

Adherence to Dietary Advice and Oral Hygiene Practices Among Orthodontic Patients

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Introduction: Adherence to dietary advice and proper oral hygiene practices during orthodontic treatment are critical to maintaining good oral health and achieving successful treatment results. Thus, understanding patients' habits and practices before, during, and after orthodontic treatment is needed to ensure better oral health-related behavior among these patients.

Purpose: To investigate sugar-related dietary habits, visits to dental hygienists and dentists, and oral hygiene practices among patients during orthodontic treatment and after treatment compared to patients before treatment.

Methods: A cross-sectional self-administered survey collected data from 375 patients (aged 10 years and older) from the Orthodontic Department at King Abdulaziz University Dental Hospital, Jeddah, Saudi Arabia. Patients were grouped according to their history of receiving orthodontic treatment into: patients before orthodontic treatment, patients during treatment, and patients after treatment. The survey assessed sugar-related dietary habits, frequency of visits to hygienists and dentists, and oral hygiene practices.

Results: Patients during orthodontic treatment and those after treatment were less likely to eat sticky food compared to patients before treatment (OR=0.4, 95% CI=0.2–0.9 and OR=0.5, 95% CI=0.3–0.9, respectively). No significant differences were found in the odds of dental visits among the groups. Compared to patients before orthodontic treatment, patients during treatment and patients after treatment had higher odds of tooth brushing twice or more per day (OR=4.8, 95% CI=1.7–14.3, and OR=4.0, 95% CI=1.2–13.6, respectively) and were more likely to brush for an adequate time (OR=2.6, 95% CI=1.6–4.4 and OR=1.9, 95% CI=1.0–3.5, respectively). Moreover, the likelihood of flossing once daily was higher in patients during treatment and in patients after treatment relative to those before treatment. However, only patients during orthodontic treatment used interdental brushes more than patients before treatment.

Conclusion: Patients' oral health-related behavior seems to improve during and after orthodontic treatment. The findings of this study suggest that orthodontists can play a role in improving oral hygiene practices among their patients. More reinforcement of dietary instructions and periodic dental and hygiene visits is needed during orthodontic follow-up appointments.

Keywords: oral health, orthodontic appliances, diet, dental hygienist, dentist, toothbrushing

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Introduction

The orthodontic practice has attracted many patients who choose to have orthodontic treatment to improve their dental esthetics and function. Its popularity can also be related to positive effects of orthodontic treatment on patients' self-regard and social interaction.¹ It has been shown that malocclusion can negatively affect

patients' oral health-related quality of life, especially the psychological aspects.² By addressing malocclusion, orthodontic treatment can enhance individuals' dental function and esthetics as well as their social wellbeing and quality of life.

Orthodontic treatment may impact oral hygiene, given that orthodontic appliances tend to retain food debris and plaque and pose a great challenge when cleaned.³ Adherence to oral hygiene practices, particularly during orthodontic treatment, is critical for maintaining good oral health. Poor oral hygiene can lead to permanent damage to dental tissues ranging from white spot lesions to dental caries.⁴ Moreover, recent research has shown an increase in dental plaque after placement of fixed orthodontic appliances.⁵ Failure to remove dental plaque during orthodontic treatment can be detrimental to periodontal health and may lead to the development of gingivitis and periodontitis.^{6,7} The impact of periodontal health on general health is significant and cannot be neglected. In recent years, there has been an increasing amount of literature on the links between periodontitis and coronary heart disease.^{8,9} Breakthroughs in biomarker research found an association between periodontitis and increased serum levels of various inflammatory biomarkers.^{10–12} In order to maintain good oral and periodontal health, orthodontic patients are required to practice optimal oral hygiene measures such as brushing their teeth at least twice a day and using additional tools including interdental aids and mouthwash.¹³ Therefore, maintaining an adequate level of oral hygiene during orthodontic treatment requires commitment from the patient to practice good oral hygiene measures and to develop skills that demand time, effort, and motivation.

Orthodontic treatment may also have an influence on patients' ways of eating. Patients may change their dietary habits and turn to softer food, as eating with orthodontic appliances is uncomfortable for them.^{14–17} In addition, orthodontic patients are instructed to minimize their consumption of sugary and sticky food since the risk of caries and white spot lesions is associated with increased consumption of sugar.^{18–22}

Patient adherence to oral hygiene and dietary instructions during orthodontic treatment is as important a compliance factor as regular visits and maintenance of appliances since these are all critical for obtaining successful clinical results.²³ Hence, patient selection, education, and motivation are essential steps that must be undertaken

before commencing orthodontic treatment. Furthermore, oral hygiene advice and periodic follow-up by dental professionals are important for achieving the required level of oral health awareness and maintaining patients' motivation.

Understanding orthodontic patients' oral hygiene practices, dietary habits and dental visits is useful in guiding orthodontists and dentists to ensure optimal oral health-related behaviors among these patients. Therefore, the purpose of this study is to investigate the differences in sugar-related dietary habits, visits to dental hygienists and dentists, and oral hygiene practices among patients during orthodontic treatment, and patients after treatment, compared to patients before the start of orthodontic treatment.

Methods

This cross-sectional study was approved by the Research Ethics Committee of the Faculty of Dentistry at King Abdulaziz University, Jeddah, Saudi Arabia (approval # 017–01-19) and was carried out in accordance with the principles of the Declaration of Helsinki. A comprehensive electronic survey was designed to understand the dietary habits and oral health-related behaviors among orthodontic patients. Survey questions were thoroughly reviewed by a panel consisting of two orthodontists and two dentists to ensure readability and validity of the questions. Any unfavorable ambiguous question was rephrased or removed.

Patients, aged 10 years and older, registered in the patients' list of the Orthodontic Department at King Abdulaziz University Dental Hospital were invited to participate in the study. The patients' list includes patients screened in preparation for orthodontic treatment, patients currently undergoing orthodontic treatment, as well as patients who finished their orthodontic treatment within the past 5 years. The survey was sent electronically to patients' registered phone numbers. Study objectives were clearly communicated in the survey invitation and patients were informed that their contribution is voluntary and anonymous. Parents or guardians were invited to fill the survey for their young children. Completing the survey was considered a consent to participate in the study. Sample size estimation was done using G*Power 3.1.9.2. Considering a previous study by Petrauskiene et al²⁴ we estimated that at least 368 subjects are required to achieve a power = 0.9, at alpha = 0.05, to detect an OR = 1.8 between the groups. Data collection was conducted between March and July 2019. The survey was sent to 800 patients. Of those, 375 patients completed the questionnaire.

The questionnaire initially asked patients whether they have ever received orthodontic treatment. Based on their response to this question, participants were divided into three groups: patients before the start of orthodontic treatment (G1), patients during orthodontic treatment (G2), and patients who finished orthodontic treatment (G3). Participants who never had orthodontic treatment and were not interested in receiving treatment were excluded from the study. The outcome measures were sugar-related dietary habits, attendance to dental hygiene and dental visits, and oral hygiene practices. Sugar-related dietary habits were evaluated by two questions: “how frequently do you consume sugar?” and “how frequent do you eat sticky food?”. Responses were rated on a 5-point Likert scale ranging from “never” to “always”. Frequency of visits to the dental hygienist was also assessed on the same Likert scale. Due to small frequencies, responses were grouped into “never/rarely”, “sometimes”, and “usually/always”. Dental visits were evaluated by asking participants “How often do you visit your dentist?”. Responses were either “when I have a dental problem”, “once a year”, or “twice a year”. Oral hygiene practices were assessed by measuring tooth brushing frequency (responses were “irregularly”, “once a day”, or “twice or more a day”), and duration (“≤1minute” or “≥2 minutes”). We also evaluated the use of auxiliary oral hygiene measures including the use of mouthwash (responses ranged from “never” to “always”), the use of the dental floss and interdental brushes (both measured on a scale ranging from “never” to “twice or more/day”). The survey also incorporated questions about demographics, namely, gender, age group, education, marital status and employment status. (Detailed questionnaire in [Appendix 1](#)). Reliability of the survey questions was evaluated using weighted Cohen’s kappa by requesting 10 individuals to answer the questionnaire two times with a two-week interval. Intrarater reliability of questions ranged from 0.82 to 0.9 indicating very good agreement.

Statistical analyses were carried out using IBM SPSS Statistics for Macintosh, Version 25.0 (IBM Corp, Armonk, NY). Frequency distribution of study variables was computed. Chi-square tests were used to assess the differences in demographics, dietary habits, dental hygienist and dental visits, as well as oral hygiene practices among the three study groups. Multivariate logistic regression analyses (multinomial and binary logistic regression models) were used to predict the adjusted odds of each outcome variable among patients during orthodontic

treatment (G2), and those after orthodontic treatment (G3) compared to patients before orthodontic treatment (G1) while adjusting for demographic variables. Statistical significance was tested at $\alpha=0.05$.

Results

A total of 375 patients (G1 =108, G2= 165, and G3= 102) participated in the study. The majority of the participants were females (73.1%), while 26.9% were males. Approximately one-third of G2 patients were males, compared to 29.6% of patients in G1 and only 14.7% of those in G3 ($P=0.004$). [Table 1](#) summarizes the demographic characteristics of patients in the three groups. Generally, there were statistically significant differences in the distribution of demographic characteristics among the three study groups. Patients in G3 were significantly older than G1 and G2 patients ($P<0.001$). Significant differences in the educational level of the participants were also found with G3 patients being more likely to have higher educational attainment compared to G1 and G2 participants ($P<0.001$). Most of the participants were single. G2

Table 1 Demographic Characteristics of Study Participants (N= 375)

Variables	n	G1 ^{a, b} (n = 108)	G2 ^{a, c} (n = 165)	G3 ^{a, d} (n = 102)
Gender*				
Male	101	29.6%	32.7%	14.7%
Female	274	70.4%	67.3%	85.3%
Age**				
<18 years	90	27.8%	31.5%	7.8%
18–25 years	176	42.6%	48.5%	49.0%
≥ 26 years	109	29.6%	20.0%	43.1%
Education**				
School student	88	31.5%	27.9%	7.8%
High school diploma	89	30.6%	24.8%	14.7%
Intermediate diploma	11	2.8%	3.6%	2.0%
Bachelor's degree	169	33.3%	41.2%	63.7%
Postgraduate degree	18	1.9%	2.4%	11.8%
Marital status**				
Single	289	79.6%	86.1%	59.8%
Married	86	20.4%	13.9%	40.2%
Employment*				
Student	216	61.1%	65.5%	41.2%
Unemployed	85	24.1%	16.4%	31.4%
Employed	74	14.8%	18.2%	27.5%

Notes: *P value <0.01; **P value <0.001. ^aColumn percent. ^bG1 is patients before orthodontic treatment. ^cG2 is patients during orthodontic treatment. ^dG3 is patients after orthodontic treatment.

patients were most likely to be single (86.1%) compared to 79.6% of G1 patients, and 59.8% of patients in G3 ($P<0.001$). Furthermore, G1 and G2 had more students and less employed participants, compared to G3 ($P=0.001$).

Comparisons of sugar-related dietary habits, dental hygienist visits, and dental visits among the study groups are presented in Table 2. There were no significant differences in the frequency of sugar consumption, or the frequency of eating sticky food among the three groups ($P=0.9$ and $P=0.07$, respectively). Approximately 16% of all participants reported visiting the dental hygienist usually or always, and the frequency of dental hygiene visits varied significantly among the groups ($P=0.005$). Most of the participants reported visiting a dentist only when they have a problem. Although G2 participants were less likely to visit the dentist twice a year, there were no significant differences in dental attendance among the three groups ($P=0.4$).

Table 3 presents results from multinomial logistic regression models predicting dietary habits and attendance

to hygiene and dental visits among study participants. After controlling for demographic confounders, the odds of consuming sugar in G3, and consuming sugar sometimes in G2 were higher relative to G1. However, these associations were not statistically significant (model 1). The frequency of sticky food consumption differed significantly among the three groups. G3 patients were 50% less likely to eat sticky food sometimes than never or rarely, compared to patients in G1 (OR= 0.5, 95% CI=0.3–0.9). Moreover, compared to G1 patients, patients in G2 were 60% less likely to eat sticky food usually or always (OR= 0.4, 95% CI=0.2–0.9) (model 2). Model 3 shows the adjusted odds of hygienist visits in G2 and G3 patients, relative to G1. G3 patients were 70% less likely to visit the hygienist sometimes than never or rarely when compared to G1. Both G2 and G3 had higher, yet not statistically significant, odds of visiting the hygienist usually to always compared to G1. Dental attendance in G2 patients did not differ significantly from that of G1 patients. While G3 patients had higher odds of visiting a dentist relative to G1 patients, the association was not statistically significant (OR= 1.1, 95% CI=0.4–2.7 and OR= 2.3, 95% CI=1.0–5.5, for dental visits once/year and twice/year, respectively).

A comparison of oral hygiene practices among participants in the three groups is shown in Table 4. About 78% of all participants reported brushing twice a day or more, with 87.3% of G2 patients brushing twice or more daily compared to 70.4% and 71.6% of G1 and G3 patients, respectively ($P<0.001$). Patients in G2 were also more likely brush for 2 minutes or more ($P=0.001$). Significant differences were found in the use of mouthwash ($P=0.004$) and interdental brushes ($P<0.001$) among the three groups. Nevertheless, no statistically significant differences were found in dental floss use ($P=0.08$).

Adjusted odds of oral hygiene practices in G2 and G3 in relation to G1 are presented in Table 5. Generally, G2 and G3 patients had better tooth brushing practices relative to G1 patients. Patients in G2 had 4.8 times the odds of brushing their teeth 2 times or more per day compared to G1 patients. Moreover, G3 patients had significantly higher odds of brushing their teeth once a day and twice or more per day compared to G1 (OR=5.4, 95% CI=1.4–20.7 for brushing once/day, and OR= 4.0, 95% CI=1.2–13.6 for brushing twice or more/day). Additionally, the odds of brushing for 2 minutes or more were, respectively, 2.6 and 1.9 times greater among G2 and G3 patients relative to patients in G1 (model 6). Regarding the use of adjunctive

Table 2 Comparison of Dietary Habits, Hygienist Visits, and Dental Visits Among Study Participants (N= 375)

Variables	n	G1 ^{a, b} (n = 108)	G2 ^{a, c} (n = 165)	G3 ^{a, d} (n = 102)
How frequent do you consume sugar?				
Never/rarely	36	11.1%	9.1%	8.8%
Sometimes	136	32.4%	38.8%	36.3%
Usually/always	203	56.5%	52.1%	54.9%
How frequent do you eat sticky food?				
Never/rarely	165	34.3%	45.5%	52.0%
Sometimes	174	52.8%	47.3%	38.2%
Usually/always	36	13.0%	7.3%	9.8%
How often do you visit the dental hygienist?*				
Never/rarely	145	33.3%	38.2%	45.1%
Sometimes	169	57.4%	44.8%	32.4%
Usually/always	61	9.3%	17.0%	22.5%
How often do you visit your dentist?				
When I have a problem	280	76.9%	77.0%	68.6%
Once a year	49	11.1%	13.3%	14.7%
Twice a year	46	12.0%	9.7%	16.7%

Notes: *P value <0.01. ^aColumn percent. ^bG1, patients before orthodontic treatment; ^cG2, patients during orthodontic treatment; ^dG3, patients after orthodontic treatment.

Table 3 Adjusted Odds Ratios for Dietary Habits, Hygienist Visits, and Dental Visits Among Study Participants (N=375)^a

Model	Patient Group	Adjusted OR (95% CI)		
		How frequent do you consume sugar?		
		Never/ rarely	Sometimes	Usually/always
1	G1 G2 G3	Ref.	Ref. 1.3 (0.5–3.2) 1.6 (0.6–4.5)	Ref. 1.0 (0.4–2.4) 1.5 (0.6–4.2)
		How frequent do you eat sticky food?		
		Never/ rarely	Sometimes	Usually/always
2	G1 G2 G3	Ref.	Ref. 0.6 (0.4–1.1) 0.5 (0.3–0.9)*	Ref. 0.4 (0.2–0.9)* 0.7 (0.3–2.0)
		How often do you visit the dental hygienist?		
		Never/ rarely	Sometimes	Usually/always
3	G1 G2 G3	Ref.	Ref. 0.6 (0.4–1.1) 0.3 (0.2–0.6)**	Ref. 1.6 (0.7–3.8) 1.8 (0.7–4.6)
		How often do you visit your dentist?		
		When I have a problem	Once a year	Twice a year
4	G1 G2 G3	Ref.	Ref. 1.1 (0.5–2.4) 1.1 (0.4–2.7)	Ref. 0.8 (0.4–1.9) 2.3 (1.0–5.5)

Notes: ^aThe reference group is G1, patients before orthodontic treatment; G2, patients during orthodontic treatment; and G3, patients after orthodontic treatment. *P value <0.05; **P value <0.01. Models 1 and 2 are adjusted for gender, marital status and employment. Models 3 and 4 are adjusted for gender, age, education and marital status.

oral hygiene measures, G2 patients had higher, yet not significant, odds of using mouthwash sometimes and usually/always in relation to G1. There were no significant differences in mouthwash use between G3 patients compared to G1 (model 7). The odds of using the dental floss once a day were greater among G2 and G3 patients compared to G1 (OR=2.6, 95% CI=1.2–5.7 and OR= 2.5, 95% CI=1.1–6.1, for G2 and G3, respectively). Nevertheless, the odds of flossing twice or more a day did not differ significantly between G2 and G3 relative to G1. Model 9 shows the adjusted odds of interdental brush use among participants. Compared to G1 patients, G2 patients had higher odds of using interdental brushes. The use of interdental brushes in G3 patients nevertheless did not differ significantly than that in G1 patients.

Discussion

Oral hygiene practices are considered the most constant adherence factor among orthodontic patients.²⁵ On the one hand, their adherence to oral hygiene and dietary advice is crucial for the success of their orthodontic treatment. On the other hand, the lack of adherence might lead to dental and periodontal damage. Thus, this study was conducted to examine the differences in sugar-related dietary habits, visits to dental hygienists and dentists, and oral hygiene practices among patients during and after orthodontic treatment compared to patients before the start of treatment. The findings of the current study indicated that patients under active treatment and even those after treatment had better oral hygiene practices and consumed sticky food less frequently compared to patients before treatment.

Table 4 Comparison of Oral Hygiene Practices Among Study Participants (N=375)

Variables	n	G1 ^{a, b} (n = 108)	G2 ^{a, c} (n = 165)	G3 ^{a, d} (n = 102)
Tooth brushing frequency**				
Irregularly	22	12.0%	3.0%	3.9%
Once/day	60	17.6%	9.7%	24.5%
Twice or more/day	293	70.4%	87.3%	71.6%
Tooth brushing duration*				
≤ 1 minute	173	59.3%	36.4%	48.0%
≥ 2 minutes	202	40.7%	63.6%	52.0%
Use of mouthwash*				
Never	82	22.2%	19.4%	25.5%
Rarely	87	26.9%	14.5%	33.3%
Sometimes	163	39.8%	52.7%	32.4%
Usually or always	43	11.1%	13.3%	8.8%
Use of dental floss				
Never	104	36.1%	26.1%	21.6%
Irregular	155	38.0%	40.6%	46.1%
Once a day	79	13.0%	24.8%	23.5%
Twice or more/day	37	13.0%	8.5%	8.8%
Use of interdental brush**				
Never	124	43.5%	20.0%	43.1%
Irregular	92	20.4%	26.7%	25.5%
Once a day	74	16.7%	24.8%	14.7%
Twice or more/day	85	19.4%	28.5%	16.7%

Notes: *P value <0.01; **P value <0.001. ^aColumn percent. ^bG1, patients before orthodontic treatment; ^cG2, patients during orthodontic treatment; ^dG3, patients after orthodontic treatment.

The average age of active orthodontic patients in this study was older (68.5% >18 years) compared to those in previous studies, which investigated younger participants.^{26–28} The increased number of responses among adults could be due to the method used for survey invitation, which was sent to patients' registered phone numbers. In this study, the majority of the participants were females (73.1%), with males comprising 26.9% of the sample. This distribution of gender is consistent with the literature and with the distribution of patients who attend orthodontic practice and seek orthodontic treatment.^{24,26,27,29,30} This might be because females are more concerned about esthetics than males and have a higher demand for orthodontic treatment.^{31,32} However, some studies reported different patterns of gender distribution, with more males undergoing orthodontic treatment than females.^{33,34}

Diet is an important component of oral health as the kind of food trapped between brackets affects the type of plaque that can build up. Increased sugar intake can be a risk factor for caries and white spot lesions.³⁵ In addition, sticky food is more likely to get stuck between brackets for a longer time. Thus, patients are advised by orthodontists to avoid eating sticky food and reduce their sugar consumption. The present study found a high level of sugar consumption among all patients (52.1–56.5%). Moreover, although not statistically significant, sugar consumption was higher in patients during and after treatment compared to controls. Nadar et al reported a similar finding with only 50% of patients avoiding sugar.³⁶ However, a previous study reported a lower sugar consumption among patients during orthodontic treatment (14%).³⁷ Although sugar consumption did not vary significantly among the groups, patients under active treatment and those after treatment were significantly less likely to consume sticky food compared to patients before treatment.

Orthodontic treatment may cause dietary changes since some patients may opt to eat less frequently due to the constant need to brush their teeth to eliminate the food trapped in their appliances.¹⁷ In addition, their diet can be influenced by instructions from the orthodontists to avoid sweets as well as hard and sticky food. Thus, they are likely to adhere to a soft diet to maintain the appliances. However, patients may fail to follow their orthodontist's advice on sugary and sticky food as their effects on teeth are not immediate. In addition, some may still prefer to consume these types of foods and overcome the risks by simply brushing their teeth more frequently. Changing dietary habits during orthodontic treatment is related to age in that it is more significant among adults (>18), who are more aware of consequences than younger patients.³⁸ The latter are less likely to consider their orthodontist's advice and change their dietary habits.^{39,40} Patients may also find it difficult to follow their orthodontist's advice completely and change their dietary habits as they find the advice unrealistic.^{40,41} The findings of this and previous studies highlight the importance of dealing with patients' expectations as well as reinforcing dietary advice through informed consent and constant reminders during follow-up visits.

The results of this study indicated higher odds of frequent visits to hygienists among the patients during and after orthodontic treatment. However, after controlling for demographics, the odds of these patients visiting a hygienist usually or always were not significantly different than in

Table 5 Adjusted Odds Ratios for Oral Hygiene Practices Among Study Participants (N=375)^a

Model	Patient Group	Adjusted OR (95% CI)			
		Tooth brushing frequency			
		Irregularly	Once/day	≥ 2 times/day	
5	G1	Ref.	Ref.	Ref.	
	G2		2.2 (0.6–7.7)	4.8 (1.7–14.3)**	
	G3		5.4 (1.4–20.7)*	4.0 (1.2–13.6)*	
		Tooth brushing duration			
		≤ 1 minute	≥ 2 minutes		
6	G1	Ref.	Ref.		
	G2		2.6 (1.6–4.4)***		
	G3		1.9 (1.0–3.5)*		
		Use of mouthwash			
		Never	Rarely	Sometimes	Usually/always
7	G1	Ref.	Ref.	Ref.	Ref.
	G2		0.6 (0.3–1.3)	1.4 (0.7–2.7)	1.4 (0.7–2.7)
	G3		0.9 (0.4–2.1)	0.5 (0.2–1.0)	0.5 (0.2–1.0)
		Use of dental floss			
		Never	Irregular	Once/day	≥ 2 times/day
8	G1	Ref.	Ref.	Ref.	Ref.
	G2		1.5 (0.8–2.7)	2.6 (1.2–5.7)*	1.0 (0.4–2.3)
	G3		2.0 (1.0–4.1)	2.5 (1.1–6.1)*	1.2 (0.4–3.2)
		Use of interdental brush			
		Never	Irregular	Once/day	≥ 2 times/day
9	G1	Ref.	Ref.	Ref.	Ref.
	G2		2.9 (1.5–5.8)**	3.3 (1.6–6.8)**	3.4 (1.7–6.9)***
	G3		1.1 (0.5–2.3)	0.8 (0.4–1.9)	0.8 (0.3–1.7)

Notes: ^aThe reference group is G1, patients before orthodontic treatment; G2, patients during orthodontic treatment, and G3, patients after orthodontic treatment. *P value <0.05; **P value <0.01; ***P value <0.001. Models 5 and 9 are adjusted for gender, age, and marital status. Model 6 is adjusted for gender, age, education, and marital status. Model 7 is adjusted for gender, age, education, and employment. Model 8 is adjusted for gender, age, marital status and employment.

controls. Furthermore, patients after treatment were significantly less likely to visit a hygienist sometimes. Previous studies indicated more frequent visits to dental hygienists by orthodontic patients.^{24,42} In contrast, Atassi and Awartani reported a low frequency of visits to hygienists among orthodontic patients, though there was no control group in their study.³⁷ The frequency of dental visits in this study also did not differ significantly between the groups. Petrauskiene et al reported better dental attendance among patients that underwent orthodontic treatment. However, their study focused mainly on adolescents.²⁴

The most important step in the mechanical removal of dental plaque is brushing teeth at least twice a day for

a minimum of two minutes. Proper brushing is vital for ensuring dental and gingival health. In fact, brushing frequency is correlated with gingival enlargement.³⁴ In this study, patients under active orthodontic treatment (G2) and those after treatment (G3) were significantly more likely to brush their teeth twice per day or more. These patients also had higher odds of brushing their teeth for two minutes or more in comparison to the control group (G1). Many studies observed a high percentage (>90%) of orthodontic patients brushing their teeth at least twice a day.^{27–29,43} In comparison, other studies reported reduced adherence to toothbrushing (<65%).^{26,30,33,34,37} These varying findings could be attributed to several reasons, such as differences

in demographic factors or oral hygiene advice protocols implemented in the different countries and hospitals investigated in these studies.

The use of dental floss is associated with better gingival health in orthodontic patients.⁴⁴ However, only 33.3% of active orthodontic patients in this study reported using the dental floss once a day or more. Atassi and Awartani described that, among Saudi orthodontic patients, the use of dental floss was as low as 6%.³⁷ Furthermore, Martignon et al indicated less frequent dental floss use among orthodontic patients compared to the reference group.⁴³ These findings can be explained by the fact that dental floss cannot be easily used in the presence of fixed orthodontic appliances. Thus, patients might be reluctant to use it while undergoing orthodontic treatment.

Slightly more than half of active orthodontic patients in this study used an interdental brush at least once daily. Previous studies, meanwhile, reported low utilization of interdental brushes (7–23%) among orthodontic patients.^{28,30,33,37} Collectively, the findings showed that the use of interdental tools, such as dental floss and interdental brushes, was significantly higher among the patients under active orthodontic treatment (G2) compared to the control group (G1). Similar findings were described by Petrauskiene et al.²⁴ In contrast, many other studies indicated lower utilization of interdental tools among patients.^{28,30,37,42,44–46}

During orthodontic treatment, ideal oral hygiene may not be achieved simply by the mechanical removal of dental plaque. Daily rinsing with fluoridated mouthwash can significantly improve dental health and reduce white spot lesions.^{47–49} In the current study, patients during treatment had higher odds of using mouthwash. However, this was not a significant finding compared to the control group. Petrauskiene et al reported a statistically significant increase in mouthwash use among orthodontic patients compared to controls.²⁴ In contrast, other studies found lower adherence to the use of mouthwash.^{28,30,36,42,50} A possible explanation for this finding might be that the use of mouthwash was not reinforced as well as the use of interdental tools.

Comparing active orthodontic patients (G2) and deboned orthodontic patients (G3) to the control group (G1) revealed interesting data. Improvement in oral hygiene practices during orthodontic treatment can be attributed to continuous monitoring and the oral hygiene instructions that are given during monthly follow-up visits. Orthodontic residents are trained to give all their patients comprehensive oral hygiene instructions together with dietary advice on sugary and sticky food consumption

when starting orthodontic treatment and at every follow-up appointment. Another possible explanation for this improvement in oral hygiene practices during orthodontic treatment is the retentive nature of orthodontic appliances, which require more frequent cleaning. Improved oral hygiene practices were observed among patients even after orthodontic treatment as patients seemed to develop good oral hygiene habits and skills, which they picked up during orthodontic treatment and retained after its completion. Hence, patients' increased awareness through the long course of orthodontic treatment may be considered an additional benefit of such a treatment.

To the best of our knowledge, this study is the first to evaluate dietary habits and oral hygiene measures among patients after orthodontic treatment. Previous studies also did not control for demographic confounders when comparing oral health-related behavior among orthodontic patients. Nevertheless, this study has some limitations. The data were collected using a self-administered questionnaire, so patient responses might have been affected by social desirability and recall issues. In addition, the findings of this study might not be generalizable to patients in populations with different characteristics. Further longitudinal studies following patients before, during and after orthodontic treatment are necessary to understand the influence of orthodontic treatment on individuals' oral health-related behavior.

Conclusion

The findings of this study suggest that oral health-related behaviors seem to improve during and after orthodontic treatment. Patients during orthodontic treatment had better oral hygiene practices and were less likely to consume sticky food frequently compared to those who had yet to start treatment. The present study also provides evidence on patients after orthodontic treatment. These patients appear to adhere to some of the good oral hygiene practices. Nevertheless, sugar consumption and visits to dental hygienists and dentists did not vary significantly between the groups. With these findings, we can conclude that orthodontists may play a role in improving oral hygiene practices among their patients. However, additional efforts by orthodontists are required to reinforce dietary instructions and routine dental visits before the start of orthodontic treatment and during follow-up visits to maintain good oral health.

Abbreviations

OR, odds ratios; CI, confidence intervals.

Disclosure

The authors report no conflicts of interest in this work.

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