question regarding the duration of treatment is not an easy one to answer since it depends on a number of factors such as the expertise of the clinician, their scientific background, and several patient-related factors (1). Success of the orthodontic treatment highly depends on the precise prediction of treatment duration (2). Patients who have more accurate information regarding their treatment duration often better comply and cooperate with their orthodontist, and also have more rational expectations and often feel satisfied with the treatment outcomes (3-5).

In recent years, the demand for esthetic and orthodontic treatments has greatly increased among both adolescents and adults (6). The duration of treatment is a major concern for both patients and orthodontists. Patients would want to know the duration of their treatment so they can estimate the treatment cost and discomforts caused by orthodontic brackets (7). In addition, orthodontists should make the treatment plan based on specific patient needs. Thus, dental clinicians can build trust and increase the success of treatment by correct estimation of treatment duration (7).

It should be noted that prolongation of treatment course compromises an important aspect of treatment, *i.e.*, cost-effectiveness for patients. On the other hand, shorter treatment courses are frequently associated with fewer side effects (8, 9). Orthodontic treatment is often accompanied by some biological complications, and longer treatments may also increase the risk of root resorption (10, 11). Thus, adequate knowledge of the factors affecting the course and duration of treatment can help orthodontists achieve favorable results in the shortest time possible (7).

Several factors can affect the treatment duration such as age and gender, type of bracket, molar relationship at the treatment onset, and extraction or non-extraction orthodontic treatment plan (6). This study aimed to assess the effect of possible factors affecting the duration of fixed orthodontic treatment. ❑

MATERIALS AND METHODS

Study design and setting

This cross-sectional study evaluated the records of 688 fixed orthodontic patients (183 males and 505 females) who received treatment in Urmia University of Medical Sciences Department of Orthodontics between 2016 and 2020.

Inclusion and exclusion criteria

The inclusion criteria were as follows: fixed orthodontic treatment of both the maxilla and mandible with pre-adjusted Roth 0.22 system, achieving normal overjet and overbite (2-4 mm) at the end of treatment, and closure of tooth extraction spaces in patients with extraction orthodontic treatment plan. Patients who required orthognathic surgery, those with two-stage treatment plans (initially with a removable appliance and then with fixed appliance), patients treated by removable appliance only and those with impacted teeth were all excluded.

Main variables

Study variables, including age group at the treatment onset [1) 10-15 years old, 2) 15-20 years, 3) 20-25 years old, 4) 25-30 years old, 5) 30-35 years old, and 6) 35-40 years old], gender [1) male, 2) female], treatment plan [1) non-extraction or 2) extraction treatment], pattern of extraction [1) two maxillary first premolars, 2) four maxillary and mandibular first premolars, 3) four maxillary first premolars and mandibular second premolars, 4) asymmetric pattern of extraction of premolars, and 5) one mandibular central incisor], frequency of missed treatment session [1) one or fewer, 2) more than one], duration of absence, frequency of bracket fracture/debonding [1) total one bracket debonding, 2) total two bracket debonding, 3) total three bracket debonding, 4) total four bracket debonding, 5) total five or more bracket debonding], and the total frequency of treatment sessions were all collected from patient records. The time interval between the onset of orthodontic treatment (bonding of fixed appliances) and its completion (removal of fixed appliances) was recorded as the total treatment duration in months.

Statistical analyses

Data were analyzed using IBM SPSS Statistics version 26 (IBM SPSS Statistics, IBM Corp, Armonk, USA). They were expressed as mean (SD), and frequency (percentage) for numeric and categorical variables, respectively. The mean values of treatment duration were compared by independent t-test, and one-way ANOVA. The Pearson's correlation test, the Kendall's tau-b, Chi-square tests, and multivariate linear regression were used to analyze the correlations between different variables and treatment duration for different. To determine the final influential factors affecting the treatment duration, the four variables with significant effects (gender, missed treatment sessions, bracket debonding, and treatment plan) were entered into a linear regression model. According to the best-fit strategy, the forward model was applied. ❑

RESULTS

Records of 688 patients were evaluated including 505 (73.4%) females and 183 (26.6%) males. The mean age of patients was 17.04±5.4 years (range, 10±40). According to the independent t-test, the mean age was not significantly different between males and females (P=0.761).

Correlation of age and gender with treatment duration

The mean treatment duration was 18.45±4.87 months in the entire study population. This rate was 19.09±5.6 months for male patients, and 18.22±4.56 months for female ones. Independent t-test showed that the mean treatment duration in male patients was significantly longer than that in female patients (P=0.040). The mean frequency of treatment sessions was not significantly different between genders (P=0.189). Table 1 presents the mean treatment duration in patients with different age groups. One-way ANOVA did not find a significant difference in treatment duration among different age groups (P=0.279). The Pearson's correlation test showed no significant correlation between age at the treatment onset and treatment duration (r=0.050, P=0.192).

TABLE 1. Mean treatment duration in patients in different age groups of the study

Age group (years)	Number	Mean	Standard deviation
10-15	287	18.29	4.83
16-20	208	18.5	4.98
21-25	120	18.5	4.43
26-30	54	18.11	4.69
31-35	14	21.29	7.89
36-40	5	20.6	2.7
Total	688	18.45	2.7

Correlation of treatment plan with treatment duration

Table 2 presents the mean treatment duration in patients with extraction treatment plan based on different extraction protocols. Out of 688 pa-

TABLE 2. Mean treatment duration in patients with extraction treatment plan based on different extraction protocols

Treatment protocol	Number	Percentage	Mean	Standard deviation
Two maxillary first premolars	114	42.5	20.11	4.394
Four maxillary and mandibular first premolars	88	32.8	19.19	4.341
Maxillary first premolars and mandibular second premolars	44	16.4	20.52	4.112
Asymmetric pattern of extraction of premolars	13	4.9	21.00	4.453
Mandibular central incisors	9	3.4	18.00	2.500
Total	268	100	1.85	¾

tients, 268 (39%) were treated with extraction and 420 (61%) with non-extraction treatment plan. Independent t-test showed that the mean duration of treatment in patients with extraction treatment plan was significantly longer than that in patients with non-extraction treatment plan (19.85±4.306 versus 17.56±5.012 months, P<0.001). Also, according to the independent t-test, the mean frequency of treatment sessions in the extraction group was significantly higher than that in the non-extraction group (19.91±4.122 *versus* 16.85±3.905 sessions, P<0.001). Asymmetric pattern of extraction was associated with the longest treatment duration; however, the difference among different extraction patterns was not significant (P=0.189).

Correlation of missed treatment sessions with treatment duration

Table 3 presents the frequency of missed sessions in different age groups. Of all, 592 (86%) patients had ≤ one missed session, while 96 (14%) had missed > one missed treatment sessions. The mean treatment duration was 17.83±4.42 months in subjects with none or one missed session and 22.27±5.74 months in those missing ≥ two sessions. According to independent t-test, the difference between the two groups was statistically significant (P<0.000). Patients who missed ≥ two sessions had a higher mean frequency of treatment sessions but not significantly (P=0.686). One-way ANOVA showed no significant difference in the frequency of missed sessions among different age groups (P=0.883). The Chi-square test showed no significant difference in the frequency of missed sessions between male and female patients (≤ 1 or ≥ 2).

TABLE 3. Frequency of missed sessions in patients in different age groups

Age group (years)	Number	Mean	Standard deviation
10-15	287	0.97	0.53
16-20	208	1.02	0.54
21-25	120	0.87	0.44
26-30	54	1.05	0.52
31-40	19	0.82	0.34
Total	688	0.97	0.51

TABLE 4. Frequency and mean (±SD) of bracket debonding in different age groups

Age group (years)	Number	Mean	Standard deviation (SD)
10-15	287	1.18	0.07
16-20	208	0.9	0.06
21-25	120	0.74	0.06
26-30	54	0.55	0.07
31-40	19	0.82	0.22
Total	688	1	0.04

Correlation of bracket debonding and treatment duration

The frequency of bracket debonding in different age groups is shown in Table 4 and the mean treatment duration and frequency of treatment sessions based on the occurrence of bracket debonding is detailed in Table 5. Comparison of treatment duration between patients with no bracket debonding (18.15±4.70 months) and those with ≥ one bracket debonding (18.99±5.13 months) by the independent t-test revealed a significant difference (P=0.030). As shown by one-way ANOVA, frequency of bracket debonding was significantly higher in 10-15-year-old age group than other age groups (P<0.000). The Chi-square test revealed no significant difference in frequency of bracket debonding between male and female patients (P=0.129).

Correlation of missed treatment sessions with treatment duration based on the occurrence of bracket debonding

Independent t-test indicated that the mean treatment duration in patients with at least one bracket debonding was significantly higher than that in patients with no bracket debonding (P=0.030). The Pearson's correlation test showed a significant linear correlation between bracket debonding and treatment duration (r=0.098, P=0.01). Independent t-test showed that, although the mean frequency of treatment sessions was higher in patients with at least one bracket debonding, this difference was not significant (P=0.890). The Kendall's tau-b was applied to analyze the correlation of bracket debonding and frequency of treatment sessions, which found no significant correlation (r=0.007, P=0.825). However, the Kendall's tau-b showed a significant correlation between the frequency of missed sessions and bracket debonding (r=0.069, P=0.048), such that higher

Number of bracket debonding	Frequency (%) of bracket debonding	Treatment duration (mean±SD)	Frequency of treatment sessions (mean±SD)
0	438 (63.7%)	18.15 ± 4.7	18.02 ±4.18
1	153 (22.2%)	18.74 ± 5.35	17.83 ±3.83
2	58 (8.4%)	19.16 ± 4.8	19.07 ±4.86
3	25 (3.6%)	19.48 ± 4.65	17.28 ± 3.00
4	10 (1.5%)	20.30 ± 5.61	17.08 ± 3.5
5	3 (0.4%)	18 ±1.73	16.67 ± 0.57
9	1 (0.1%)	25	23

TABLE 5. Mean treatment duration and frequency of treatment sessions based on the occurrence of bracket debonding

frequency of missed sessions was associated with higher frequency of bracket debonding.

Regression model of the effect of variables on treatment duration

The results of regression model indicated that the sum of independent variables had a moderate correlation with the dependent variable (R=0.403). Regression analysis also revealed R2adj=0.158, indicating that 15.8% of all changes in treatment duration depended on the three independent variables: missed sessions, treatment plan, and bracket debonding had the greatest effect on the treatment duration (Table 6). ❑

TABLE 6. Results of regression model (forward method)

Independent variable	Regression coefficient	P value
Gender	0.681	0.079
Missed sessions***	4.394	<0.001
Treatment plan***	2.431	<0.001
Bracket debonding**	0.821	0.021

DISCUSSION

Considering the fact that prolongation of treatment course increases the prevalence of side effects, high prevalence/extent of active caries lesions, risk of complications and treatment costs, identification of factors that prolong the treatment course is of utmost importance (12). In this study, we evaluated the factors affecting fixed orthodontic treatment duration. The effects of six independent variables including age, gender, treatment plan, frequency of missed treatment sessions, duration of absence, and frequency of bracket debonding on the treatment duration were evaluated in this study. In brief, the results showed that the frequency of missed treatment sessions, type of treatment plan, and frequency of bracket debonding had the greatest effect on increasing the treatment duration, in descending order. These effects remained significant even after eliminating the linear changes of other independent variables. The effect of age on treatment duration has not been well-explained. Some studies found that chronological age had no significant effect on treatment duration (6, 7, 13-17), while some others reported otherwise (8, 18-20). It has been discussed that dental age at the treatment onset has a more significant effect than the chronological age on treatment duration due to biological differences that cause delay in tooth movement in older patients (18, 21). On the other hand, it appears that the chronological age affects patient cooperation, which has a direct effect on treatment duration (18, 21-24).

The regression model showed a significant positive correlation between chronological age and treatment duration that might be due to cumulative effects of age-related parameters such as patient cooperation. Thus, age may be considered as an influential factor on the treatment course (8, 21).

Several studies have shown that gender does not affect orthodontic treatment duration (6-8, 13, 14, 17, 25), in contrast to the findings of

Aidaros *et al* (18), who reported a significantly longer duration of treatment in male patients.

In the present study, treatment duration was significantly longer in males. However, the regression model showed no significant correlation between gender and treatment duration. It may be concluded that gender, as an independent variable, does not affect the treatment course and difference in this respect between males and females may be attributed to the linear effects of other independent variables on gender and treatment duration (6-8, 13, 14, 25).

Our study showed that higher frequency of missed sessions was significantly correlated with longer duration of treatment. This finding is justified by the fact that regular patient visits are imperative for arch wire adjustments and guiding of tooth movement (6, 7, 16, 18, 25-27). Controversy exists regarding the effect of type of treatment plan on treatment duration and unanimous agreement has not been reached on this statement (8, 14, 18). Some believe that the non-extraction treatment has a simpler treatment course, and is used for treatment of localized malocclusion problems while the extraction treatment plan is indicated for marked discrepancies that require greater tooth movement. Vig *et al* showed that extraction of teeth prolonged the treatment time by five months on average. Similarly, Alger noticed that for extraction patients, treatment time averaged 4.6 months longer than for non-extraction cases (16).

In the present study, we found teeth extraction to be one of the most substantial variables. Treatment duration in patients with extraction treatment plan was on average 2.29 months longer than that in the non-extraction group. In case of tooth extraction, a longer time would be required for successful leveling and alignment of teeth, closure of empty extraction spaces, achieving adequate overjet and overbite (2-4 mm), and a satisfactory facial appearance. Our finding is in agreement with the systematic review by Mavreaset *et al* (27) that shows dental extractions increase duration of orthodontic treatment.

The results of the present study indicate that frequency of bracket debonding significantly affects treatment duration. The results indicated significantly longer duration of treatment in patients with even one bracket debonding and also repeated bracket debonding. The same results were reported by Melo *et al* (6), Bichara *et al* (7), Skidmore *et al* (14), and Beckwith *et al* (25).

A long interval between bracket debonding and rebonding changes the direction and magnitude of loads applied to the teeth and can alter the treatment course. Thus, a longer time would be required to achieve optimal results. The present study showed significantly higher frequency of bracket debonding in 10-15-year-old patients. It appears that older patients have better cooperation that can affect the treatment duration. This was also observed by Aidaros *et al* (18).

Other than factors that may be in hands of the orthodontists, like those of treatment plan and the use of brackets and wires, there is one major factor, namely patient cooperation and adherence to a strict schedule of orthodontic visits, that determines the duration of orthodontics treatment. Therefore, informing patients about their role in the treatment process and finding ways to improve patient cooperation can result in avoiding elongation of orthodontic treatment duration. Newer orthodontic treatment modalities like clear aligners may afford shorter treatment periods, but patient cooperation still seems to be of paramount importance in duration of orthodontic treatment regardless of the treatment plan. The need for use of long-term retainers by the patients may further be evidence for the fact that treatment that involves moving teeth and jaw alignment is a commitment for the patient for achieving better oral conditions. ❑

CONCLUSIONS

Based on the results of the present study, missed sessions, treatment plan, and bracket debonding have the greatest effect on the duration of fixed orthodontic treatment. ❑

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