Incidence of orthodontic appliance failures during the COVID-19 lockdown period

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Introduction: As a result of the rapid spread of the disease caused by severe acute respiratory syndrome coronavirus 2, the World Health Organization declared a global pandemic on March 11, 2020. Governments worldwide adopted various measures to stop or slow the spread of coronavirus disease 2019 (COVID-19). One widely used measure was lockdown; workers who could work from home were instructed to do so, and nonessential businesses—including dental clinics—were closed for weeks or months. The purpose of this investigation was to document the incidence of fixed orthodontic appliance failures and the periodontal health status of patients undergoing fixed orthodontic treatment during and after the lockdown period. **Methods:** The sample comprised 350 orthodontic patients (mean age, 16.85 ± 2.59 years; 249 female, 101 male) who underwent orthodontic and periodontal examinations in Adıyaman, Turkey, after a mean lockdown period of 103.7 ± 21.3 days. Frequencies of an orthodontic bracket, elastic ligature, molar band, and miniscrew failures of oral ulcers were recorded, and periodontal parameters were assessed. The effects of sex, age, and the bracket systems used in the patients on the frequencies of these failures were analyzed. **Results:** It was revealed that 15.42% (n = 54) of all patients had ≥1 bracket bonding failure, and 8.16% (n = 4) of the patients with miniscrew implantation had ≥1 miniscrew failure. The incidence of bracket bonding failure was significantly higher in men than in women. No significant relationship was found between periodontal parameters and bracket bonding failure. Plaque and gingival scores were higher than those reported for a similar population before a lockdown. **Conclusions:** The results indicated that orthodontic appliances might have higher frequencies of failure during a lockdown than normal times, and lockdown periods may worsen the periodontal health status of the patients. (Am J Orthod Dentofacial Orthop 2022;161:e87-92)

At the end of December 2019, Chinese health authorities reported a cluster of patients of severe pneumonia, which was later officially identified as coronavirus disease 2019 (COVID-19).[1] As a result of the rapid spread of the disease caused by severe acute respiratory syndrome coronavirus 2, a global pandemic was declared by the World Health Organization on March 11, 2020.[2]

Since the beginning of the pandemic, maintaining a social distance of 1-2 m from other people has been the most commonly recommended measure for the prevention of COVID-19 infection.[3] However, it is highly difficult to maintain such a distance during dental procedures because they require close physical contact between patients and dental practitioners. Because of this difficulty and the potential for aerosol spread of the virus during these procedures, both orthodontists and patients are exposed to an increased risk of COVID-19 infection during the procedures.[4-7]

The COVID-19 pandemic brought not only the risk of death from the viral infection but also strict measures such as national lockdown, travel restrictions, and the closure of schools and public places. In addition, numerous countries worldwide recommended postponement or cancelation of nonurgent dental procedures because of the aforementioned risk factors.[8,9] Because orthodontic treatments are longitudinal processes requiring regular follow-up, they were abruptly suspended for millions of people worldwide during the pandemic.[10]

The indefinite postponement of orthodontic treatments and the impact of lockdown conditions are likely

to reduce the motivation of orthodontic patients. Moreover, the disruption of daily routines during lockdown has been associated with maintaining an unhealthy diet.[11] Under such conditions, orthodontic patients may consume foods that are prohibited from their diet. In turn, poor oral hygiene, along with the loss and replacement of orthodontic appliances, may slow down the treatment and may lead to increased clinical costs in terms of time and materials and loss of labor and time for the patients.

This study aimed to investigate the incidence of failure of fixed orthodontic appliances and periodontal health status in patients undergoing fixed orthodontic treatment after the lockdown period and to analyze the effect of gender, age, and the type of bracket system used in the patients.

MATERIAL AND METHODS

The study was approved by Adıyaman University, Adıyaman, Turkey (Approval No: 2020-06-15T15_29_26), and ethical approval was obtained from Adıyaman University Ethics Committee (Approval No: 2020/7-12). Written consent was obtained from each subject or guardian.

Inclusion criteria were as follows:

1. Patients were pursuing a fixed orthodontic treatment at Adıyaman University, Faculty of Dentistry, Department of Orthodontics.
2. Clinicians used 0.022 slot stainless steel brackets (MBT system, Mini Master Series; American Orthodontics, Sheboygan, Wis) and molar tubes (Direct Orthodontic Tubes; American Orthodontics) as the conventional bracket system or using Damon Q (Ormco, Glendora, Calif) as the self-ligating bracket system.
3. Brackets bonded in ≥1 arch or at least to the level of first molars (brackets and tubes were grouped under the larger group of brackets). Enamel surfaces etched with a 37% phosphoric etchant liquid gel (3M ESPE, St Paul, Minn) with the use of the same primer (Transbond XT Primer; 3M Unitek, Monrovia, Calif) and the same adhesive paste (Transbond XT Light Cure, 3M Unitek).
4. Absence of hypoplasia or restoration on the buccal surfaces to which brackets are bonded.
5. Brackets were ligated to the archwires with the same elastomeric ligatures (Quik-Stik, 3M Unitek).
6. Orthodontic molar bands (3M Unitek) cemented with the same glass ionomer cement (GC Fuji I, GC Corporation Tokyo, Japan).
7. Ball-head miniscrews (Tomas-pin EP, Dentaurum, Ispringen, Germany) (length, 8 mm; diameter,

1.6 mm) implanted to the maxilla, the interradicular region, and the mucogingival junction.

On March 17, 2020, the Turkish Health Ministry canceled all nonurgent dental procedures, and thus orthodontic appointments were postponed indefinitely. Dental services were reopened on June 1, 2020, and dental appointments were rescheduled in accordance with the new measures introduced by the local authorities and World Health Organization.

The most common orthodontic failures presented by the patients during their first appointments after the lockdown period included bracket debonding, detachment of elastomeric ligatures, relapse caused by bracket debonding, and elastomeric ligature detachment, loss of miniscrew stability, and molar band failure. During the appointments, periodontal parameters were assessed by a specialist periodontist (M.C.) after clinical assessment. The amount of dental plaque at the gingival margin was measured using the Silness and Löe Plaque Index, and the status of gingivitis was determined using the Löe and Silness Gingival Index.[12]

Statistical analysis

Statistical power analyses were performed using G-POWER (Faul, Erdfelder, Lang, & Buchner, 2007). On the basis of a 0.5 effect size, 80% power, and a sampling error of 0.05, the minimum sample size was calculated as 128.

Statistical analyses were performed using NCSS (version 1.0; NCSS, LLC, Kaysville, Utah). Descriptives were expressed as mean, standard deviation, median, frequency, ratio, minimum, and maximum. The normal distribution of data was assessed using the Shapiro-Wilk test. Groups were compared using the Mann-Whitney U test for continuous variables with the nonnormal distribution. Interrater reliability was assessed using the Friedman test. Correlations between qualitative variables with nonnormal distribution were determined using Spearman's Correlation Coefficient. A $P < 0.01$ and < 0.05 were considered significant as applicable.

RESULTS

Of the 498 patients receiving fixed orthodontic treatment, 350 of them met the inclusion criteria and were included in the study. The 350 patients comprised 249 (71.1%) women and 101 (28.9%) men with a mean age of 16.85 ± 2.59 years. The mean time from the last appointment before lockdown to the clinical examination and periodontal assessment after the lockdown was 103.7 ± 21.3 days.

The mean plaque index score was 1.66 ± 0.5, the mean gingival index score was 1.8 ± 0.47, and the mean pocket depth was 3.42 ± 0.9 mm.

Table I. Descriptive statistics

Parameters	Patients	Patients detected with the failure (n)	Patients detected with the failure (%)
≥1 Bracket bonding failure	350	54	15.42
≥1 Elastomeric ligature detachment	337	49	14.54
≥1 Relapse caused by bracket bonding failure or elastomeric ligature detachment	86	23	26.74
≥1 Miniscrew failure	49	4	8.16
≥1 Molar band failure	88	6	6.81
Ulceration	350	15	4.3

Table II. Comparison of failures among the four orthodontists

Parameters	Operator A (n = 89)	Operator B (n = 91)	Operator C (n = 84)	Operator D (n = 86)	P*
Bracket bonding failure	0.22 ± 0.58; 0-3 (0)	0.25 ± 0.55; 0-2 (0)	0.23 ± 0.88; 0-6 (0)	0.21 ± 0.53; 0-3 (0)	0.664
Miniscrew failure	0.01 ± 0.11; 0-1 (0)	0.01 ± 0.11; 0-1 (0)	0.01 ± 0.11; 0-1 (0)	0.01 ± 0.11; 0-1 (0)	0.801
Molar band failure	0.02 ± 0.21; 0-2 (0)	0.02 ± 0.15; 0-1 (0)	0.02 ± 0.15; 0-1 (0)	0.01 ± 0.11; 0-1 (0)	0.881
Plaque index score	1.77 ± 0.56; 1-3 (2)	1.58 ± 0.6; 0-3 (2)	1.62 ± 0.57; 1-3 (2)	1.67 ± 0.55; 1-3 (2)	0.850
Gingival index score	1.81 ± 0.49; 1-3 (2)	1.83 ± 0.47; 0-3 (2)	1.87 ± 0.44; 1-3 (2)	1.69 ± 0.47; 1-2 (2)	0.379
Pocket depth	3.58 ± 1.01; 2-6 (3)	3.28 ± 0.84; 1-5 (3)	3.42 ± 0.87; 2-5 (3)	3.4 ± 0.89; 2-5 (3)	0.898

Note. Values are mean ± standard deviation and minimum-maximum (median).
*Friedman test.

Table I presents the types and frequencies of orthodontic failures presented by the patients. Table II presents the Friedman test results of the evaluation of failure types by 4 orthodontists, in which no significant difference was found among the orthodontists.

No significant difference was found between the conventional and self-ligating bracket systems with regard to bracket bonding failure ($P = 0.454$; $P > 0.05$) (Table III), whereas the frequency of bracket bonding failure was significantly higher in men than in women ($P = 0.001$; $P < 0.01$). In contrast, no significant relationship was found between gender and periodontal parameters ($P > 0.05$) (Table IV).

A negative correlation was found between age and bracket bonding failure ($r = -118$, $P < 0.05$), whereas no significant correlation was found between plaque formation or gingival index scores and bracket bonding failure ($P > 0.05$) (Table V).

DISCUSSION

COVID-19 has led to unprecedented major health, humanitarian, and financial crises. However, to our knowledge, the effect of this pandemic on the treatment of orthodontic patients has not yet been investigated. Accordingly, the present study investigated the incidence of the failure of orthodontic appliances and periodontal health status in orthodontic patients that were reexamined after the lockdown period.

The results indicated that over the 103-day (~3.4 months) lockdown period, 15.2% of the patients had ≥1 bracket bonding failure. Littlewood and Mitchell[13] and O'Brien et al[14] evaluated the incidence of failure in brackets bonded with conventional methods in patients with a split-mouth design and reported the rates of patients who had ≥1 failure over the 6- and 12.4-month follow-up periods were 45% and 42.3%, respectively. However, these rates were reported for brackets applied by the same orthodontist in each study and for follow-up periods of 6 and 12 months, respectively. A comparison between these studies and the present study seems unlikely because the present study had a different trial design and a relatively shorter treatment duration. However, given that our study had a shorter treatment duration and that the incidence of bracket bonding failure in our study was assessed when the treatments of the patients were continuing, the incidence assessed in our study was higher than those reported in the literature. Lockdown conditions are likely to cause reduced physical activities and an increased incidence of unhealthy diets,[15] which, in turn, may lead to obesity[16] and bracket bonding failure, mainly because of the consumption of prohibited foods that may not be tolerated by the brackets.

In our study, no significant difference was found between the conventional and self-ligating bracket systems with regard to bracket bonding failure. However, previous in vitro studies reported that self-ligating brackets showed greater shear bond strength than conventional brackets.[17,18] In contrast, a previous in vivo study by Pandis et al,[19] in a similar way to our study,

Table III. Comparison of the bracket systems with regard to the frequency of bracket bonding failure

Parameter	Bracket system	N	Mean ± standard deviation	Minimum-maximum (median)	P*
Bracket bonding failure	Conventional	337	0.23 ± 0.65	0-6 (0)	0.454
	Self-ligating	13	0.31 ± 0.63	0-2 (0)	

*Mann-Whitney test.

Table IV. Sex-based comparison of failures

Parameter	Sex	n	Mean ± standard deviation	Minimum-maximum (median)	P*
Bracket bonding failure	Female	249	0.15 ± 0.46	0-3 (0)	0.001[†]
	Male	101	0.43 ± 0.94	0-6 (0)	
Elastomeric ligature detachment	Female	241	0.2 ± 0.67	0-4 (0)	0.942
	Male	96	0.25 ± 0.9	0-6 (0)	
Plaque index score	Female	249	1.64 ± 0.56	0-3 (2)	0.594
	Male	101	1.7 ± 0.59	1-3 (2)	
Gingival index score	Female	249	1.81 ± 0.49	0-3 (2)	0.504
	Male	101	1.77 ± 0.43	1-2 (2)	
Pocket depth	Female	249	3.44 ± 0.96	1-6 (3)	0.605
	Male	101	3.37 ± 0.74	2-5 (3)	

*$P <0.01$; [†]Mann-Whitney test.

Table V. Correlations between parameters

Correlations	r	P*
Age/bracket bonding failure	−0.118	0.028[†]
Plaque index score/bracket bonding failure	0	0.961
Gingival index score/bracket bonding failure	0.088	0.212

*$P <0.05$; [†]Spearman correlation coefficient.

found no significant difference between the 2 bracket systems with regard to the frequency of bonding failure.

Our male patients had a higher incidence of bracket bonding failure than female patients. Some previous studies[19-21] found no significant difference between genders with regard to bracket bonding failure, whereas Adolfsson et al,[22] in a similar way to our study, found a higher incidence of bracket bonding failure in men compared with women and suggested that this difference could be associated with the higher masticatory force in men. In contrast, numerous studies published during the COVID-19 pandemic have indicated higher anxiety scores in women than men,[23-25] which could be related to the higher sensitivity of women to the avoidance of prohibited foods.

In our study, a negative correlation was found between age and the incidence of bracket bonding failure. Interestingly, younger patients had fewer bracket bonding failures that could be attributed to the fact that the diets of children were controlled mostly by their parents during the lockdown period compared with adults.

Elastomeric ligatures are commonly used for securing orthodontic archwires into brackets. These systems are well tolerated by patients because they are highly practical and do not cause a sharp termination that may lead to oral ulceration, particularly during the lockdown. In our study, 14.54% of the patients had ≥1 incidence of elastomeric ligature detachment. Previous in vitro studies indicated that elastomeric ligatures immersed in a simulated oral environment showed approximately a 30% reduction in tensile strength after 28 days. On the basis of this finding, the authors suggested that elastomeric ligatures should be replaced at each monthly appointment to reduce the risk of rupture.[26-28] In our study, elastomeric ligatures had not been replaced over the 103-day lockdown period, which showed that elastomeric ligatures have the potential to remain stable in the oral environment despite the reduction in their strength properties.

In our study, relapse occurred in ≥1 tooth in 26.74% of patients with bonding failure or ligature detachment. This finding suggests that wire ligature could be used instead of elastomeric ligature, particularly for controlling the rotation of the teeth after the correction of the rotation.

The plaque and gingival scores of our patients were found to be remarkably higher than those reported by a study that was conducted with a similar population before the lockdown period.[29] This difference could be associated with the probable reduction in the chairside motivation of oral hygiene during monthly appointments. In turn, this reduced motivation leads to

increased concerns about gingival health and decalcification among patients.

Among patients who underwent miniscrew implantation, 8.16% had ≥1 miniscrew failure, which corresponded to 4.54% of the total number of miniscrews implanted in the patients. A previous meta-analysis indicated the overall miniscrew failure rate as 13.5%.[30] In our study, the patients had a lower incidence of miniscrew failure despite the deterioration of oral hygiene, which could be ascribed to the fact that our study covered a short period and that evaluated the maxilla only, which has been shown to have a relatively lower incidence of failure in the literature.[30]

Of the patients with a molar band, 6.81% had ≥1 incidence of molar bond failure during the lockdown period. Millett et al[31] reported that 30% of the patients who had molar bands cemented with conventional GC had ≥1 incidence of band loss. In contrast, Gillgrass et al[32] evaluated band failure with different band cement materials and reported that the overall band failure rate was 2.8% for the conventional glass ionomer. Our study had a remarkably higher rate (4.21%), which could be associated with the short period of the study and the diet changes caused by lockdown conditions, which could involve consumption of hard or sticky foods that may exceed the mechanical bonding of the band.

Our study was limited in several ways. First, there was no standardization for some parameters that could affect the failure rates in our study, including the socio-economic and dental status of the patients, classification of the malocclusion, the resultant mechanotherapy, face types, and eating habits influenced by the culture. Secondly, the study evaluated a specific population over a certain follow-up period, as in other cross-sectional studies. Accordingly, the study results may not be generalized to private clinics and/or other countries, and further studies with larger populations investigating other periods of the pandemic and patients with other orthodontic appliances in other countries are needed.

CONCLUSIONS

To our knowledge, this is the first study in the literature to investigate the effects of this unprecedented global pandemic on the treatment of orthodontic patients. The results indicated that orthodontic appliances may have higher frequencies of failure during the lockdown period than normal times and that lockdown periods may worsen the periodontal health status of the patients. Moreover, it was also revealed that the frequency of bracket bonding failure varied between male and female patients, and a negative correlation was

established between age and the frequency of bracket bonding failure. Further studies are needed to investigate the causes and solutions of orthodontic appliance failures during the lockdown periods.

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