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CLEANING METHODS AND MATERIALS FOR REMOVABLE ORTHODONTIC APPLIANCES: A QUESTIONNAIRE STUDY

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Abstract: This study aimed to identify the recommendations of orthodontists practicing in Turkey to their patients regarding the cleaning of removable orthodontic appliances (ROAs) and to analyse whether their advice was promoted by the coronavirus disease of 2019 (COVID-19) pandemic. A questionnaire link was sent via an e-mail to 1018 members of the Turkish Orthodontic Society, including an informative letter about the study. A total of 133 orthodontists answered the questionnaire acceptably. Almost all participants of this study recommended their patients to brush ROAs (94.7%). A majority of orthodontists advised to use a cleaning agent besides brushing. Patients were advised to brush generally two or three times a day and use the cleaning agent less often. A total of 77.4% of the participants stated that the COVID-19 pandemic did not change their recommendations regarding the cleaning of ROAs. A prevalent cleaning method advised by respondents was brushing. Taking into consideration the COVID-19 pandemic, orthodontists in Turkey had better increase prescription of a chemical cleaning agent for ROAs.

Keywords: Brushing, Chemical cleaning, Survey, COVID-19, Removable orthodontic appliances

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1. Introduction

Removable orthodontic appliances (ROAs) are routinely used in orthodontic practice for simple dental movements and orthopedic treatment, and as a retainer and a space maintainer. They increase the amount of microbial dental plaque due to their large surface areas, retentive parts, porous surface structures, and restriction of the flushing effect of saliva on dental and mucous tissues. Maturation of, and increase in, microbial dental plaque affects intraoral flora. The disruption of the balance in the ecosystem of the oral cavity can lead to caries, periodontal damage, candidiasis, and halitosis (Poklepovic et al., 2013). ROAs that have not been effectively cleaned, especially during the global COVID-19 pandemic, are likely to be an important source of cross-infection for clinicians, technicians, and patients in the dental clinics.

Various mechanical and chemical methods are used for the cleaning of ROAs (Duyck et al., 2016). The mechanical techniques include the use of ultrasonic devices, microwave oven, and brushing (Duyck et al., 2016). As a cheap and easily accessible method, brushing is the most preferred one among mechanical methods. The use of chemical agents is recommended to control bacterial biofilm formation in patients because mechanical methods are insufficient to completely eliminate microorganisms in some critical reactive sites on ROAs (Levrini et al., 2015; Ghazal et al., 2019). Cleaning agents can be classified into several groups according to their chemical structure and usage areas: (a) chemical disinfectants, (b) enzymes, and (c) household products (Nakamoto et al., 1991; Rueggeberg, 2009; Unlu Sogut, 2013; Kiesow et al., 2016).

Successful cleaning of ROAs depends on the individual compliance of patients and the cleaning recommendations of orthodontists. The absence of a standard protocol for the cleaning of ROAs has led to different opinions among orthodontists all over the world (Fathi et al., 2015). The purpose of this study was to investigate the advice of orthodontists in Turkey to their patients about the cleaning of ROAs and whether their advice was affected by the COVID-19 pandemic.

2. Material and Methods

The survey questions were sent to orthodontists by the Turkish Orthodontic Society (TOD) via an e-mail. A total of 1108 orthodontists were registered at TOD at the time of sending the questionnaire. The survey questions included demographic information of participants (Table 1) and their recommendations to their patients about brushing and using a cleaning agent for ROAs. In addition, whether the recommendations of participants were affected by the COVID-19 pandemic was investigated.

In this questionnaire, the participants were asked to reply 16 questions prepared via Google forms. The participants were given the opportunity to mark more than one option for some questions and asked to

complete the questionnaire by skipping some questions due to their previous answers to some questions (please see supplementary survey).

Table 1. Demographic characteristics of participants

Sex	Percentage
Female	59.4
Male	40.6
Age	
20–30	26.3
31–40	40.6
41–50	19.6
51–60	9.8
>61	3.7
Academic title	
Professor	5.3
Associate Professor	3.8
Assistant Professor/Lecturer	15.8
Orthodontic Specialist Student/Doctoral Student	20.3
Orthodontic Specialist (Orthodontist)	54.1
Retired	0.8
Years of experience	
Less than 5 years	23.3
5–10 years	34.6
10–15 years	11.3
15–20 years	6.0
More than 20 years	24.8
Occupation	
State hospital	8.3
Private	52.6
University	39.1

The questionnaire link was sent to 1108 TOD members via an e-mail. With a reminder e-mail sent after 2 weeks, the total response time of the questionnaire was 2 months. The obtained data were assessed using IBM SPSS 23.0 (IBM Corp., NY, USA). Cross-tabulation and Fisher exact test were used to analyse the relationship between the academic degrees of the participants and their answers to 4th - 11th questions. Additionally, multiple response analysis was used for some questions in which the respondents were allowed to choose more answers to one question. The participants were allowed to mark more than one option for the 12th and 13th questions. Categories with zero frequency were not included in this analysis.

2.1. Ethical Consideration

The study was approved by the Non-Interventional Clinical Research Ethics Committee of the Burdur Mehmet Akif Ersoy University (03.06.2020-2020/06-GO 2020/141).

3. Results

In this study, the questionnaire was answered acceptably by 133 orthodontists (12%), which comprised 79 women and 54 men. The average age of the participants in this study was 37.7±10.2 years (Table 1). They included 7 professors, 5 associate professors, 21 assistant professors/lecturers, 27 orthodontic specialist students/doctoral students, 72 orthodontic specialists (orthodontists), and 1 retired orthodontist. Considering the experience in the field of orthodontics, the time elapsed since the beginning of the specialty education was 0–10 years for 59.4% of the participants. Out of all the respondents, 8.3% were state hospital specialists, 52.6% were private practice clinicians, and 39.1% were university academic personnel. The answers given by the participants regarding their recommendations for cleaning ROAs, including brushing and use of cleaning agent, are given in supplementary survey. According to the Cross-tabulation and Fisher exact test, no statistically significant relationship was found between the answers and the academic degree, except for the 10th question ($P < 0.05$) (Table 2).

According to multiple response analysis, all participants in this study, regardless of their academic titles, recommended bleach, liquid soap, commercial solution, commercial agent, and other options at a similar rate. The toothpaste option received different amounts of advice from the participants according to multiple response analysis. Table 2 shows that there were statistically significant differences between the professors and orthodontic specialist students/doctoral students about the toothpaste option. Professors recommended a high rate of the use of toothpaste, while low rates were recommended by orthodontic specialist students/doctoral students. According to multiple response analysis, a similar relationship was found between associate professors and orthodontic specialists among the participants who marked the vinegar option (Table 2).

A majority of participants in this study stated that the COVID-19 pandemic did not cause a change in their advice to their patients regarding the cleaning of ROAs. Additionally, most of the participants reported that they would disinfect the removable orthodontic appliances in their clinics using the materials and methods recommended by the infection committee.

4. Discussion

Methods used for mechanical cleaning of ROAs included brushing and using microwave ovens and ultrasonic devices (Nikawa et al., 1999). The use of microwave ovens has restrictions such as the lack of usage standardization and possible damage to the appliance structure and the presence in certain centers (Klironomos et al., 2015). Ultrasonic devices are similarly found in limited centres and can cause cross-infection (Cruz et al., 2011). The cheapest and most preferred mechanical method is brushing (Eichenauer et al., 2011; Lamas et al., 2016; Tsolakis et al., 2019).

Since mechanical methods are insufficient to completely destroy microorganisms in some critical reactive sites in

ROAs, the use of chemical agents to control microbial biofilm formation in individuals is recommended (Paranhos et al., 2007; Levrini et al., 2015; Ghazal et al., 2019).

The participation rate of this study (12%) was lower than that of similar study performed in Turkey (Yetkiner et al., 2014). This may be due to the fact that excessive questionnaire participation e-mails were sent via TOD, so rate of the participants might have decreased. The majority of participants in this study were middle-aged, female, and orthodontic specialists (orthodontist).

Table 2. Frequency and percentage distribution of participants' recommendations on the cleaning of ROAs and its association with different academic degrees

	Associate Professor		Assistant Professor/Lecturer		Orthodontic Specialist (Orthodontists)		Professor		Retired		Orthodontic Specialist Student/Doctoral Student		
	n	%	n	%	n	%	n	%	n	%	n	%	P
Q 6: Recommendation of brushing													
Yes	5	4.0	21	16.7	68	54.0	7	5.6	1	0.8	24	19.0	.60*
No	0	0.0	0	0.0	4	57.1	0	0.0	0	0.0	3	42.9	
Q 7: Recommendation of an extra brush													
Yes	3	4.2	14	19.4	38	52.8	2	2.8	1	1.4	14	19.4	.59*
No	2	3.7	7	13.0	30	55.6	5	9.3	0	0.0	10	18.5	
Q 8: Recommendation of the softness of the brush													
Soft	1	11.1	1	11.1	5	55.6	1	11.1	0	0.0	1	11.1	.071*
Medium	2	4.8	11	26.2	20	47.6	4	9.5	0	0.0	5	11.9	
Hard	0	0.0	0	0.0	5	83.3	0	0.0	1	16.7	0	0.0	
No comment	2	3.0	8	11.9	37	55.2	2	3.0	0	0.0	18	26.9	
Q 9: Recommendation of the frequency of tooth brushing													
Less than once a day	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	.272*
Once a day	2	5.9	3	8.8	22	64.7	1	2.9	0	0.0	6	17.6	
Twice a day	1	2.9	10	28.6	18	51.4	1	2.9	0	0.0	5	14.3	
Three times a day	2	4.9	4	9.8	22	53.7	2	4.9	1	2.4	10	24.4	
More than three times a day	0	0.0	2	14.3	6	42.9	3	21.4	0	0.0	3	21.4	
Q 10: Recommendation of cleaning agent besides brushing													
Yes	5	5.2	15	15.5	59	60.8	5	5.2	0	0.0	13	13.4	.006*
No	0	0.0	6	20.7	9	31.0	2	6.9	1	3.4	11	37.9	
Q 11: Recommendation of cleaning agent except brushing													
Yes	3	7.1	1	9.1	8	72.7	2	4.8	0	0.0	2	18.2	1.000*
No	0	0.0	0	0.0	4	80.0	0	0.0	0	0.0	1	20.0	
Q 12: Recommendation of types of cleaning agent													
Household bleach	1^{a}	20.0	0	0.0	2^{a}	3.3	0	0.0	0	0.0	0	0.0	**
Toothpaste	$1^{a,c,d}$	20.0	$2^{a,b}$	13.3	$20^{a,c,d}$	32.8	4^{c}	80.0	0	0.0	$1^{b,d}$	6.7	
Liquid soap	2^{a}	40.0	8^{a}	53.3	35^{a}	57.4	1^{a}	20.0	0	0.0	12^{a}	80.0	
Vinegar	2^{a}	40.0	$3^{a,b}$	20.0	3^{b}	4.9	$1^{a,b}$	20.0	0	0.0	$1^{a,b}$	6.7	
Commercial mouthwash	0	0.0	1^{a}	6.7	5^{a}	8.2	1^{a}	20.0	0	0.0	1^{a}	6.7	
Commercial cleaning tablets	3^{a}	60.0	8^{a}	53.3	44^{a}	72.1	3^{a}	60.0	0	0.0	8^{a}	53.3	
Other	0	0.0	1^{a}	6.7	4^{a}	6.6	0	0.0	0	0.0	0	0.0	
Q 13: Recommendation of the frequency of cleaning agent													
Less than once a day	2^{a}	40.0	2^{a}	13.3	11^{a}	18.0	2^{a}	50.0	0	0.0	0	0.0	**
Once a day	2^{a}	40.0	3^{a}	20.0	24^{a}	39.3	0	0.0	0	0.0	6^{a}	37.5	
Twice a day	1^{a}	20.0	7^{a}	46.7	9^{a}	14.8	1^{a}	25.0	0	0.0	5^{a}	31.3	
Three times a day	1^{a}	20.0	1^{a}	6.7	7^{a}	11.5	1^{a}	25.0	0	0.0	5^{a}	31.3	
More than three times a day	0	0.0	0	0.0	2^{a}	3.3	0	0.0	0	0.0	0	0.0	
According to the manufacturers' instructions	1^{a}	20.0	3^{a}	20.0	16^{a}	26.	0	0.0	0	0.0	1^{a}	6.3	

P < 0.05; Q = question; *cross-tabulation with the Fisher exact test; **multiple response analysis. ^{a,b,c,d}A relationship exists between groups indicated by the same letter in a line.

The participants mostly continued their profession as a private practitioner and had less than 10 years of professional experience. Similar results with the aforementioned data were reported in a questionnaire

study performed on orthodontists in Turkey (Paşaoğlu et al., 2016).

The brushing recommendation rate of orthodontists in Turkey to their patients using ROAs was 94.7%. Similarly, about 99.4% of Greek orthodontists, 84% of Brazilian orthodontists, and 99.8% of German orthodontists advised brushing ROAs to their patients (Eichenauer et al., 2011; Lamas et al., 2016; Tsolakis et al., 2019). The recommendation of brushing in all academic degrees as at high rates and no statically difference demonstrates crystal clear the effectiveness of brushing ($p>0.05$). Further, 57.1% of orthodontists who participated in this study recommended the use of a brush different from their toothbrush. Moreover, 54% of the participants who recommended brushing of ROAs to their patients did not advise about brush stiffness. The proportion of participants who recommended the use of soft brushes for ROAs was 7.3%. The reason may be that ROAs were used for a short time compared with dentures. Herewith, this could be lead ignorance of the potential side effects of brushing on the appliances. Most of the participants advised their patients to brush their appliances two or more times a day. They probably advised their patients to brush their appliances after brushing their teeth. Consequently, the reason for the lack of statistically significant similarity among the participants at all academic degrees on an extra brush recommendation, hardness of brush and frequency of brushing may be the lack of a gold standard stated in the literature on this subject.

Moreover, 76.9% of the participants recommended their patients to use a cleaning agent for cleaning their ROAs besides brushing them. Similarly, a majority of Greek, Brazilian, and German orthodontists proposed brushing and the use of a cleaning agent for cleaning ROAs (Eichenauer et al., 2011; Lamas et al., 2016; Tsolakis et al., 2019). Cleaning agents mostly recommended by orthodontists in Turkey were commercial, removable appliance-cleaning tablets and liquid soap (Please see supplementary survey). Besides brushing, German orthodontists recommended 90% toothpaste, Brazilian orthodontists recommended 74.4% toothpaste, and Greek orthodontists recommended about 70.06% denture cleansers (Eichenauer et al., 2011; Lamas et al., 2016; Tsolakis et al., 2019). The reason of professors' toothpaste recommendation to their patients, who were the most academically experienced group in this study, might be the easy access to toothpaste, as similar to the aforementioned studies. The participants of this study recommended using these cleaning agents mostly once a day. The reason may be that the companies manufacturing commercial removable appliance-cleaning tablets (denture cleansers) often recommend it once a day. However, Greek orthodontists recommended the use of cleaning agents few times a week (Tsolakis et al., 2019).

Further, 77.4% of participants of this study stated that the COVID-19 pandemic did not change the aforementioned recommendations. Also, 72.2% of the respondents said that they cleaned ROAs with any safe disinfectant available in their clinics before the COVID-19 pandemic, while 56.4% of them said that they would continue in the same manner after the pandemic. In other words, more than half of the participants believed that the efficient cleaning of ROAs was achieved in the clinic.

Hygiene of ROAs is important for the systemic and oral health of patients. The cleaning of removable devices is also extremely important for both dental team members and other patients due to the risk of cross-infection. However, still no consensus exists on the cleaning of ROAs for international dental healthcare workers. Further clinical and microbiological investigations are required to determine the ideal cleaning method. After the COVID-19 pandemic, the cleaning of ROAs has become vital. Reliable scientific data are needed to clarify the relationship of unfamiliar COVID infection with dental procedures and treatments.

Including a small population and a limited number of questions could be the limitations of this study. More significant results could be obtained by using a wider population and more questions.

5. Conclusion

In conclusion, the most prescribed cleaning method by orthodontists in Turkey was brushing. In addition, a majority of participants recommended extra cleaning agents complementary to brushing. The COVID-19 pandemic did not cause a difference in Turkish orthodontists' advice to their patients regarding the cleaning of ROAs.

Author Contributions

All tasks have been performed by single author.

Conflict of Interest

The author declares that there is no conflict of interest.

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