

Evaluation of bracket failure in relation to different factors in patients experiencing comprehensive orthodontic treatment: A Retrospective Cohort Study.

Evaluación de la falla del bracket en relación con diferentes factores en pacientes que reciben tratamiento ortodóntico integral: Un estudio de cohorte retrospectivo.

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Abstract: Objective: The aim of this study was to investigate loose brackets in relation to various related factors in orthodontic patients who had completed orthodontic treatment. Material and Methods: In this retrospective study, 738 medical records of patients who had undergone comprehensive orthodontic treatment and matched specific inclusion criteria were selected. Paired t-tests and ANOVA, along with the Mann-Whitney test and Kruskal-Wallis analyses were performed to compare the means of variables between selected subgroups. Results: Loose brackets were found most frequently on premolars, followed by incisors and then canines ($p < 0.01$). Male and young patients were found to have a higher incidence of loose brackets compared to female and adult patients ($p = 0.044$ and $p < 0.01$, respectively). The highest correlation coefficient value was found between treatment duration and total number of loose brackets (0.393), which was statistically significant. Conclusions: The frequency of total number of loose brackets increased with younger age group. Premolar teeth were found to be the most commonly affected teeth, followed by incisors and canines. Mandibular teeth presented more loose brackets than maxillary.

Keywords: Orthodontics; orthodontic brackets; treatment failure; patient compliance; retrospective studies.

Resumen: Objetivo: Fue investigar brackets sueltos en relación con varios factores relacionados en pacientes ortodónticos que habían completado el tratamiento de ortodoncia. Material y Métodos: En este estudio retrospectivo, se seleccionaron 738 registros médicos de pacientes que se habían sometido a un tratamiento ortodóntico integral y criterios de inclusión específicos coincidentes. Se realizaron pruebas t pareadas y ANOVA, junto con la prueba de Mann-Whitney y los análisis de Kruskal-Wallis para comparar las medias de las variables entre los subgrupos seleccionados. Resultados: Se encontraron corchetes sueltos con mayor frecuencia en los premolares, seguidos de incisivos y luego caninos ($p < 0.01$). Se encontró que los pacientes masculinos y jóvenes tenían una mayor incidencia de corchetes sueltos en comparación con los pacientes femeninos y adultos ($p = 0.044$ y $p < 0.01$, respectivamente). El valor del coeficiente de correlación más alto se encontró entre la duración del tratamiento y el número total de corchetes sueltos (0.393), que fue estadísticamente significativo. Conclusiones: La frecuencia del número total de corchetes sueltos aumentó con el grupo de edad más joven. Los dientes premolares fueron los dientes más afectados, seguidos de los incisivos y los caninos. Los dientes mandibulares presentan más brackets sueltos que los maxilares.

Palabras Clave: Ortodoncia; brackets de ortodoncia; fracaso del tratamiento; cumplimiento del paciente; estudios retrospectivos.

INTRODUCTION.

Patient compliance is an important factor in the success of medical and dental treatment modalities. Haynes has defined compliance as "The extent to which a person's behavior (in terms of taking medications, following diets, or executing life style changes) coincides with medical or health advice".¹ Like other dental specialties, orthodontics requires an essential degree of patient compliance to increase the efficiency and effectiveness of any treatment modality.²

Patient cooperation is an essential factor in the timely, successful outcome of orthodontic treatment.³ Although clinicians' knowledge and skills remain significant, patients' cooperation (along with their parents') plays an important role in achieving the desired results.³ Several studies have described factors that could affect patient compliance, such as pain and discomfort,⁴ functional and aesthetic impairment,⁵ dislike of the appliance,⁶ and the patient's psychological well-being.⁷ These factors ultimately influence an early termination of orthodontic treatment.

In patients experiencing orthodontic treatment, the number of brackets lost is considered inversely proportional to patient compliance.⁸ It has been shown that each lost bracket (*i.e.* that needs to be re-bonded) in fixed orthodontic treatment can cause an increase in treatment duration of 0.3 months.⁹ Moreover, several brackets de-bonding leads to longer treatment time, on average by 1.5 months.⁹ Not keeping up with scheduled appointments is considered the second most important factor (after the type of extraction) affecting treatment duration in orthodontics, acting as a measure of overall patient compliance.^{10,9} Furthermore, males were found to be associated with longer orthodontic treatment duration compared to females.¹¹

To our knowledge from the indexed literature, there are limited studies regarding the frequency of loose brackets and other multifaceted factors that may influence patient compliance in achieving desired treatment outcomes in orthodontic patients. Therefore, the objective of the present study was to determine the frequency of loose brackets in a sample of patients who had completed their orthodontic treatment, and to associate and correlate the number of loose brackets with patient age, overjet (OJ), over bite (OB), treatment duration (TD) and standardized failure rate (SFR).

MATERIALS AND METHODS.

This present retrospective study was approved by the Ethical Committee of King Saud University. The study followed the recommendation of STROBE statement for retrospective study designs. A total of 738 medical records of patients that were treated in the department of orthodontic practice in King Saud University, Saudi Arabia in a period of one year, from June 2017 to June 2018, were evaluated according to the following criteria:

- Fixed appliances for both maxillary and mandibular arches.

- Progress notes and full documentation from start to finish of orthodontic treatment, including a record of no-show appointments along with loose bracket descriptions.

- Orthodontic duration lasting no more than 5 years of active treatment.

Patient gender and age were identified. Those under 18 years of age were allocated to the adolescent group, while those aged 18 years and over were labelled as adults.

The frequency of loose brackets was recorded for each patient throughout their treatment chart. Specifications of the site of bracket (maxillary, mandibular, incisor, canine, and premolar) were recorded.

For each patient, the following variables were also collected: total number of loose maxillary brackets (UB), total number of loose mandibular brackets (LB), loose incisor brackets (IB), loose canine brackets (CB), loose premolar brackets (PB), and total number of loose brackets (TLB). Orthodontic treatment duration from onset to the date of de-bonding was recorded (TD).

In addition, failure to attend appointments was reflected by calculating the Standardized Failure Rate (SFR), which is the total number of failed (cancelled or no-show) appointments divided by the total number of appointments (failed and attended) multiplied by 100.

Pre-treatment occlusal characteristics were recorded, including molar angle classification, overjet (OJ), and overbite (OB). These characteristics were recorded from patient files as found in the treatment planning chart. If the data was missing in patient files, the treating orthodontist was asked to refer to the study model, if accessible; otherwise, the variable was listed as 'missing'. The extraction pattern (non-extraction, maxillary and mandibular, maxillary only, and mandibular only) was also recorded.

Statistical Analysis

The data were subjected to statistical tests with SPSS 16.0 statistical software (SPSS, Chicago, IL) for calculation of the mean and median values in addition to descriptive statistics for all the studied variables. Furthermore, t-test and ANOVA were used to compare the means of variables between selected subgroups. To confirm the results further, and to match the nature of distribution of some variables, we applied the appropriate non-parametric tests (Mann-Whitney test and Kruskal–Wallis analyses) to test for any corresponding statistical significance between associated variables.

RESULTS.

Table 1 displays the descriptive statistics of the collected variables. The age of patients ranged from 11 to 55 years, with a mean of 16.57 (±5.63). Females outnumbered males

in both age groups. The adolescent group consisted of 64.2% females and 35.8% males, whereas the adult group included 58.9% females and 41.1% males.

The mean TLB for adolescents was 1.66 (±2.42), while for adults was 0.86 (±1.48), with a statistically significant difference of TLB between the different age groups ($p < 0.01$). There was a statistically significant difference in TLB regarding gender ($p = 0.044$). The mean TLBs for females and males were 1.23 (±2.41) and 1.56 (± 1.95), respectively.

The means of loose UB and loose LB were (0.64) and (0.7) respectively, while the mean TLB was found to be 1.35 (±2.13). There were no significant differences between the mean UB (0.64) compared with the mean LB (0.7). The highest correlation coefficient values were found between PB and LB (0.732). However, PB was also correlated with UB (0.64), and both values were shown to be statistically significant ($p < 0.01$).

Table 1. Descriptive statistics of the studied variables.

	Age	UB	LB	IB	CB	PB	TLB	TD	SFR	OB	OJ
n	738	738	738	738	737	738	736	738	738	497	496
Missing	0	0	0	0	1	0	2	0	0%	241	242
Mean	16.57	0.64	0.70	0.34	0.26	0.74	1.35	22.64	10.3%	3.11	2.86
Median	15.00	0	0	0	0	0	1.0	21	7.1%	3	3.00
Standard deviation	5.6	1.2	1.4	0.81	0.71	1.41	2.13	10.23	11.4%	2.12	2.23
Minimum	11	0	0	0	0	0	0	6	0%	-9	-4.0
Maximum	55	9	17	6	6	14	20	58	52%	10	14.0

UB: total loose maxillary brackets. **LB:** total loose mandibular bracket. **IB:** loose incisor brackets. **CB:** loose canine brackets. **PB:** loose premolar brackets. **TLB:** total loose brackets. **TD:** orthodontic treatment duration months. **SFR:** standardized failure rate. **OB:** overbite. **OJ:** overjet.

Table 2. Correlation between loose brackets, overbite, and overjet.

		Maxillary	Mandibular	Incisor	Canine	Premolar	Total
Maxillary	Pearson Correlation significant (2-tailed)	1					
Mandibular	Pearson Correlation significant (2-tailed)	0.33**	1				
Incisor	Pearson Correlation significant (2-tailed)	0.49**	0.53**	1			
Canine	Pearson Correlation significant (2-tailed)	0.52**	0.44**	0.24**	1		
Premolar	Pearson Correlation significant (2-tailed)	0.64**	0.73**	0.25**	0.24**	1	
Total loose brackets	Pearson Correlation significant (2-tailed)	0.78**	0.82**	0.61**	0.58**	0.83**	1

** : Correlation is significant at the 0.01 level (2-tailed). * : Correlation is significant at the 0.05 level (2-tailed).

Table 3. Correlations among TLB, OB, OJ, Age, TD, and SFR.

		TLB	OB	OJ	Age	TD	SFR
TLB	Pearson Correlation	1					
	significant (2-tailed)						
OB	Pearson Correlation	0.07	1				
	significant (2-tailed)	N.S.					
OJ	Pearson Correlation	0.07	0.35**	1			
	significant (2-tailed)	N.S.	0.001				
Age	Pearson Correlation	-0.22**	-0.10	-.21**	1		
	significant (2-tailed)	0.001	N.S.	0.001			
TD	Pearson Correlation	0.39**	0.10*	0.14**	-0.18**	1	
	significant (2-tailed)	0.001	0.02	.001	0.001		
SFR	Pearson Correlation	7.3%*	-0.074	1%	-0.06	17.4%**	1
	Sig. (2-tailed)	0.05	N.S.	N.S.	N.S.	0.001	

** : Correlation is significant at the 0.01 level (2-tailed). * : Correlation is significant at the 0.05 level (2-tailed). TLB: Total loose brackets. OB: overbite. OJ: Overjet. TD: orthodontic treatment duration. SFR: standardized failure rate. TLB: Total loose brackets. OB: overbite. OJ: Overjet. TD: orthodontic treatment duration. SFR: standardized failure rate.

Table 2 illustrates the correlations among all loose bracket groups, overbite (OB), and overjet (OJ). Premolar teeth were found to be the most frequently affected, followed by incisors and then canines. Mandibular teeth had more loose brackets than maxillary teeth. OJ and OB had no significant relation with TLB.

The lowest mean of treatment duration was for the non-extraction group (20.96 months±10.36), while the highest mean was for the maxillary extraction group (27.07 months±10.48). Both ANOVA and Kruskal–Wallis one-way analyses indicated statistically significant differences between the means/medians of each category ($p < 0.01$). Table 3 shows the correlations among TLB, OB, OJ, age, TD, and SFR. The highest correlation coefficient value was found between TLB and treatment duration (0.393), which was statistically significant.

DISCUSSION.

The orthodontic literature has reported the compliance of patients attending orthodontic clinics from different perspectives. The occurrence of de-bonded brackets during orthodontic treatment may increase operators' chairside time and would certainly lengthen overall treatment duration. The present study provides a unique assessment of loose brackets as a measure of patient compliance and associate number of loose brackets with

patients age, overjet (OJ), over bite (OB), treatment duration (TD) and standardized failure rate (SFR). The type of study is distinctive as it provides scientific evidence to substantiate the existing practice and knowledge to achieve desired outcomes and goals during and after orthodontics treatment.

In the present study a significant difference ($p < 0.01$) of TLB between adolescents and adults was observed, implying that adults are more interested in the treatment, in appointment-keeping, and appliance maintenance to meet their aesthetic demands. Weiss *et al.*,¹² concluded that patients ages 12 years and younger are less cooperative in keeping appointments and in protecting appliances from breakage. Moreover, current evidence suggests that patients seek orthodontic treatment out of concern for aesthetics rather than for health or function. This would be a vital motivating factor that leads the adult population toward presenting a lower number of TLB, as compared with adolescents.¹³ In addition, parents perceive a greater need for orthodontic treatment for their children than do the children themselves, which could indicate a lack of interest in the treatment and awareness of its importance among children.¹⁴

In the current study, the means of treatment duration were found to be statistically significant ($p < 0.01$) according to extraction categories.

The non-extraction pattern had the lowest mean of duration (20.96 months), which correlates with the results from a previous study which concluded that the type of extraction as the most important factor affecting the duration of orthodontic treatment.¹¹ Furthermore, the results displayed a slight positive correlation between SFR and TLB (0.073), which was found to be statistically significant ($p=0.05$). Findings of the previous study had indicated an average SFR of 10.3% for patients who completed the treatment, while it was 21.4% for the group who discontinued treatment. It was also concluded that patients who cancelled or failed to keep appointments were more likely to discontinue treatment.¹⁵ These findings are found to be in accordance with the results of the present study.

As occasionally class II div. 2 usually presents with an increased OB, it was hypothesized that such an altered anterior occlusal relationship would influence the lower bonded bracket stability. Class II div. 2 reflected the highest overbite ($4.18\text{mm}\pm 2.09\text{mm}$) among the sample. Interesting, in the present study the mean OB for Class II div. 2 was not clinically significantly different from that of Class I ($3.19\text{mm}\pm 1.79\text{mm}$) and Class II div. 1 ($3.42\text{mm}\pm 2.27\text{mm}$), possibly explaining that, although Class I malocclusion had the highest mean TLB, this was not reflected as a statistically significant difference.

In the sample under study, non-extraction was the most prevalent pattern of extraction (59%), matching the highest expression of Class I malocclusion implying non-extraction as a more common treatment approach.¹⁶ Moreover, a comparison of the mean TLBs for incisors and canines among extraction categories showed no statistically significant difference. However, PB was found to be statistically different ($p<0.01$), with the highest mean for the non-extraction group ($0.89\text{mm}\pm 1.626\text{mm}$).

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A possible explanation of these results is that in non-extraction cases, the posterior segment is fully retains function, leading to a more complex occlusal relationship and mechanical loading that affect the stability of, and potentially increase, premolar loose brackets.¹⁷

Due to the pattern of mastication and orientation of maxillary and mandibular tooth contacts, the mandibular arch was expected to have a higher frequency of loose brackets. Although the mean of LB (0.7) was higher than that of UB (0.64), it was not statistically significant ($p=0.38$). Interestingly, in our study, premolars were found to be the most frequently affected teeth, followed by the incisors and then the canines, which agrees with previously published results showing that posterior teeth have higher rates of failure.¹⁸

CONCLUSION.

Within the limitations of the present study it is observed that the frequency of total loose brackets increased in the younger age group. Types of malocclusion, and extraction versus non-extraction, had no effect on the presence of total loose brackets. Premolar teeth were found to be the most frequently affected regarding loose brackets. The highest correlation coefficient value was found between TLB and treatment duration, which was statistically significant.

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