VOLUME • CİLT: 8 • ISSUE • SAYI: 3 • DECEMBER • ARALIK • 2024
ONLINE ISSN: 2630-6247

ERD

EUROPEAN JOURNAL OF RESEARCH IN DENTISTRY

AVRUPA DİŞ HEKİMLİĞİNDE ARAŞTIRMA DERGİSİ

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Publisher
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ERD European Journal of Research in Dentistry

VOLUME • CİLT: 8 • ISSUE • SAYI: 3 • DECEMBER• ARALIK • 2024
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CONTENTS / İÇİNDEKİLER

ORIGINAL ARTICLES / ARAŞTIRMA MAKALELERİ

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ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

Evaluation of Dentists' Awareness and Attitudes Towards Infection Control in Turkey: A Survey Study

Türkiye'deki Diş Hekimlerinin Enfeksiyon Kontrolüne Yönelik Farkındalık ve Tutumlarının Değerlendirilmesi: Bir Anket Çalışması

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Article History

Submitted	05.09.2024
Revised	05.09.2024
Accepted	10.10.2024
Published	31.12.2024

ABSTRACT

Objectives: The aim of this study was to investigate the knowledge, attitudes and competences of dentists in the Turkish community regarding infection control.

Materials and Methods: This cross-sectional, descriptive, online survey was conducted from July to December 2020, in Turkey. A survey was circulated via e-mail and WhatsApp groups to dentists. The survey consists of thirty questions with two parts. The first part included demographic data about the participants. The second part included questions designed to evaluate dentists' awareness of and attitudes toward infection control. Statistical analysis was performed using the SPSS version 29.0 software. A p value of <0.05 was considered to indicate statistical significance.

Results: A total of 238 people responded to our survey. Among the participants, 127 were female and 111 were male, with a mean age of 38.5 ± 12.5 years. All of them are dentists and studying or working in Turkey. Ninety-five of the participants considered themselves in the risk group related to infectious diseases. It was observed that dentists in universities took more anamnesis about infectious diseases from patients than dentists working in other places ($p < .05$). Compared with men, women are significantly more likely to be vaccinated against hepatitis B ($p < .05$).

Conclusions: This study provides data on the level of infection control compliance among dentists in Turkey. The results of the present study revealed that knowledge about infection control was greater than that reported in previous studies.

Keywords: Blood-borne pathogens, dentists, infection control, surveys and questionnaires, infectious disease transmission.

ÖZ

Amaç: Bu çalışmanın amacı, Türk toplumundaki diş hekimlerinin enfeksiyon kontrolüne ilişkin bilgi, tutum ve yeterliliklerini araştırmaktır.

Gereç ve Yöntemler: Bu kesitsel, tanımlayıcı, çevrimiçi anket Temmuz-Aralık 2020 tarihleri arasında Türkiye'de gerçekleştirilmiştir. Anket, e-posta ve WhatsApp grupları aracılığıyla diş hekimleriyle paylaşılmıştır. Anket formu iki bölümden ve otuz sorudan oluşmaktadır. İlk bölümde katılımcılara ilişkin demografik veriler yer almaktadır. İkinci bölümde ise diş hekimlerinin enfeksiyon kontrolü konusundaki farkındalık ve tutumlarını değerlendirmeyi amaçlayan sorular yer almaktadır. İstatistiksel analiz SPSS versiyon 28.0 yazılımı kullanılarak gerçekleştirilmiştir. p değerinin <0.05 olması istatistiksel olarak anlamlı kabul edilmiştir.

Bulgular: Ankete toplam 238 kişi yanıt vermiştir. Katılımcıların 127'si kadın, 111'i erkektir ve yaş ortalamaları 38,5 ± 12,5 yıldır. Katılımcıların tamamı diş hekimidir ve Türkiye'de okumakta ya da çalışmaktadır. Katılımcıların %95'i kendilerini bulaşıcı hastalıklarla ilgili risk grubunda görmektedir. Üniversitelerde çalışan dişhekimlerinin diğer yerlerde çalışan dişhekimlerine göre hastalardan bulaşıcı hastalıklarla ilgili daha fazla anamnez aldıkları görülmüştür ($p < .05$). Kadınların Hepatit B'ye karşı aşılanma olasılığı erkeklere göre istatistiksel olarak anlamlı derecede daha yüksektir ($p < .05$).

Sonuç: Bu çalışma, Türkiye'deki diş hekimleri arasında enfeksiyon kontrolüne uyum düzeyi hakkında veri sağlamaktadır. Çalışmanın sonuçları, enfeksiyon kontrolü hakkındaki bilginin önceki çalışmalara göre daha yüksek olduğunu göstermiştir.

Anahtar Kelimeler: Kanla bulaşan patojenler, diş hekimleri, enfeksiyon kontrolü, anketler, bulaşıcı hastalıklar

How to cite this article: Berkel, G., Can S., B., K., Bayram, F. Evaluation of Dentists' Awareness and Attitudes Towards Infection Control in Turkey: A Survey Study. *European Journal of Research in Dentistry*, 2024;8(3): 92-98. DOI: http://dx.doi.org/10.29228/erd.77

INTRODUCTION

Dental treatments carry a high risk due to close contact with the patient and exposure to infectious substances, including body fluids such as saliva and blood (Walsh, 2011). This working environment exposes dental health workers to the risk of acquiring hepatitis B, COVID-19, HIV and other potentially serious infectious diseases (Cheng et al., 2012).

Another important issue related to dentistry is aerosols. Aerosols may contain water droplets, saliva, blood, microorganisms and other debris. The practice of dentistry involves the use of rotating instruments such as aeretors, micromotors and ultrasonic scalers, which produce large quantities of aerosols (Harrel & Molinari, 2004; CDC, 2020). The World Health Organization (WHO) declared the coronavirus disease (COVID-19), which developed with the 'severe acute respiratory syndrome coronavirus' (SARS-CoV-2) agent, as a pandemic in 2020 (WHO, 2020). The transmission routes of COVID-19 from person to person are direct transmission (such as coughing, sneezing and droplet inhalation) and contact transmission (contact with mucosal membranes of the mouth, nose and eyes and droplets and aerosols) (Barca et al., 2020; Xu et al., 2020; Peng et al., 2020).

Cross infection can be defined as the transmission of infectious agents between patients and staff in a clinical setting (Mutlu et al., 1996). This transmission may be from the patient to the health personnel or from the health personnel to the patient. Therefore, updating dentists' knowledge and practices of infection control and precautions is of primary importance for the protection of their own health and that of their patients (Morris et al., 1996).

To date, there are many studies have been conducted in many countries investigating infection control practices and the knowledge and attitudes of dentists (Cheng et al., 2012; Agarwal et al., 2015; Haridi et al., 2016). To promote safer dental health services, it is necessary to determine the level of compliance with infection control procedures among dentists working in health centres in Turkey. However, there are no up-to-date, adequate data on infection control practices among dentists in Turkey. Therefore, the aim of this study was to investigate the knowledge, attitudes and competences of dentists in the Turkish community regarding infection control.

MATERIALS AND METHODS

Study Design

A cross-sectional, descriptive, online survey was conducted from July to December 2020 at Marmara University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery. The study protocol was approved by the Institutional Clinical Research Ethics Committee (Date: 01.06.2020, No:2020/38). The survey was shared with all participants who agreed to participate in the study via e-mail and WhatsApp groups via the purposive sampling technique. The questionnaire was written in Turkish and contained multiple-choice and yes/no questions.

Data Collection Methods

The survey form consists of thirty questions with two parts. The first part included demographic data about the participants including age, sex, education, specialization, workplace, number of patients examined and treated daily, and training on sterilization and disinfection. The second part included questions aimed at assessing dentists' awareness and attitudes toward infection control such as contact exposure, precautions taken, vaccination, information on sterilization and disinfection reliability. The questions in the second part of the survey are divided into 3 categories. These categories are named as general overall knowledge, average perception and overall attitude. Questions 9, 10, 11 and 25 in which the knowledge of the participants was questioned, were included in the overall knowledge group; questions 11, 18, 23, 24, 26 and 27, in which their perceptions and thoughts were questioned were included in the average perception group; questions 12, 13, 17, 19, 20, 21, 28, 29 and 30 in which their attitudes and behaviours were questioned were included in the overall attitude group.

The survey was accompanied by a cover letter explaining the aims of the study and the confidential use of information. The data were collected anonymously as they did not contain personal information.

Statistical Analysis

Descriptive data were expressed as the means ± standard deviations (SDs) for numerical data and were calculated as frequencies and percentages for categorical data. The normality of the distribution of the data was evaluated via the Shapiro-Wilk test. The chi-square test was used to compare categorical data if the groups could be combined, and Fisher's exact test was used if the groups could not be combined (specialization branches, etc.). Correlation analysis (Pearson or Spearman) was performed to evaluate the relationships between continuous variables. SPSS version 29.0 software (IBM Corp., Armonk, NY, USA) was used for statistical analysis. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 238 people responded to our survey. Among the participants, 127 were female and 111 were male, with a mean age of 38.5±12.5 (range 23-71) years. All of the participants have graduated or are currently studying at universities in Turkey. The majority of the participants were general dentists (53.3%) and the other participants were dental specialists. The majority of participants worked in private practices (38.2%) and private dental clinics (32.8%), but some of the participants worked in universities (24.4%) or public dental health centres (2.9%). A total of 61.3% of the participants reported

the number of patients they examined daily and 80.3% reported the number of patients they treated daily as 0-10. A total of 55.9% of the participants stated that they did not take any lessons on sterilization and disinfection during their education in their faculties, and 58.8% stated that they did not receive any training on sterilization and disinfection after graduating from the faculty. The demographic characteristics of the respondents are shown in Table 1.

Table 1. Demographic Data (first part of the survey).

Question		n (%)
1. Age	20-30	94 (39.6)
	31-40	47 (19.8)
	41-50	54 (22.7)
	51-60	26 (10.9)
	>60	16 (6.7)
2. Gender	Male	111 (46.6)
	Female	127 (53.4)
3. Education	Istanbul University	76 (31.9)
	Marmara University	43 (18.1)
	Hacettepe University	23 (9.7)
	Ege University	16 (6.7)
	Gazi University	10 (4.2)
	Other	70 (29.4)
4. Specialization	Dentist	107 (53.3)
	Oral and Maxillofacial Surgeon	39 (16.4)
	Periodontologist	19 (8.0)
	Pedodontist	13 (5.5)
	Orthodontist	13 (5.5)
	Restorative Dentistry Specialist	13 (5.5)
	Other	34 (14.2)
5. Workplace	Private Practice	91 (38.2)
	Private Dental Clinic	78 (32.8)
	University	58 (24.4)
	Public Dental Health Center	7 (2.9)
	Other	4 (1.7)
6. Number of patients examined daily	0-10	146 (61.3)
	10-20	69 (29.0)
	20-30	16 (6.7)
	>30	7 (2.9)
7. Number of patients treated daily	0-10	191 (80.3)
	10-20	39 (16.4)
	20-30	6 (2.5)
	>30	2 (0.8)
8. Training on sterilization and disinfection at school	Yes	105 (44.1)
	No	133 (55.9)
9. Training on sterilization and disinfection after school	Yes	98 (41.2)
	No	140 (58.8)

It was determined that 95% of the participants considered themselves in the risk group related to infectious diseases. 190 (the total number of people who answered yes and often) were reported to have taken anamnesis about infectious diseases before the procedure. In terms of anamnesis, 87.4% included hepatitis B, 65.5% hepatitis C, 52.5% HIV, 37.8% M. Tuberculosis, 13.4% herpes simplex type 1 and 2. When the participants were asked whether they had ever been in contact with infected blood or body fluids, 45.8% said no. Almost half of the participants (47.8%) reported the number of contacts with infected material in the last 1 year as 0-10 and the most common cause of injury was contaminated syringes/needle sticks (38.2%). After the injury, 28.2% of the participants did nothing, 8.4% were vaccinated, 12.2% had antigen titer control appropriate for the type of infected material to confirm transmission, 15.1% had serological antibody screening test, 1.7% had disease-specific immunoglobulin control and 0.4% received disease-specific treatment. A total of 43.7% of the participants found it unnecessary to always screen for blood-borne diseases by taking blood from the patient before treatment. While 95% of the participants received hepatitis B vaccination, only 61.3% received 3 doses of vaccine. A total of 84.9% of the participants had their anti-HBs titer checked after vaccination. A total of 55.9% of the participants stated that they did not receive any other vaccines to protect against infectious diseases other than those they received during childhood. A total of 87.4% of the participants stated that they did not trust the sterilization unit and 63.9% stated that they did not trust the solutions used in the disinfection of the units. The participants were asked whether they knew the content of the disinfectant used in the disinfection of the dental unit where they worked, and 55.9% said no, whereas 19.3% said yes. When the participants who answered yes were asked about the content of the disinfectant, 42.4% answered as alcohol and phenolic compounds, 24.4% as chlorine compounds, 10.9% as quaternary ammonium compounds, 10.9% as hydrogen peroxide, and 10.9% as detergent. A total of 70.2% of the participants stated that only wiping rotary instruments such as hand piece or micromotors with disinfectants is not sufficient to prevent cross infection, and 66.8% stated that they should be sterilized after each patient. When asked about the protective equipment used by the participants when treating a patient they knew to be infected, 87.4% answered about surgical masks, 85.7% answered about face shields, 75.2% answered about non-sterile gloves, 76.1% answered about protective goggles, and answered about 65.1% special protective masks (N95, N97, etc.). When the participants were asked which protective equipment they would use even if there was no suspicion of infection after the SARS-CoV-2 pandemic, 81.5% reported that they would use surgical masks, 85.3% would use face shields, 82.4% would use non-sterile gloves, 67.6% protective goggles, and 74.4% would use special protective masks (N95, N97, etc.). A total of 96.6% of the participants indicated that they disposed of sharps and medical equipment in separate waste bins (Table 2).

Table 2. Dentists' awareness of and attitudes toward infection control (second part of the survey).

Question		n (%)
10.Do you think you are in a risk group for infectious diseases?	Yes	228 (95.8)
	No	10 (4.2)
11.Do you take a history of infectious diseases?	Yes	165 (69.3)
	Often	25 (10.5)
	Rarely	40 (16.8)
	No	8 (3.4)
12.Which diseases would you ask as a separate question?	Hepatitis B	208 (87.4)
	Hepatitis C	156 (65.5)
	HIV	124 (52.5)
	M. Tuberculosis	90 (37.8)
	Herpes simplex types 1 and 2	32 (13.4)
	Other	38 (16)
13.Have you ever had contact with infected blood or body fluids?	Yes	90 (37.8)
	No	109 (45.8)
	Not sure	39 (16.4)
14.What is the number of contacts with infected material in the last 1 year?	0-10	114 (47.8)
	11-20	6 (2.5)
	>20	8 (3.3)
15.How were you exposed to infected material?	Infected sharp object puncture wound	73 (30.7)
	Contaminated syringe/needle stick	91 (38.2)
	Mucosal contact	55 (23.1)
	Infected cut	6 (2.5)
	Other	8 (3.4)
16.What precautions did you take after suspicious/infected contact?	Nothing	67 (28.2)
	Vaccinated	20 (8.4)
	Checking the antigen titer (HIV, HCV, HbsAg, etc.)	29 (12.2)
	Serological antibody screening test (anti HBs, anti CMV, etc.)	36 (15.1)
	Checking for disease-specific immunoglobulins	4 (1.7)
	Receive treatment	1 (0.4)
17.Do you think that every patient should be screened for blood-borne diseases by taking blood from them before treatment?	Yes	74 (31.1)
	No	104 (43.7)
	Not sure	53 (22.3)
18.Have you had the hepatitis B vaccine?	Yes	226 (95.0)
	No	10 (4.2)
19.How many doses of Hepatitis B vaccine have you had?	1 dose	8 (3.4)
	2 doses	32 (13.4)
	3 doses	146 (61.3)
	Not sure	40 (16.8)
20.Have you had your Anti-HBs titer checked after vaccination?	Yes	202 (84.9)
	No	20 (8.4)
	Not sure	4 (1.7)
21.Have you been vaccinated other than in childhood?	Yes	105 (44.1)
	No	133 (55.9)
22.Do you trust the sterilization unit of the institution where you work?	Yes	187 (78.6)
	No	21 (8.8)
	Undecided	30 (12.6)
23.Do you think the solutions used for disinfection of the units are reliable?	Yes	129 (54.2)
	No	23 (9.7)
	Undecided	86 (36.1)
24.Do you know the content of the disinfectant used in your dental unit?	Yes	46 (19.3)
	No	133 (55.9)
	Not sure	55 (23.1)
25.If your answer is yes, which one(s) do you use?	Alcohol and phenolic compounds	101 (42.4)
	Chlorine compounds	58 (24.4)
	Quaternary ammonium compounds	26 (10.9)
	Hydrogen peroxide	26 (10.9)
	Detergent	26 (10.9)
	Other	65 (27.3)
26.Do you think it is sufficient to wipe rotating instruments such as aerators with disinfectant?	Yes	24 (10.1)
	No	167 (70.2)
	Undecided	47 (19.7)
27.Do you think that rotary instruments such as aerators should be sterilized after each patient?	Yes	159 (66.8)
	No	41 (17.2)
	Undecided	38 (16.0)
28.What protective equipment do you use when treating a patient you know to be infected?	Surgical mask	208 (87.4)
	Face shield	204 (85.7)
	Non-sterile gloves	179 (75.2)
	Protective goggle	181 (76.1)
	Special protective mask (N95, N97, etc.)	155 (65.1)
	Other	8 (3.4)
29.After the SARS-CoV-2 pandemic, what protective equipment do you intend to use even if there is no suspicion of infection?	Surgical mask	194 (81.5)
	Face shield	203 (85.3)
	Non-sterile gloves	196 (82.4)
	Protective goggle	161 (67.6)
	Special protective mask (N95, N97, etc.)	177 (74.4)
	Other	6 (2.5)
30.Do you dispose of the sharps you use in separate waste bins?	Yes	230 (96.6)
	No	8 (3.4)

The relationship between the workplace and taking anamnesis from infectious diseases was analyzed. It was seen that the p value of Fisher's exact test was less than 0.05. In other words, there is a significant difference in terms of taking anamnesis about infectious diseases from patients according to the institution of employment. More anamnesis information about infectious diseases was obtained from patients in universities and other institutions (Table 3).

Table 3. Relationships between the workplace and taking a history of infectious diseases.

		Do you take a history of infectious diseases?			
		Yes	No	Total	p-value
Workplace	Private Practice	7	20	27	.016*
	Private Dental Clinic	7	16	23	
	University	8	3	11	
	Public Dental Health Center	1	1	2	
	Other	2	0	2	
Total		25	40	65	

*Fisher's exact test

When the relationship between sex and hepatitis B vaccination status was analyzed, it was observed that the p value of Fisher's exact test was less than 0.05, that is, there was a statistically significant difference between sex and hepatitis B vaccination status. Compared with males, females are statistically more likely to be vaccinated against hepatitis B (Table 4).

Table 4. The relationship between sex and hepatitis B vaccination.

		Have you had the hepatitis B vaccine?		Total	Exact Significance (2-sided)	Exact Significance (1-sided)
		Yes	No			
Gender	Female	125	1	126	.007*	.005*
	Male	101	9	110		
Total		226	10	236		

*Fisher's exact test

There was no significant relationship between the age of the participants and the overall knowledge category since the p value was greater than 0.05. However, since the p value < 0.05 and the correlation coefficients are – 0.277 and – 0.133 respectively, there is a weak negative relationship between age and average perception and age and overall attitude. Accordingly, as age increases, average perception and overall attitude scores decrease. (Table 5)

Table 5. Change in overall knowledge, overall attitute and average perception categories according to age.

		Age	Overall Knowledge
Age	Correlation Coefficient	1,000	-,098
	Significance (2-tailed)	.	,131
	n	237	237
Overall Knowledge	Correlation Coefficient	-,098	1,000
	Significance (2-tailed)	,131	.
	n	237	238
		Age	Overall Attitute
Age	Correlation Coefficient	1,000	-,133
	Significance (2-tailed)	.	**,041***
	n	237	237
Overall Attitute	Correlation Coefficient	-,133	1,000
	Significance (2-tailed)	,041	.
	n	237	238
		Age	Average Perception
Age	Correlation Coefficient	1,000	-,277
	Significance (2-tailed)	.	**,000***
	n	237	237
Average Perception	Correlation Coefficient	-,277	1,000
	Significance (2-tailed)	,000	.
	n	237	238

*Spearman's rho test

DISCUSSION

Dentists face the risk of contracting life-threatening infectious diseases through contact with patients' blood, saliva or aerosol droplets. Therefore, infection control practices such as the use of personal protective clothing, medical waste management, decontamination and sterilization of equipment are vital in preventing cross-infection in dentistry. This study investigated the attitudes of dentists in Turkey toward infection control procedures. Most of the participants reported that they considered themselves at risk for infectious diseases. Most of the surveyed dentists were vaccinated against hepatitis B, but women were much more likely to be vaccinated than men. As the age of the participants increased, their perceptions and attitudes toward infection control procedures decreased.

Adequate training has a significant effect on compliance with sterilization procedures (Abdulraheem et al., 2012; Tada et al., 2014). As reported in previous studies (Yang & Mullan, 2011; Shaghaghian et al., 2014), educational programmes for the prevention of occupational exposure to bloodborne pathogens play an important role in improving the knowledge and safe behaviours of healthcare workers. However, according to the results of our study, 55.9% of the participants stated that they did not receive any training on sterilization and disinfection during their education at the faculty, whereas 58.5% stated that they did not receive any training on this subject after graduation. In addition, in our study, dentists working in universities questioned the presence/absence of infectious diseases more frequently than dentists working in other institutions.

It is known that live blood cells and bacterial and viral particles can survive in hand tools even after thorough disinfection. Therefore, any instrument that comes into contact with blood should be sterilized in an autoclave (Lewis et al., 1992; Kohn et al., 2003). In this study, 70% of the participants said that simply wiping rotary instruments such as high-speed handpiece with disinfectants would not be sufficient. A total of 66.8% said that they should be sterilized after each patient. In a study similar to the results of our study (Miller, 1991), it was shown that 94% of dentists in Kuwait also used autoclaves to sterilize hand instruments. In our study, 10% stated that wiping the rotary instruments with disinfectants was sufficient.

A study by Miller (Lewis et al., 1992) explained the reason for this as the fear of dentists that the autoclave may damage rotary instruments and dental equipment.

Studies in other societies have reported that females are more fearful of infectious diseases than men (Doshi et al., 2021; Wieckiewicz et al., 2021; Formighieri Giordani et al., 2022). The authors of a survey examining psychological distress among Chinese inviduals during the COVID-19 pandemic also reported that women expressed significantly higher levels of psychological distress than men (Qiu et al., 2020). In this study, women were more likely to have received the hepatitis B vaccine than men. This may be explained by women's greater fear of infectious diseases, similar to that reported in the literature. In our study, no relationship was found between age and having knowledge about infection control practices. However, it was found that younger dentists were more likely to comply with infection control practices. This finding is in line with the findings of other researchers who reported that younger healthcare professionals are more inclined to implement clinical practice guidelines than older professionals (Cleveland et al., 2012; Francke et al., 2008).

Many survey studies conducted after the onset of the COVID-19 pandemic have revealed dentists' concerns about their occupational safety and the need for infection control education and training (Bakaeen et al., 2021; Hooshyar et al., 2022; Campus et al., 2023). In our study, the protective equipment used by participants when treating a patient they knew to be infected was similar to the protective equipment used after the SARS-CoV-2 outbreak, even when infection was not suspected. In fact, the use of special protective masks increased even more after the pandemic. These results, similar to those in the literature, revealed changes in the participants' infection protection procedures after the pandemic.

CONCLUSIONS

In conclusion, this study provides data on the level of infection control compliance among dentists in Turkey. The results of our study revealed that dentists in Turkey have incorporated this issue more into their daily practice after the COVID-19 pandemic and their level of knowledge about infection control is higher than that reported in previous studies. It also emphasizes the importance of infection control education in developing knowledge, attitudes and behaviors regarding infection control. However, large-scale observational studies are needed to reach more reliable conclusions on this subject.

This study received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Funding: The author(s) received no financial support for the research.

Conflicts of interest: The authors declare that they have no conflict of interest.

Ethics Committee Approval: This study was approved by Ethics Committee of Marmara University, Noninvasive Clinic Ethics Committee (Approval date: 01.06.2020; Number: 2020/38)

Author Contributions:

Research idea: G.B.

Design of the study: G.B.

Acquisition of data for the study: G.B.&F.B.&S.B.K.C.

Analysis of data for the study: F.B.&S.B.K.C

Interpretation of data for the study: F.B.

Drafting the manuscript: S.B.K.C.

Revising it critically for important intellectual content: F.B.

Final approval of the version to be published: G.B.&F.B.

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

Investigation of the Effect of TiO_2 Nanotube Application on Titanium Ceramic Bond Strength

TiO_2 Nanotube Uygulamasının Titanyum Seramik Bağlantı Kuvveti Üzerine Etkisinin Araştırılması

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Article History

Submitted	11.12.2024
Revised	20.12.2024
Accepted	21.12.2024
Published	31.12.2024

ÖZ

Amaç: Titanyum, korozyon direnci, hafifliği ve biyouyumluluğu nedeniyle sabit protezlerde altyapı materyali olarak tercih edilmektedir. Titanyum-seramik bağlanma dayanımının arttırması için yüzey işlemlerine ihtiyaç duyulmaktadır. Bu çalışmanın amacı anodizasyon yöntemiyle oluşturulan TiO_2 nanotüp uygulamasının makaslama bağlanma dayanımı üzerine etkisini araştırmaktır.
Gereç ve Yöntemler: Otuz adet titanyum silindir numunesi (12 mm çap, 10 mm yükseklik) hazırlandı ve yüzeyleri 300, 600 ve 1200 silisyum karbür aşındırıcılarla parlatıldı ve yüzey işlemlerine göre 3 gruba ayrıldı. Birinci grup kontrol grubu, ikinci grup 120 µm Al_2O_3 ile 75 psi' de 20 mm mesafeden 20 saniye boyunca kumlandı, üçüncü grup TiO_2 nanotüpleri oluşturmak için 40 V' da anodize edildi. Her gruptan bir numune taramalı elektron mikroskobu ve lazer profilometre cihazlarıyla incelendi. Üretici talimatlarına göre seramik (7x5 mm) numuneler üzerine uygulandı. Bağlantı testleri üniversal test makinesi kullanılarak gerçekleştirildi. Elde edilen veriler tek yönlü ANOVA ve Tukey testi ile analiz edildi.
Bulgular: En düşük bağlanma dayanım değeri kontrol grubundan elde edilmiştir (7,23±1,6 MPa). Ayrıca, TiO2 nanotüp uygulamasının (25,29±2,1 MPa) seramik bağ dayanımını arttırmada kumlama yönteminden (19,69±1,21 MPa) daha etkili olduğu bulunmuştur. Tüm gruplar arasındaki fark istatistiksel olarak anlamlı (P<.05) ve tüm gruplardaki kopmalar adeziv tip olarak tespit edilmiştir.
Sonuç: Uygulama sürecinde ek ekipmanlara ihtiyaç duyulsa bile, elde edilen daha yüksek bağlanma dayanımı TiO_2 nanotüp uygulamasını kumlamaya göre üstün kılmaktadır.
Anahtar Kelimeler: Titanyum, Seramik, Anodizasyon, Kumlama, Makaslama Bağlantı Dayanımı.

ABSTRACT

Objectives: Titanium is preferred as a framework for fix partial denture because of the corrosion resistance, light weight and biocompatibility. Surface treatments must be performed to increase the titanium-ceramic bond strength. The objective of this study was to investigate the effect of the TiO_2 application by anodization on shear bond strength between.
Materials and Methods: Thirty commercially pure titanium cylinder specimens (12mm diameter, 10mm height) were polished with 300, 600 and 1200 silicon carbide abrasives and divided into 3 groups according to the surface treatments. The first group is control group, second group was sandblasted (120 µm Al_2O_3 at 75 psi from a distance 20mm for 20 sec), the third group was anodized at 40V to form TiO_2 nanotubes. One specimen from each group was examined under scanning electron microscope and surface roughness by laser profilometer. Low fusing ceramic was applied (7x5 mm) onto the specimens according to the manufacture's instruction. Shear bond strength tests were performed using universal testing machine. The data was analyzed with One-way ANOVA and Tukey test.
Results: The lowest shear bond strength was obtained from the control group (7,23±1,6 MPa). Furthermore, TiO_2 nanotube application (25,29±2,1 MPa) was found to be a more effective than sandblasting method (19,69±1,21 MPa) to increase ceramic bond strength. The difference between all groups were statistically significant (P<.05) and the failure modes of all groups were adhesive.
Conclusions: Even if additional equipments are needed in the application process, the obtained higher bond strength made TiO_2 nanotube application superior to sandblasting.
Keywords: Titanium, ceramic, anodization, sandblasting, shear bond strength.

How to cite this article: Coşkun, M., Saraçoğlu, S. Investigation of the Effect of TiO2 Nanotube Application on Titanium Ceramic Bond Strength. *European Journal of Research in Dentistry*, 2024;8(3): 99-103. DOI: http://dx.doi.org/10.29228/erd.78

INTRODUCTION

In modern dentistry, achieving a balance between aesthetic appearance and mechanical strength remains a critical challenge. Although the use of zirconium is more effective than metal-supported prostheses in meeting the aesthetic requirements, the use of a metal substructure in screw retained implant supported hybrid prosthesis, fix partial dentures, and crowns is still a method applied in many cases due to its resistance to the stresses caused by torquing the screw. Additionally, metal substructures offer simplicity in production, low costs, ease of application, and appropriate to all treatment plans (Adachi et al., 1990; de Almeida-Júnior et al., 2010; Al Hussaini et al., 2005).

Among metals used for fabricating dentures, titanium stands out as the first choice due to its high corrosion resistance, superior mechanical properties, excellent biocompatibility, and lightweight structure. However, the uncontrollable thick oxide layer formed on titanium after the casting process negatively impacts the metal-ceramic bond strength (Adachi et al., 1990).

The advent of computer-aided design (CAD) and computer-aided manufacturing (CAM) in dentistry has significantly advanced titanium substructure fabrication. By milling titanium from homogeneously produced blocks, these technologies enable the production of highly accurate restorations with precise marginal fits (Abduo et al., 2014).

The success and longevity of prosthetic restorations depend not only on the restoration's adhesion to the tooth but also on the bond strength between the substructure material and the applied ceramic (Aboushelib et al., 2005). This bond strength is closely related to the chemical compatibility of metal and ceramic as well as the surface treatments applied to the metal (Alkhadashi et al., 2020). Surface treatments aim to enhance the mechanical connection by increasing the ceramic-substructure contact area through the creation of a rough surface and undercuts areas for retention (Coskun et al., 2018; Shillingburg et al., 1997).

Common surface treatments that used for roughening are sandblasting, acid application, bur application, and laser roughening (Akar & Emre, 2023). Among these, sandblasting is the most widely used due to its simplicity. However, it requires a delicate balance. Airborne-particle abrasion (APA) at high pressure can cause abrasion and weaken the substructure material, while inadequate cleaning after the APA application, the embedded Al_2O_3 particles in metal structure reduce the metal-ceramic bond strength (Adachi et al., 1990).

Most surface treatments rely on creating roughness through an abrasive effect on material surface. Unlike abrasive methods, n-TiO_2 application by anodization process works by adding material rather than removing it. It was first applied as a surface treatment on titanium implants and its effects on osteointegration were examined and found to be biologically compatible and mentioned that n-TiO_2 application increase the wettability of the titanium and had positive effects on osteointegration (Von Wilmowsky et al., 2012). Furthermore, in different research it was mentioned that the application of n-TiO_2 increase the titanium-resin cement bond strength (Akar et al., 2023).

Anodization is an electro-chemical process used to form nanoscale titanium dioxide (n-TiO_2) tubes on the surface of titanium. This process is carried out by placing the titanium sample as an anode in an electrolyte solution.

Hydrofluoric acid (HF), ammonium fluoride (NH_4F) or other fluoride-containing solutions are usually used as a medium. It is possible to vary the diameter and length of the tubes with the applied voltage and application time. With the help of fluorine ions, a process of dissolution and re-deposition takes place on the titanium surface, forming a tube-like structure in the process (Lin et al., 2010; Von Wilmowsky et al., 2012; Zhao et al., 2015) In terms of biocompatibility, n-TiO_2 provide a biocompatible surface that promotes cell growth. The diameter and length of the tubes can be adjusted using different parameters according to the application requirements (Zhao et al., 2010, 2015).

This study specifically aims to evaluate the effects of n-TiO_2 formed by anodization process on titanium-ceramic bond strength and to compare these effects with APA, the most widely applied method. The hypothesis is that both methods will increase the bonding between the titanium ceramic and that APA will be more effective.

MATERIALS AND METHODS

Thirty titanium (Ti-6Al-4V) cylindrical specimens with a 9x11 mm dimension were cut from a grade V titanium rod (ITI; Straumann, Basel, Switzerland). The specimens' surfaces were polished manually with 600, 900, 1200 grits silicon carbide abrasives (English abrasives; Atlas, Türkiye), respectively and cleaned ultrasonically for 10 min with water.

The Ti specimens were divided into 3 groups of 10 each to received different surface treatments. In control group no surface treatment was performed, in sandblasting group specimens were subjected to APA, and the samples in TiO_2 group were treated with anodization method.

The samples in the control group were directly applied with low fusing ceramic (Ti22, Noritake, Japan) without any surface treatment.

In sandblasting group, the samples were treated with 120 µm Al_2O_3 (Metoxides, Dordmund, Germany) at 75 psi from a distance 20 mm for 20 sec. To clean the surface from Al_2O_3, the samples were cleaned ultrasonically for 20 min and then left in room temperature to dry.

The samples in TiO_2 nanotube group, first cleaned with acetone and methanol then rinsed with water for 15 minutes. The samples were immersed in a unit filled with a solution containing 1 wt % ammonium florid (NH_4F) and a solvent of 3 wt % water and 96 wt % glycol at 30 ^{0}C. This unit had 2 electrode cells, one was Ti foil served as an anode (working electrode), the other one was platinum

foil serves as a cathode (counter electrode). The voltage was set to 40 V for 40 minutes. At the end of the duration samples were cleaned with water then left to dry at room temperature.

To determine the surface alterations after surface treatments one specimen from each group was examined at x100K under scanning electron microscope (SEM) (LEO 440; Zeiss, Germany) and to determine the surface roughness of the one specimen from each group was examined with profilometer (SPM-8100 FM, Shimadzu, Japan).

The ceramic application was performed according to the manufacture's instruction. First bonding agent applied and fired then opaquing agent application was performed. With the use of custom-made mold (5 mm internal diameter, 3 mm thick) low-fusing ceramic (Ti22, Noritake, Japan) was fired in a dental porcelain furnace (Programat P310, İvoclar Vivadent, Liechtenstein).

Shear-bond tests were performed using a universal testing machine (Lloyd LF Plus, Segensworth Fareham, England) with a speed 0.5 mm/min cross head speed. The failure modes were determined visually and classified into three groups:

Type A: Adhesive, at the interface.

Type C: Cohesive, within the ceramic.

Type AC: Combined

The obtained data were analyzed by using 1-way analysis of variance and the Tukey post-hoc test by SPSS (IBM SPSS Statistics, v22; IBM Corp., NY, USA). The significance level was set at α=0.05 for statistical evaluation.

RESULTS

The SEM image of the samples of all groups is presented in Fig. 1. From the images of air particle abrasion (b) and anodization group (c), surface modifications can be observed clearly. In anodization group TiO_2 nanotubes aligned properly, there is no space between the tubes and the holes located at the inner section of the tubes can be seen clearly.

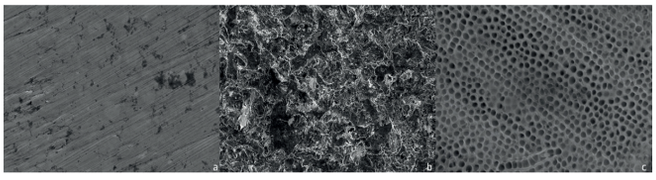

Figure 1: SEM images of all samples. (a) is control group, (b) is APA group, (c) is n-TiO2 group

The surface roughness values are presented in Table 1. The Ra values of the control group is 0.359 µm, air abrasion group is 0.263 µm, anodization group is 0.196. The lowest Ra value was obtained from the anodization group. The non-contact AFM image of control group is presented in Fig 2, APA group is in Fig 3, and the n-TiO_2 is in Fig 4.

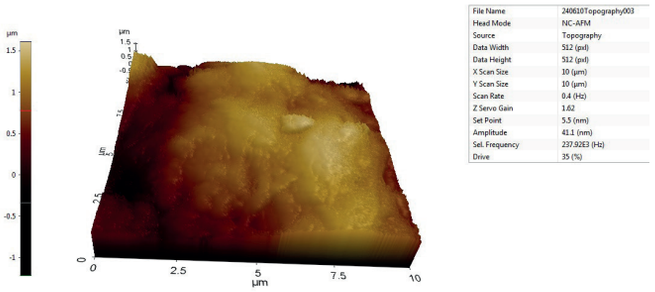

Figure 2: The non-contact AFM image of the control group.

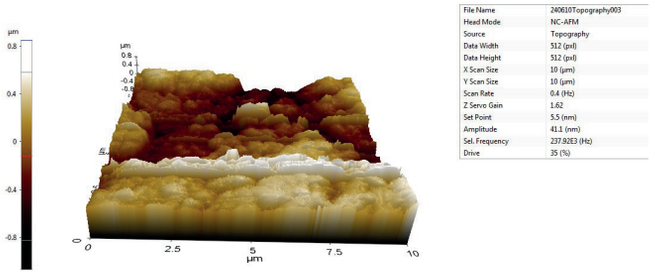

Figure 3: The non-contact AFM image of the sample after APA.

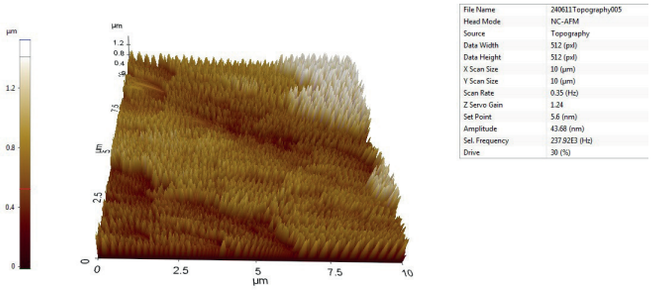

Figure 4: The noncontact AFM image of the sample after anodization.

Table 1. Surface roughness values (Ra)

	Control Group	APA Group	n-TiO_2
Surface Roughness	0.359	0.263	0.196

The shear-bond strength values obtained in this study are presented in Table 2. According to the SBS test the highest bond strength value between ceramic and titanium was obtained from anodization group (25.29±2.1 MPa). In APA group the SBS value was 19,69±1.21 MPa and the lowest SBS value was obtained from control group (7.23±1.6 MPa). The differences between groups are statistically significant (*P*<.05).

Table 2. Shear bond strength values (MPa)

	Control Group	APA Group	n-TiO_2
Shear Bond Strength	7.23	19.69	25.29

The failure modes of all samples in 3 groups showed adhesive failure which means the failure were on the interface between ceramic and titanium.

DISCUSSION

In this study, the effects of n-TiO_2 on the shear bond strength (SBS) between titanium and ceramic were investigated and compared with APA. The results demonstrated that the surface treatment methods significantly affect the bond strength between ceramic and titanium. The TiO_2 nanotube application by anodization process yielded the highest shear bond strength, followed by sandblasting, while the control group showed the lowest. These findings underscore the importance of surface treatments to improve the performance and longevity of titanium-ceramic restorations. According to the results obtained, the n-TiO_2 application proving more effective than the traditional airborne-particle abrasion method. Consequently, the hypothesis suggesting superior bond strength from APA treatment was partially supported.

APA increased the surface roughness which provides a larger contact area for the ceramic, thus strengthening the bond strength. However, the sandblasting process requires precise control over several factors. One of the most crucial aspects is the thorough cleaning of the titanium surface after sandblasting. Failure to remove residual Al_2O_3 particles can not only cause allergic reactions in patients but can also weaken the bond strength between the metal and ceramic (Al Hussaini & Al Wazzan, 2005). However, there is no need for additional cleaning after the anodization procedure. Unlike the APA, the anodization process changes the tomography by means of Ti tubes adhering to the surface which are biocompatible.

The parameters of the sandblasting process, such as Al_2O_3 particle size, pressure, and distance from the material, play a significant role in determining the quality of the bond strength. Furthermore, all these parameters must be rearranged for the material used as substructure because of the hardness difference (Śmielak & Klimek 2018). While some studies have searched the influence of these variables however, few have compared all parameters comprehensively, highlighting the need for more research to standardize the process for optimal results.(Abi-Rached et al., 2012; Coskun et al. 2018). In this research the parameters were chosen according to the Abi-Rached's research in which 50,120, and 250 µm Al_2O_3 were used and mentioned that the 120 µm was the most effective (Abi-Rached et al., 2012).

The superior bond strength achieved by the n-TiO_2 group can be attributed to the increased surface area and nanoscale roughness provided by the anodization process. The uniform and well-aligned nanotube structure observed in SEM image (Fig. 3) likely contributed to improved mechanical interlocking with the ceramic. This is consistent with studies indicating that nanoscale surface modifications enhance adhesion by creating a more effective interface for bonding between titanium and resin cement (Akar & Coskun, 2023).

According to the profilometric analysis, the roughness values created on the samples, n-TiO_2 creates a lower roughness value compared to the APA process. However, when the data were analyzed in terms of bond strength, it is determined that the highest values were obtained in the n-TiO_2 group. It could be attributed that of the preferred surface roughness detection method, the non-contact profilometer method allows only a limited area to be measured on the sample, while it does not provide complete information about the general structure of the samples. A second reason is that the oxide layer, which is the basis of the chemical bonding between ceramic and titanium, could be made more controlled by nanotube application. While the oxide layer on titanium is normally formed as a flat surface, the oxide layer is formed as a rough structure due to the F ion in the liquid medium in the anodization process (Çolak, 2008).

The findings of this study have significant implications for clinical practice. The higher bond strength achieved with TiO_2 nanotube application suggests that this method could enhance the durability and reliability of titanium-ceramic restorations. While the process requires additional equipment and expertise, the long-term benefits may outweigh the initial investment. Specifically, the enhanced adhesion could reduce the risk of debonding failures, which are a common cause of prosthetic restoration failure.

CONCLUSION

In conclusion, the TiO_2 nanotube application by anodization demonstrates significant potential as a surface treatment method for improving titanium-ceramic bond strength. Despite requiring additional equipment and expertise, its ability to achieve superior adhesion and biocompatibility makes it a promising alternative to conventional methods like sandblasting. Future studies should focus on optimizing the anodization parameters and evaluating its performance under clinical conditions to maximize its applicability in restorative and implant dentistry.

Conflicts of Interest

The authors declare that there is no conflict of interests.

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

The Effect of Animal and Plant-Based Protein On Enamel Micro-hardness: An in vitro Study

Hayvansal ve Bitkisel Protein Kaynaklı İçeceklerinin Mine Mikro Sertliği Üzerine Etkisi: in vitro Çalışma

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Article History

Submitted	30.09.2024
Revised	13.11.2024
Accepted	17.12.2024
Published	31.12.2024

ÖZ

Amaç: Protein açısından zengin içecekler dişleri diş erozyonuna karşı koruma potansiyeline sahiptir. Ancak, protein açısından zengin içeceklerin dişler üzerindeki etkileri ile ilgili araştırmalar sınırlıdır. Bu nedenle, bu çalışma günümüzde sıklıkla tüketilen bitkisel ve hayvansal kaynaklı protein açısından zengin içeceklerin in vitro koşullarda mine mikro sertliği ve yüzey pürüzlülüğü üzerindeki etkisini araştırmayı amaçlamıştır.

Gereç ve Yöntemler: Çekilen daimi arka dişler (15 premolar ve 15 molar) bukkal yüzeyleri açıkta kalacak şekilde akrilik bloklara gömüldü. Dişler her grupta 6 diş olacak şekilde; G1-kakao aromalı protein açısından zengin süt; G2-çikolata aromalı peynir altı suyu proteini tozu; G3-bezelye proteini tozu; G4-pirinç proteini tozu; ve G5-yapay tükürük (kontrol) gruplarına ayrıldı. Her içeceğe ait pH değerleri kaydedildi. Ayrılan dişler bu içeceklerde her gün 5 dakika olmak üzere 30 gün boyunca inkübe edildi. Başlangıç, 4.haftanın sonu ve 3. ayın sonunda dişlerin mikro sertlik ve yüzey pürüzlülüğü ölçümleri yapıldı.

Bulgular: Çalışmada kullanılan hem bitkisel hem de hayvansal tüm protein içeceklerinin mine mikro sertliğini artırdığı tespit edilmiştir. Bezelye proteini tozuyla yapılan içecek mine mikro sertliğinde en yüksek artışa neden olmuştur. Öte yandan, pirinç proteini tozu içeceğinin diş yüzey pürüzlülüğünü diğer içeceklere göre önemli ölçüde azalttığı belirlenmiştir.

Sonuç: Bu çalışmada kullanılan tüm protein içeceklerinin mine mikro sertliğini farklı oranlarda artırdığı bulunmuştur. Proteince zengin bu içeceklerin dişler üzerindeki etkileri içeceğin kimyasal bileşimine ve dişlerle temas süresine göre farklılık gösterdiği tespit edilmiştir.

Anahtar Kelimeler: Mine mikrosertliği, Protein içecekleri, Yüzey Prozitesi, Diş

ABSTRACT

Objectives: Protein-rich beverages have the potential to protect the teeth against dental erosion. However, there is a lack of research on the effects of protein-rich beverages on the teeth. Therefore, this study aimed to investigate the effect of plant and animal-based protein-rich beverages, that are frequently consumed today, on enamel microhardness and surface roughness under in vitro conditions..

Materials and Methods: The extracted permanent posterior teeth (15 premolars and 15 molars) were embedded in acrylic blocks, leaving the buccal surfaces of the teeth exposed. The extracted teeth were then divided randomly into five groups (n=6 per group): G1-cocoa-flavored protein-rich milk; G2-chocolate-flavored whey protein powder; G3-pea protein powder; G4-rice protein powder; and G5-artificial saliva (control). The pH of each beverage was assessed. The teeth were incubated in these beverages every day for 5 minutes for 30 days. Microhardness and surface roughness were measured at the baseline, at the 4th week and the third months.

Results: It was found that all the protein beverages used in the study, both plant and animal-based, increased enamel microhardness. The beverage made with pea protein powder showed the highest increase in enamel microhardness. On the other hand, the rice protein powder beverage has been found to decrease tooth surface roughness significantly higher than the other beverages.

Conclusions: It was found that all protein beverages used in this study increased enamel microhardness at different rates as the effects of these beverages on teeth depend on the chemical composition, contact time with teeth and pH.

Keywords: Enamel, Microhardness, Protein Beverages, Surface Rougness, Teeth.

How to cite this article: Doganci, İ., İnsel, B., P., Tufan, E., Akbay, T.,T. The Effect of Animal and Plant-Based Protein on Enamel Micro-Hardness: An in Vitro Study. *European Journal of Research in Dentistry*, 2024;8(3): 104-109. DOI: http://dx.doi.org/10.29228/erd.79

INTRODUCTION

The use of protein supplements in daily nutrition has increased due to the rise in healthy eating habits, especially among people who exercise regularly. Additionally, there has been a growing demand for plant-based protein supplements among vegetarian consumers (Kårlund et al., 2019). There is limited research available on the effects of animal or plant-based protein powders and protein riched milk on the tooth structure. However, there are some studies that reported that the increase in fast and on-the-go eating as a result of modern life has led to an increase in the frequency of dental erosion (Sato et al., 2021; Rusyan et al., 2022; Mobley et al., 2009). This has become a common problem for developed societies (Addy & Shellis 2006). Dental erosion is the loss of dental hard tissue with a multifactorial etiology due to prolonged contact and repetition of low pH, unsaturated solutions to the dental tissues (Erdoğan & Bolaca 2023). It can occur due to extrinsic and intrinsic factors. Extrinsic factors result from consuming acidic foods, drinks, and drugs, as well as from occupational exposures. These factors can increase the risk of dental erosion, especially when they are consumed regularly or in large quantities (Moynihan & Petersen 2004). Intrinsic factors, on the other hand, come from stomach acid and can be caused by eating disorders, reflux disease, or alcohol abuse (Kanzow et al., 2016). While acidic foods and drinks with low pH play a significant role, other factors such as calcium, phosphate, and fluorine levels, saliva composition, buffer capacity, diet and consumption habits, lifestyle, and oral hygiene practices also contribute to the erosive process. These factors, combined with abrasion from incorrect oral hygiene practices, can lead to dental erosion (Inchingolo et al., 2023).

Various methods have been attempted to prevent dental erosion due to its irreversible nature.

One such method is the addition of calcium and phosphate salts to acidic beverages. However, this approach can result in an undesirable taste due to the high calcium content. An alternative method that has shown positive results is the addition of protein supplements, such as ovalbumin and casein, to acidic beverages (Ferreira et al., 2015). Fluoride is a frequently used substance to enhance the remineralization of enamel. However, because of the risk of toxicity associated with high concentrations of fluoride, alternative ingredients are being considered.

Studies have shown that milk and dairy products, such as cheese and yoghurt, exhibit cariostatic effects on human and animal models because of their phosphoprotein, casein, and calcium content. Whey extract is a dairy product that contains a high concentration of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP). CPP-ACP is defined as a milk product that aids remineralization and prevents dental caries (Nobahar et al., 2020). While studies have shown that milk has a protective effect against dental erosion, it is often consumed with flavored beverages rather than pure milk. It is assumed that these added ingredients may interfere with the protective effect of milk against dental erosion (Lachowski et al., 2014).

Currently, consumers who prioritize their health are changing their food preferences to attain

specific physiological advantages, minimize the risk of certain diseases, and align with foods

that fulfill their body's essential nutritional needs (Kadam et al., 2018). As the demand for protein-enriched food products increases, interest in plant-based alternatives is also growing. The substitution of milk protein with plant protein will mainly occur in prepared foods, such as nutritional drinks (Arranz et al., 2023). There has been a growing demand for plant-based protein supplements among vegetarian consumers. There is limited research available on the effects of animal or plant-based protein powders and protein milk on tooth structure. Therefore, this study aimed to investigate the effects of protein-based beverages, which are commonly consumed currently, on enamel structure *in vitro*.

MATERIALS AND METHODS

Study Design

This study was approved by the ethics committee Marmara University, Institute of Health Sciences Non-Interventional Clinical Research Ethics Committee (Approval Date:19.12.2023, Approval Number: 114).

The teeth used in this study were collected within a 2-month period. The extracted permanent posterior teeth (15 premolars and 15 molars) were embedded in acrylic blocks, leaving the buccal surfaces of the teeth exposed. The extracted teeth were then divided randomly into five groups (n=6 per group): G1-cocoa-flavored protein-rich milk; G2-chocolate-flavored whey protein powder; G3-pea protein powder; G4-rice protein powder; and G5-artificial saliva (control). The formula of the artificial saliva formula was adjusted to contain 0.62g KCl, 0.17g $CaCl_2$, 1.1gK_2HPO^4, 0.3g KH_2PO_4, 0.87g NaCl, and a pH of 7 in 1000ml. The teeth were incubated in these beverages every day for 5 minutes for 30 days. Microhardness and surface roughness were measured at the baseline, at the 4th week and the third month. The pH of each beverage was also assessed.

Specimen Preparation

The collected permanent premolar and molar teeth were cleaned using pumicewater slurry with a polishing brush at a low-speed handpiece to remove debris or calculus before the study. The crown was separated from the root with the help of a diamond disc. To assess the microhardness of the samples, the teeth were embedded in an auto-polymerizing acrylic resin, leaving a portion of the buccal enamel visible. The sample number was inscribed at the base of each sample. Sample surfaces were polished using 400,600, 1200-grit abrasive paper.

The samples were randomly divided into 5 groups with 3 premolars and 3 molars in each group.The prepared samples were kept in distilled water at room temperature until the experiment was performed.

The Beverages

In this study, the effects of beverages containing animal and plant-based proteins on tooth enamel hardness and roughness were investigated. The source of animal-based proteins were the protein enriched milk (SEK, Türkiye) and whey protein (Fellas, Türkiye). The source of plant-based proteins were rice protein powder (Saf, Türkiye) and pea protein powder (Saf, Türkiye).

The beverages to be tested were prepared at a protein concentration of 8.8%. The beverages were re-prepared every week and kept in the refrigerator during this period. The pH values of the beverages used in the experiment were measured with a pH meter (Mettler Toledo,Switzerland)

Experimental Procedure

Tooth samples were kept in the prepared beverages for 5 minutes daily, then washed with distilled water and dried. Tooth samples were stored in artificial saliva at 37°C until the next immersion period. The control group was kept in artificial saliva throughout the experiment and the artificial saliva solution was renewed daily for all samples. This experiment was continued for 1 month with measurements of microhardness and surfaceroughness. After 1 month, to obtain an additional 3 months of data, the tooth samples were kept in the prepared beverages for 7.5 hours and the microhardness and surface roughness measurements were repeated. Based on the estimate that these beverages were consumed for 5minutes per day, it was assumed that 7.5 hours of immersion would simulate 3 months of use of these beverages (Shiozawa et al., 2015).

Surface Microhardness Test

Microhardness measurements were made with the Vickers microhardness machine (Falcon 400, Innovatest) at Istanbul Kent University. After drying the samples, microhardness was measured at the center of the polished area in each sample using a Vickers hardness tester (Alrahlah et al., 2023). For this purpose, a 50 g load was applied to three points at the center of each sample for 15 seconds by the diamond indenter of the device. Each load application created a diamond-shaped indentation on the samples. The average of the three measurements was taken and used as the Vickers hardness value.

Surface Roughness Test

Surface roughness measurements were made with the portable surface roughness tester (SJ-410, Mitutoyo) at Istanbul Kent University. The Ra parameter was measured at a traversing speed of 0.5 mm/s and a cut-off length of 0.08 λc. The surface of the samples was measured

three times, and the resulting roughness value was determined by averaging the measurements.

Statistical Analysis

Statistical analyses were performed using the GraphPad Prism 6.0 package program (GraphPad Software, San Diego, CA, USA). Results were presented as mean and standard deviation (SD).

The normality of the distribution of all data was determined. The data showed a normal distribution, thus parametric tests were used. One-Way Analysis of Variance (One-Way ANOVA) was used to compare the means of more than two groups and identify differences. The post hoc Tukey test also analyzed the difference in variable subgroups. The cut-off point for significance was applied to interpretations, where $p < 0.05$ was regarded as significant.

RESULTS

Microhardness Results

The Vickers microhardness (VHN) values were presented at Fig. 1, Fig. 2. and Fig. 3. The microhardness of the tooth enamel kept in artificial saliva (control group) did not show a statistically significant change at the fourth week and the third month compared to the baseline (Fig. 1).

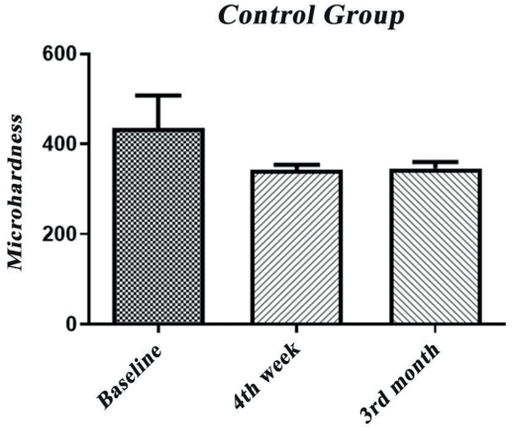

Figure 1: Microhardness of Control Group

When the teeth were kept in animal protein-based beverages, cocoa-flavored high protein milk significantly increased microhardness after 4 weeks and 3 months compared to the baseline. Whey protein beverage did not cause any significant change in microhardness after 4 weeks and 3 months compared to the baseline (Fig. 2).

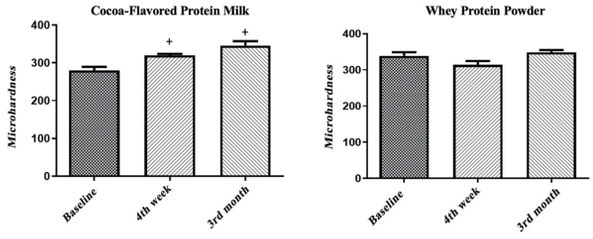

Figure 2: Effect of Animal-Based Proteins on Microhardness

When the teeth were kept in plant protein-based beverages, pea protein beverages significantly increased the microhardness at the end of week 4 and month 3 compared to the baseline. Keeping the teeth in rice protein beverage did not significant change the microhardness at the end of week 4 but exhibited a significant increase at the end of 3 months period (Fig. 3).

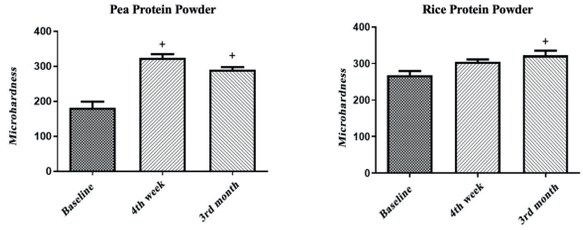

Figure 3: Effect of Plant – Based Proteins on Microhardness

Surface Roughness Results

The surface roughness values were presented at Fig. 4, Fig. 5 and Fig. 6.

The surface roughness values of the tooth enamel kept in artificial saliva (control group) did not significantly change at ehe end of week 4 and month 3 compared to the baseline (Fig. 4). When the teeth were kept in animal protein-based beverages, cocoa flovred high-protein milk did not change the surface roughness of the tooth enamel significantly at the end of week 4, but decreased the surface roughness at the end of third month compared to the baseline. Keeping teeth in a whey protein beverage significantly decreased the surface roughness at the end of week 4 and month 3 compared to the baseline (Fig. 5).

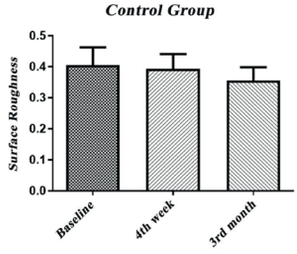

Figure 4: Surface Roughness of Control Group

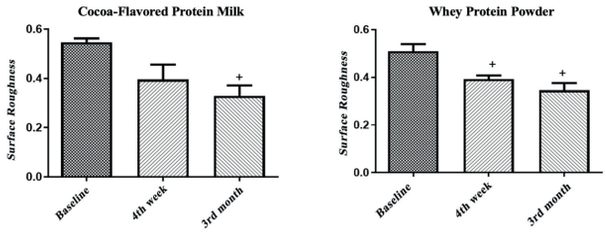

Figure 5: Effect of Animal-Based Proteins on Surface Roughness

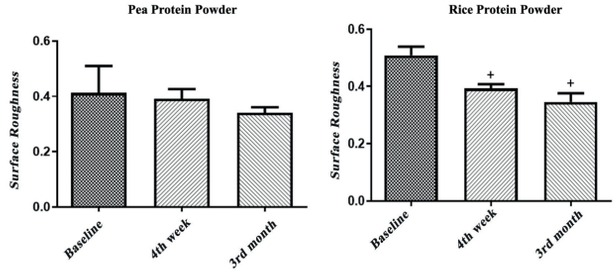

Figure 6: Effect of Plant-Based Proteins on Surface Roughness

When the teeth were kept in plant protein-based beverages, the surface roughness values of the tooth enamel kept in a pea protein beverage group did not change significantly at the end of week 4 and month 3 compared to the baseline. Keeping the teeth in the rice protein beverages, significantly decreased the surface roughness values of tooth enamel at the end of week 4 and month 3 compared to the baseline.

DISCUSSION

Poor eating habits are one of the main factors in the formation of erosive tooth wear (Dugmore & Rock 2004), but it has been reported that healthy eating habits can have positive effects on teeth (Huew et al., 2011). Since demineralization and remineralization cycles are continuous in the mouth, Ca and P ions lost during demineralization can be returned to the tooth structure by the remineralization process. In this study, it was aimed to show the effect of beverages with different types of protein content as a demineralizing or remineralizing agent after immersion in these beverages. An in vitro study was conducted using extracted teeth to provide more controlled conditions.

Nowadays, dieters, vegetarians and athletes have started to prefer high protein drinks as meal supplements. Studies on the effects of these protein-rich drinks, which can be of plant or animal origin, on oral and dental health are limited. Therefore, the aim of this study was to evaluate the erosive potential of the selected animal and plant

protein-based beverages by measuring the tooth enamel microhardness and surface roughness.

In this study, an in vitro experimental model was used considering the effects of patient follow-up and standardization stages. In vitro experimental models are frequently used methods in the study of demineralization and remineralization procedures for enamel. Mudumba et al. stated that long-term exposure to acid attacks was used for 10-60 minutes and short-term exposure for 1-4 minutes in in vitro study models. Bashir and Lagerlöf stated that saliva saturated with calcium and phosphate returned to its previous saturation 5 minutes after exposure to citric acid. Many similar dental erosion studies have also followed 5-minutes immersion cycles (Shiozawa et al., 2015). In this study, dental samples were immersed in protein drinks once a day for 5 minutes to simulate daily protein drink consumption of consumers and then the samples were stored in artificial saliva at 37°C to simulate the oral environment. The samples from the control group were kept in artificial saliva solution without any treatment. After the four-week experimental period, samples were immersed in beverages for 7.5 hours at a time to simulate 3 months of use, based on the work of Guler et al., (2005).

Studies have shown that casein and ovalbumin can adsorb onto the enamel surface, reduce hydroxyapatite dissolution, and these proteins can effectively reduce the erosive potential of acidic solutions and commercially available soft drinks (Arends et al., 1986; Hemingway et al. 2011; Reynolds & Black 1987; Ferreira et al., 2015).

According to the results obtained in this study, commercially available plant and animal proteins did not have a negative effect on teeth microhardness and roughness. In addition to the fact that the beverages used in the study did not have a negative effect on contact with teeth, they also had positive effects on microhardness and porosity. The results of this study show that consumption of whey protein beverage did not lead to a statistically significant change in microhardness at the end of 3 months compared to the baseline level. In contrast, Rezvani et al., (2015) in their study comparing the effect of casein phosphopeptide – amorphous calcium phosphate (CPP-ACP) and whey extract (as a natural CPP-ACP) on enamel microhardness, found promising findings in terms of the effectiveness of whey extract on enamel microhardness. The reason for this difference is probably attributable to the methodological differences between the two studies and the varying durations of contact with the material. In this study, there was a significant increase in enamel microhardness of teeth kept in cocoa-flavored protein milk at 4 weeks and 3 months compared to the baseline level. A similar result was observed in a study conducted by Khan et al., (2022) where an increase in enamel microhardness was noted after continuous immersion in plain milk and flavored milk.

In the literature, there were no study that evaluates the effect of pea and rice protein beverages on dental erosion, therefore, this study will form the basis for future studies on the effects of plant-based proteins on teeth.

According to the plant-based protein beverages results, at the end of the week 4 and month 3, pea and rice protein beverages increased the enamel microhardness compared to baseline. Both of these plant-based proteins provided protection against enamel surface softening.

In order to explain these differences, it was assumed that the nature, aminoacid content and molecular weight of the both animal and plant based proteins could affect their adsorption to enamel.

According to previous studies, the effect of treatment solutions on surface roughness varies depending on the type of material (Münchow et al., 2014; Al-Samadani, 2013). Ferreira et al,. (2015) reported that casein did not prevent dental erosion caused by orange juice, whereas commercially available calcium-modified fruit juice reduced erosion of both enamel and dentin. In this study while the immersion of teeth in high-protein milk reduced the surface roughness at the end of the month 3, whey protein beverage reduced both at the end of the week 4 and month 3. According to this result, whey protein showed an earlier effect on surface roughness than high-protein milk. When the teeth immersed in plant based-protein beverages, only rice protein based beverage decreased the surface roughness, pea protein did not cause any difference at the surface rougness. This result shows that rice proteins positively affect surface roughness compared to pea proteins.

CONCLUSION

The consumption of protein-rich beverages has a beneficial impact on dental health and may contribute to protective effects by supporting proper oral hygiene practices. The results of this study provide a basis for subsequent *in vivo* studies.

Conflicts of Interest

The author declares that they have no conflicts of interest.

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

Evaluation of Complications Related to Supernumerary Teeth with Cone Beam Computer Tomography

Süpernümere Dişlerle İlişkili Komplikasyonların Konik Işınlı Bilgisayarlı Tomografi ile Değerlendirilmesi

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Article History

Submitted	11.09.2024
Revised	11.12.2024
Accepted	11.12.2024
Published	31.12.2024

ABSTRACT

Objectives: The aim of this retrospective study was to evaluate the complications associated with supernumerary teeth (ST) using cone beam computed tomography (CBCT).

Materials and Methods: CBCT images of patients in all age groups who applied to Marmara University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, between 2018-2023, were retrospectively evaluated. Images with ST were detected and complications related to ST were evaluated based on the presence of resorption, malposition, impaction of the adjacent teeth and pathological formations (such as cysts or tumors). The relationship between ST-related complications and ST morphology was evaluated. Statistical analyzes of the data were evaluated using the SPSS package program. Statistical significance was accepted as $p<0.05$.

Results: SD were found to cause malposition (%39,3), impaction (%13), resorption (%3,8) and pathological formations (%1,3) of adjacent teeth at different rates. A statistically significant relationship was found between the morphology and complications ($p<0,001$).

Conclusions: The risk of complications was higher in tuberculate and supplemental morphologies, dentists should pay attention in prognosis and treatment planning in these morphologies of ST. The most common complications associated with ST were malposition and impaction of adjacent teeth. This indicates a high need for orthodontic treatment in patients with ST.

Keywords: Supernumerary teeth, cone beam computer tomography, complications, morphology, radiology

ÖZ

Amaç: Bu retrospektif çalışmanın amacı, süpernümere dişlerle (SD) ilişkili komplikasyonları konik ışınlı bilgisayarlı tomografi (KIBT) ile değerlendirmektir.

Gereç ve Yöntemler: 2018-2023 yılları arasında Marmara Üniversitesi Diş Hekimliği Fakültesi Ağız, Diş ve Çene Radyolojisi Anabilim Dalı'na başvuran tüm yaş gruplarındaki hastaların KIBT görüntüleri retrospektif olarak değerlendirildi. SD içeren görüntüler tespit edildi ve SD ile ilişkili komplikasyonlar; komşu dişlerde rezorpsiyon, malpozisyon, gömülü kalma ve patolojik oluşumların (kist, tümör gibi) varlığına göre değerlendirildi. SD ile ilişkili komplikasyonlar ve SD morfolojisi arasındaki ilişki değerlendirildi. Verilerin istatistiksel analizleri SPSS programı kullanılarak değerlendirildi. İstatistiksel anlamlılık $p<0,05$ olarak kabul edildi.

Bulgular: SD'nin komşu dişlerde farklı oranlarda malpozisyona (%39,3), gömülü kalmaya (%13), rezorpsiyona (%3,8) ve patolojik oluşumlara (%1,3) neden olduğu bulundu. Morfoloji ile komplikasyonlar arasında istatistiksel olarak anlamlı bir ilişki bulundu ($p<0,001$).

Sonuç: Tüberkülat ve suplemental morfolojideki dişlerde komplikasyon riski daha yüksektir, diş hekimleri bu SD morfolojilerine prognoz ve tedavi planlamasında dikkat etmelidir. SD ile ilgili en yaygın komplikasyonlar, malpozisyon ve komşu dişte gömülü kalmadır. Bu durum SD'li hastalarda ortodontik tedavi ihtiyacının yüksek olduğunu gösterir.

Anahtar Kelimeler: Süpernümere dişler, konik ışınlı bilgisayarlı tomografi, komplikasyonlar, morfoloji, radyoloji

How to cite this article: Güneş, Y., Borahan, M., O. Evaluation of Complications Related to Supernumerary Teeth with Cone Beam Computer Tomography. *European Journal of Research in Dentistry*, 2024;8(3): 110-115. DOI: http://dx.doi.org/10.29228/erd.80

INTRODUCTION

Supernumerary teeth (ST) are dental number anomaly defined as the presence of more than twenty deciduous teeth or thirty-two permanent teeth (Seremet, 1974). ST may be unilateral or bilateral; impacted or erupted; single or multiple; and seen in one or both jaws (Anthonappa et al., 2013). ST can occur in non-syndromic individuals or be associated with syndromes such as Ehler-Danlos syndrome, Gardner syndrome or Cleidocranial Dysostosis, and often multiple ST are associated with syndromes (Anthonappa et al., 2008; Cammarata-Scalisi et al., 2018). The etiology of ST is not clearly known and many theories have been proposed regarding the etiology of ST, such as atavism, reversion, dichotomy and dental lamina hyperactivity. Among these, the dental lamina hyperactivity theory is the most widely accepted theory (Fleming et al., 2010; Mallineni, 2014; Primosch, 1981; Rajab & Hamdan, 2002). In addition, genetic and environmental factors may play a role in the etiology of ST (Shah et al., 2008). The prevalence of ST are between 0.2%-0.8% in the deciduous dentition and 0.5%-5.3% in the permanent dentition and are more common in males (Fardi et al., 2011; Garcés-Ortíz et al., 2012; Leco Berrocal et al., 2007).

ST are usually asymptomatic and are recognised incidentally during routine panoramic evaluation (Fernández Montenegro et al., 2006; Liu et al., 2007; Subasioglu et al., 2015). Although the likelihood of ST-related complications are low, they may cause impaction, malposition, resorption of the adjacent teeth and crowding, diastema, dilaceration, cystic or tumoural lesions (Garvey et al., 1999; Mossaz et al., 2014; Park et al., 2020; Syriac et al., 2017). In addition, semi-impacted or erupted ST may cause subacute pericoronitis, gingival inflammation, periodontal abscess, plaque retention and dental caries in inaccessible areas (Parolia et al., 2011).

ST are diagnosed with clinical and radiological examination. Panoramic, periapical and occlusal radiographs, which are two-dimensional imaging methods, are used in the first stage of radiological evaluation (Rajab & Hamdan, 2002). However, traditional 2-dimensional radiography images are unable to precisely determine the positions of teeth and their spatial relationships with surrounding teeth and structures. Therefore, cone beam computed tomography (CBCT), which provides three-dimensional imaging, is recommended for detailed evaluation (Jiang et al., 2020; Liu et al., 2007).

CBCT provides detailed information for clearly determining the location and relationship of ST with important structures such as the nasopalatine canal, nasal cavity floor, maxillary sinus or mandibular canal, as well as their relationship with adjacent teeth (Scarfe et al., 2006). CBCT provides precise and accurate information about complications of ST, such as malposition, root resorption and impaction of adjacent teeth, cystic or tumoral lesions (Jiang et al., 2020; Kapila et al., 2011; Ma et al., 2021). In many studies, the clinical and radiographic features of ST were evaluated using CBCT imaging method, and it was recommended in the diagnosis and treatment planning of ST (Gurgel et al., 2012; Liu et al., 2007; Mossaz et al., 2014; Nematolahi et al., 2013). However, due to the high cost and high radiation dose of CBCT compared to two-dimensional imaging methods, its use is recommended in cases requiring detailed examination rather than routine use in the diagnosis of ST (Liu et al., 2007).

This study aimed to evaluate in detail the complications associated with ST in non-syndromic patients of all age groups with CBCT.

MATERIALS AND METHODS

In this study, CBCT images of 13.030 patients of all ages who applied to the Department of Oral and Maxillofacial Radiology at Marmara University Faculty of Dentistry for various reasons between January 2018 and April 2023 were evaluated. Images with insufficient diagnostic quality, as well as those from patients with systemic conditions or craniofacial syndromes such as cleft lip and palate, cleidocranial dysostosis, or Gardner syndrome, were excluded.

The CBCT images were obtained by an operator using a ProMax 3D Mid imaging device (PlanmecaOy, Helsinki, Finland) operated with different and avaible FOV area, 90 kVp and 10 mA, at a time of 36 s. The CBCT scans were analyzed in multiplanar reconstructions (coronal, axial and sagittal), using Romexis 2.92 software (PlanmecaOy, Helsinki, Finland). They were evaluated using a monitor screen (Monitor 23-inch Acer 1920 × 1080 pixel HP Reconstruction PC).

Ethical approval for this retrospective study was granted by the Marmara University Faculty of Medicine (Protocol No: 09.2023.63313.030).

Study Variables

Complications related to ST were evaluated based on the presence of resorption, malposition, impaction of the adjacent teeth and pathological formations (such as cysts or tumors). Resorption was considered to be present in cases where there was loss of hard tissues of the adjacent teeth roots and the continuity of the lamina dura could not be observed (Fig. 1). Malposition was diagnosed when the adjacent teeth were not in their normal position in three dimensions (Fig. 2). Impaction was diagnosed when ST prevent to eruption of adjacent teeth (Fig. 3). Pathological formations such as follicular enlargements (more than 3mm), cyst or tumours caused by ST were evaluated (Fig. 4). All these complications were evaluated as present or absent. Also ST that were not adjacent to the teeth were evaluated separately.

Figure 1: Representative CBCT images of ST-related root resorption A. Root resorption of premolar tooth in the coronal section B. Root resorption of premolar tooth in the sagittal section.

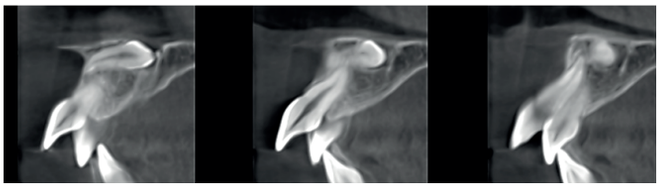

Figure 2: Representative CBCT images of ST-related malposition of maxillary incisor teeth.

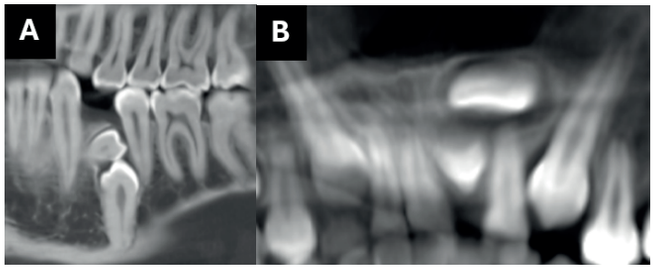

Figure 3: Representative CBCT images of ST-related impaction. A. Impaction of mandibular premolar teeth in the panoramic reconstruction. B. Impaction of maxillary central incisor teeth in the panoramic reconstruction.

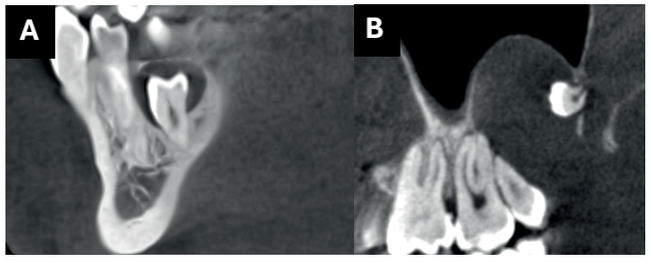

Figure 4: Representative CBCT images of ST-related cystic formations A. Cystic formation in the mandibular premolar region in the sagittal section B. Cystic formation in the maxillary molar region in the sagittal section.

Statistical Analysis

Data were analyzed by using the SPSS statistical software version 23.The frequencies among the groups were compared by using the Chi-Square Test. Multiple comparisons were made using the Bonferroni Corrected Z test and Fisher Freeman Halton test. P values less than 0,05 were considered statistically significant.

RESULTS

In this study, 400 ST detected in 217 patients, 90 (41.5%) female and 127 (58.5%) male, aged between 7 and 71, were evaluated. ST most frequently (39,3%) caused malposition of adjacent teeth, followed by impaction of adjacent teeth (13%) but they found to result in pathological formation at a very low rate (1,3%) (Table 1).

Table 1. Frequency of resorption, malposition, impaction of adjacent teeth and pathological formation.

	Number	%
Resorption of adjacent teeth		
Present	15	3.8
Absent	372	93
No adjacent teeth	13	3.3
Malposition of adjacent teeth		
Present	157	39.3
Absent	230	57.5
No adjacent teeth	13	3.3
Impaction of adjacent teeth		
Present	52	13
Absent	335	83.8
No adjacent teeth	13	3.3
Pathological formation		
Present	5	1.3
Absent	395	98.8

A statistically significant relationship was found between the morphology and resorption of adjacent teeth (p=0.005). However, the significant difference observed here was in the rates of those ST not adjacent to teeth. No relationship was found between morphology and resorption in the areas that were adjacent to teeth and were primarily evaluated in terms of resorption. However, the resorption rate (4.9%) was found to be higher in supplemental morphology than in the others (Table 2).

Table 2. Relationship between ST-related complications and ST morphology

	Morphology				Test statistics	p*
	Conical	Tuberculate	Supplemental	Germ		
Resorption of adjacent teeth						
Present	1 (1.3)	0 (0)	14 (4.9)	0 (0)		
Absent	70 (88.6)	30 (100)	268 (93.4)	4 (100)	18.504	0.005
No adjacent teeth	8 (10.1)[a]	0 (0)[ab]	5 (1.7)[b]	0 (0)[ab]		
Malposition of adjacent teeth						
Present	23 (29.1)[a]	23 (76.7)[b]	111 (38.7)[a]	0 (0)[ab]		
Absent	48 (60.8)[a]	7 (23.3)[b]	171 (59.6)[a]	4 (100)[a]	36.679	<0.001
No adjacent teeth	8 (10.1)[a]	0 (0)[ab]	5 (1.7)[b]	0 (0)[ab]		
Impaction of adjacent teeth						
Present	11 (13.9)[a]	12 (40)[b]	29 (10.1)[a]	0 (0)[ab]		
Absent	60 (75.9)[a]	18 (60)[a]	253 (88.2)[b]	4 (100)[ab]	37.238	<0.001
No adjacent teeth	8 (10.1)[a]	0 (0)[ab]	5 (1.7)[b]	0 (0)[ab]		
Pathological formation						
Present	2 (2.5)	0 (0)	3 (1)	0 (0)	1.579	0.664
Absent	77 (97.5)	30 (100)	284 (99)	4 (100)		

*Pearson's chi-squared test, a-b: There is no difference between groups with the same letter

A statistically significant relationship was found between the morphology and malposition of adjacent teeth ($p<0.001$). Tuberculate morphology was observed to contribute to the malposition more frequently (76.7%) than conical (29.1%), supplemental (38.7%) and germ (0%) morphologies (Table 2).

A statistically significant relationship was found between morphology and impaction of adjacent teeth ($p<0.001$). This complication was found to be more common and significantly higher in tuberculate morphology (40%) than conical (13.9%), supplemental (10.1%) and germ (0%) morphologies. Also no statistically significant relationship was found between morphology and the presence of pathological formations ($p=0.664$) (Table 2).

DISCUSSION

ST are a dental anomaly characterized by more teeth than the normal dentition of twenty primary teeth or thirty-two permanent teeth (Seremet, 1974). ST are usually asymptomatic and are often detected incidentally on routine examination (Fernández Montenegro et al., 2006). Although the likelihood of complications associated with ST are low, they may cause problems such as crowding, diastema, rotation, resorption, impaction and malposition of adjacent teeth. Additionally, they may lead to pathological formations such as cysts and tumors (Garvey et al., 1999; Mossaz et al., 2014; Park et al., 2020; Syriac et al., 2017). Early diagnosis and timely treatment of ST are essential to prevent such complications (Hadziabdic et al., 2022).

In the radiological evaluation of ST, two-dimensional imaging methods such as panoramic, periapical, and occlusal radiographs are generally used (Rajab & Hamdan, 2002). However, these imaging methods are often insufficient in determining the exact location of ST, their relationships with neighboring structures, and in evaluating associated complications. Therefore, CBCT, a three-dimensional imaging method, is recommended for a definitive evaluation of the radiological features of ST (Ata-Ali et al., 2014). In this study, the advantages of CBCT over other imaging methods were taken into consideration, and the complications associated with ST were evaluated in detail using CBCT.

In this study, ST were found to cause malposition (39.3%), impaction (13%), resorption (3%) of adjacent teeth and ST-related cystic formations (1.3%). Contrary to other studies, diastema, rotation and crowding caused by ST were not evaluated separately; instead, they were analyzed under a single category, malposition, in this study (Bereket et al., 2015; Hadziabdic et al., 2022; Liu et al., 2007; Ma et al., 2021; Park et al., 2020). Malposition is an indicator of the need for orthodontic treatment and it was thought that analyzing these conditions under one heading would yield more holistic results in terms of the treatment approach for ST. Consistent with most studies in the literature, malpositions (diastema, rotation, crowding) were the most common problem associated with ST. Secondly, ST were most frequently found to cause impaction of adjacent teeth (Liu et al., 2007; Ma et al., 2021; Mossaz et al., 2014; Park et al., 2020). Similar to this study, most studies in the literature, the rate of root resorption was found to be lower than malposition and impaction (Bereket et al., 2015; Hadziabdic et al., 2022; Jiang et al., 2020; Liu et al., 2007). However, pathological formations associated with ST were observed at a lower rate (1.3%) in this study compared to other studies (Demiriz et al., 2015; Hadziabdic et al., 2022; Jiang et al., 2020; Liu et al., 2007; Mossaz et al., 2014; Park et al., 2020). In a study by Jiang et al. (2020) evaluating 1149 ST in the Chinese population, the cystic formation rate was found to be 8%. This difference may be due to variations in patient populations and the timing of intervention in ST.

Previous studies have evaluated the relationship between ST morphology and complications such as malposition, resorption, impaction of adjacent teeth and pathological formations. (Hadziabdic et al., 2022; Jiang et al., 2020; Ma et al., 2021; Mossaz et al., 2014; Park et al., 2020). Ma et al. (2021) analyzed 2786 ST and found that 25% of teeth with supplemental morphology, 12.6% of teeth with conical morphology, 11.7% of teeth with tuberculate morphology and 2.7% of teeth with germ morphology caused malposition. A statistically significant relationship was found between ST morphology and malposition ($p<0.05$). Hadziabdic et al. (2022) evaluated 138 ST and found that conical morphology caused malposition of the adjacent teeth in 6.4%, tuberculate morphology teeth in 2.4% and supplemental teeth in 2%. However, no statistically significant relationship was found. In this study, consistent with Ma et al. (2021), the rate of malposition with tuberculate morphology (76.7%) was found to be significantly higher than conical (29.1%), supplemental (38.7%) and germ (0%) morphology ($p<0.001$).

The relationship between ST morphology and resorption has been investigated previously . Mossaz et al., (2014) evaluated CBCT images of 101 ST and found a significant correlation between ST morphology and resorption of the adjacent teeth ($p = 0.001$). They reported that ST with supplemental morphology caused resorption more frequently (Mossaz et al., 2014). Similarly, Jiang et al., (2020) reported that supplemental morphology (10.75%) was the most common cause of resorption and that there was a significant relationship between morphology and resorption in the adjacent teeth ($P <0.001$). Park et al., (2020) revealed that tuberculate morphology has a two times higher risk of resorption of the adjacent teeth compared to other morphologies.

In a study by Hadziabdic et al., (2022) evaluated on panoramic images of 138 ST, it was reported that only the supplemental morphology caused 2% resorption, while tuberculate and conical morphologies did not cause resorption of the adjacent teeth. No statistically significant relationship was found (Hadziabdic et al., 2022). CBCT is known to give more precise and accurate results than panoramic radiography in detecting root resorption (Wang et al., 2017). For this reason, it is

known that the studies conducted with cbct showed more reliable results about resorption.

In this study, no significant relationship was found between ST morphology and resorption in the maxillary and mandibular arch regions. However, similar to the study of Mossaz et al., (2014), Jiang et al., (2020) and Hadziabdic et al., (2022) the resorption rate of ST with supplemental morphology was found to be higher. This findings should be taken into consideration when evaluating the prognosis of teeth with supplemental morphology.

In the study by Jiang et al., (2020), the relationship between ST morphology and impaction of adjacent teeth was evaluated and no statistically significant relationship was found. However, they reported that germ morphology (10%) most frequently caused the impaction of adjacent teeth (Jiang et al., 2020). Hadziabdic et al., (2022) concluded that conical morphology caused impaction most frequently (25.5%), while tuberculate morphology caused impaction least frequently (2.4%). However, no statistically significant relationship was found (Hadziabdic et al., 2022).

In this study, a statistically significant correlation was found between ST morphology and impaction of adjacent teeth (p<0.001). The rate of tuberculate morphology impaction of adjacent teeth (40%) was found to be higher than the others. This finding was thought to be due to the larger size of tuberculate morphology, similar to the relationship observed with malposition of adjacent teeth.

Jiang et al., (2020) analyzed 1149 ST using CBCT and found a statistically significant relationship between the morphology of ST and the formation of cystic lesions. Although ST are unlikely to form cystic lesions, the lesion rate associated with tuberculate morphology was found to be the highest (15%), while no pathological formation was found in relation to germ morphology (Jiang et al., 2020). Hadziabdic et al., (2022) evaluated the relationship between follicular enlargement and ST morphology on panoramic images. However, no statistically significant relationship was found (Hadziabdic et al., 2022). Similarly, in this study, no significant correlation was found between ST morphology and pathological formations (p=0.664). Pathological formations can be re-evaluated by examining more ST with CBCT.

CONCLUSION

CBCT evaluation of complications related to supernumerary teeth is guiding dentists in terms of treatment approach. Complication risks were higher in tuberculate and supplemental morphologies, dentists should be more careful with these morphologies of ST. The most common complication was malposition of adjacent teeth, indicating that patients with ST have a high need for orthodontic treatment.

Conflict of Interest

The authors declare that they have no conflict of interest.

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

COVID-19 Pandemi Sürecinde Hastaların Protetik Diş Tedavisine Karşı Yaklaşımları

Approaches of Patients Towards Prosthetic Dental Treatment During the COVID-19 Pandemic

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Article History

Submitted	29.11.2024
Revised	02.12.2024
Accepted	17.12.2024
Published	31.12.2024

ÖZ

Amaç: Çalışmamızda, Marmara Üniversitesi Diş Hekimliği Fakültesi'ne başvuran hastaların COVID-19 pandemi sürecinde protetik diş tedavisine karşı yaklaşımlarının; yaş, cinsiyet, eğitim durumu, dental bilinç ve salgın dönemindeki kaygıları göz önünde bulundurularak tespit edilmesi amaçlandı.
Gereç ve Yöntemler: Çalışmamıza kliniğimize başvuran 18 yaş ve üstü, çalışmaya katılmayı kabul eden 56 erkek ve 45 kadın toplam 101 hasta dahil edilmiştir. Hastalara COVİD 19 pandemisinde diş hekimliği tedavilerine karşı yaklaşımları kapsamında toplam 35 soruluk bir anket uygulanmıştır. Çalışmamız Ki kare ve Fisher's exact test ile değerlendirilmiştir. Elde edilen değerlerin yorumlanmasında a:0.05 anlamlılık düzeyi ölçüt olarak kullanılmıştır.
Bulgular: Çalışmaya toplamda 101 hasta (56 erkek, 45 kadın) katılmıştır. Hastaların %82,2'si haziran 2021 itibariyle rutin diş tedavilerine başlanması gerektiğini düşünürken %17,8'i rutin diş tedavilere başlanması gerektiğini düşünmemektedir. Protez dışı diğer tedavileri erteleme durumu ile COVID-19 pandemisinin kontrol altına alındığını düşünme durumu arasında istatistiksel olarak anlamlı bir ilişki vardır. (X2: 11,09 p<0,05).
Sonuç: Sonuç olarak, hastaların COVID-19 pandemi sürecinde dental tedaviye karşı yaklaşımları incelendiğinde, diş kliniklerindeki bekleme salonlarının kalabalık olmasının hastaları tedirgin ettiği görülmüştür. Buna yönelik tedbirlerde düzenlemeye gidilmesi ve bu tedbirlerin hastalara doğru bir şekilde aktarılması gerekmektedir.
Anahtar Kelimeler: COVID-19, Dünya Sağlık Örgütü, protetik diş tedavisi

ABSTRACT

Objectives: The aim of study determined the approaches of patients who applied to Marmara University Faculty of Dentistry to prosthetic dental treatment during the COVID-19 pandemic, with a questionnaire we prepared by considering age, gender, educational status, dental awareness and concerns during the epidemic period.
Materials and Methods: A total of 101 patients, including 56 men and 45 women aged 18 and older who agreed to participate, were included in our study. A total of 35 questions were asked in a survey regarding patients' approaches to dental treatments during the COVID-19 pandemic. Our study was evaluated with the Chi-square test and the Fisher's exact test. The significance level of a:0.05 was used as a criterion in the interpretation of the obtained values.
Results: A total of 101 patients (56 men, 45 women) participated in the study. While 82.2% of the patients think that routine dental treatments should be started by June 2021, 17.8% do not think that routine dental treatments should be started. There is a statistically significant relationship between postponing other non-prosthetic treatments and thinking that the COVID-19 pandemic is under control (X2: 11.09 p<0.05).
Conclusions: As a result, when the approaches of the patients to dental treatment during the COVID-19 pandemic were examined, it was seen that the crowded waiting rooms in the dental clinics made the patients nervous. It is necessary to make arrangements in the measures for this and to convey these measures to the patients correctly.
Keywords: COVID-19, prosthontic dental treatment, World Health Organization.

How to cite this article: Kahramanoglu E., Şahin R., M., Halmedov Y., D., Halmedov M. COVID-19 Pandemi Sürecinde Hastaların Protetik Diş Tedavisine Karşı Yaklaşımları. *European Journal of Research in Dentistry*, 2024;8(3): 116-121. DOI: http://dx.doi.org/10.29228/erd.81

GİRİŞ

Yeni Koronavirüs (COVID-19), ilk olarak Çin'in Vuhan Kenti'nde aralık ayının sonlarında solunum yolu belirtileri (ateş, öksürük, nefes darlığı) gelişen bir grup hastada yapılan araştırmalar sonucunda 13 Ocak 2020'de tanımlanan bir virüstür. COVID-19, ülkemizde de ilk vakanın görüldüğü 11 Mart 2020 tarihinde Dünya Sağlık Örgütü (DSÖ) tarafından pandemi ilan edilmiştir. Hasta bireylerin öksürmeleri veya hapşırmaları ile ortama saçılan damlacıkların solunması ile bulaşır. Hastaların solunum parçacıkları ile kirlenmiş yüzeylere dokunulduktan sonra ellerin yıkanmadan yüz, göz, burun veya ağza götürülmesi ile de virüs alınabilir (Sağlık Bakanlığı COVID-19 Bilgilendirme Platformu,2020).

Sağlık Bakanlığı salgının başından itibaren DSÖ'nün önerilerini dikkate alarak hastalığın ülkemizde yayılmasının önüne geçilmek amacıyla Bilim Kurulu ile ortak toplantılar sonucu sağlık kuruluşlarında birçok tedbir almıştır (Sağlık Bakanlığı Sağlık Hizmetleri Genel Müdürlüğü, 2020).

Dental tedavi sırasında, yüksek hızlı el aletlerinin kullanımı da dahil olmak üzere, öksüren, hapşıran veya tedavi gören diş hekimliği hastaları salgılarını, tükürüklerini veya kanlarını çevreye aerosol şeklinde yayabilir. Çok sayıda damlacık ve aerosolün çevreye yayıldığı diş tedavileri sırasında diş hekimlerinin ve klinikte tedaviyi bekleyen veya tedavi olan diğer hastaların hastalığa yakalanma riski yüksektir. Bu kapsamda Sağlık Bakanlığı tarafından salgının başında acil olmayan diş tedavilerinin mümkün olduğunca ertelenmesi kararı alınmıştır. Salgının seyrine göre diş hekimliği uygulamalarına yönelik kararlar ve önlemler devamlı olarak güncellenmiştir. (Türk Diş hekimleri Birliği, 2020).

COVID-19 pandemi sürecinde Sağlık Bakanlığı tarafından alınan kararlar doğrultusunda diş hekimliği uygulamaları birçok koruyucu tedbir ve değişikliklere uğramış ve bu değişen mevcut durum kapsamında hastaların diş tedavilere karşı olan yaklaşım, davranış ve tutumları değişmiştir (Şahin & Efeoğlu, 2020).

Konu hakkında Onur Şahin ve Sezgi Cinel Şahin'in ''Türkiye'de COVID-19 Normalleşme Sürecinde Hastaların Dental Tedavilere Bakış Açısının ve Kurum Tercihlerinin İncelenmesi'' adlı anket çalışması bulunmaktadır. 765 hastanın katıldığı çalışmalarında, katılımcıların %69,30'unun dental tedaviler için özel klinikleri, %18,80'inin Diş Hekimliği Fakültelerini ve %11,90'ının ise Ağız Diş Sağlığı Merkezleri'ni tercih ettiğini tespit etmişlerdir ve hastaların COVID-19 riskine karşı kendilerinin yeterince korunduğunu düşünme durumu, COVID-19 salgınının kontrol altına alındığını düşünme durumu ve bekleme alanındaki kalabalığın endişe yaratması durumunun hastaların sağlık kuruluşlarını tercih etmesinde etkili olduğunu saptamışlardır. COVID-19 pandemi sürecinde değişen dinamiklerle birlikte hastaların endişeleri ve diş tedavilerine yaklaşımları değişiklik göstermiş ve daha fazla çalışmaya ihtiyaç duyulduğu görülmüştür (Sahin & Sahin C, 2020).

Bu çalışmada, Marmara Üniversitesi Diş Hekimliği Fakültesi'ne başvuran ve tedavileri devam eden hastaların protetik diş tedavilerine karşı olan yaklaşımlarının yaş, cinsiyet, eğitim durumu, dental bilinç, salgın hakkındaki bilgileri ve endişeleri göz önünde bulundurularak değerlendirilmesi amaçlanmıştır. Hipotezimiz COVID-19 pandemi sürecinde hastaların diş hekimliği uygulamalarına karşı yaklaşımlarının değişeceği yönündedir.

GEREÇ ve YÖNTEMLER

Çalışma Onayı

Çalışma protokolü, Marmara Üniversitesi Sağlık Bilimleri Fakültesi Girişimsel Olmayan Klinik Çalışmalar Etik Kurulu tarafından 24.06.2021 tarihinde 78 protokol numarası ile onaylandı (2021/78).

Hasta Seçimi

Bu araştırmada yer alan bireyler Marmara Üniversitesi Diş Hekimliği Fakültesi'ne Haziran 2021 – Temmuz 2021 tarihleri arasında başvuran hastalar arasından seçildi.

Araştırmaya dahil edilen bireylerde;

- Gönüllü olması
- 18 yaş ve üzerinde olması

Çalışmanın kapsamını kliniğimize başvuran tüm hastalar oluşturdu. Kliniğimize başvuran ve araştırmaya dahil edilme kriterlerine sahip olan hastalar çalışma hakkında bilgilendirildi ve çalışmaya katılmayı kabul eden hastalara bilgilendirilmiş onam formu doldurtularak imzalatıldı.

Anketin doldurulması

Hastalardan yaş, cinsiyet, eğitim durumu, dental bilinç, salgın hakkındaki bilgi ve endişelerini sorgulayan 35 sorudan oluşan bir anketi doldurmaları istendi. Anketteki soruların eksiksiz olarak cevaplanmış olmasına dikkat edildi.

İstatiksel Değerlendirme

Tüm veriler bilgisayarda IBM SPSS Statistics 22 (IBM SPSS, Türkiye) programı kullanılarak analiz edilmiştir. Sosyo-demografik özellikler ve hastalara yöneltilen sorulara ilişkin bulgular frekans analizi ile değerlendirilerek yüzde frekans olarak nitelendirilmiştir. Kategorik değişkenler arası ilişki Ki kare ve Fisher's exact test ile değerlendirilmiştir. Elde edilen değerlerin anlamlı olup olmadığının yorumlanmasında a:0.05 anlamlılık düzeyi ölçüt olarak kullanılmıştır.

BULGULAR

Çalışmamız Marmara Üniversitesi Diş Hekimliği Fakültesi'ne Haziran 2021 – Temmuz 2021 tarihleri arasında başvuran 56 erkek ve 45 kadın hasta ile yapılmıştır.

Tablo 1. Demografik Özelliklere İlişkin Dağılımlar

		n	%
Cinsiyetiniz	Erkek	56	55,40
	Kadın	45	44,60
Yaşınız	18-25	15	14,90
	25-40	27	26,70
	40-65	53	52,50
	65 yaş ve üstü	6	5,90
Eğitim durumunuz	İlkokul	26	25,70
	Lise	26	25,70
	Okuma yazma biliyorum	4	4,00
	Üniversite	45	44,60

Tablo 2. COVID-19 Pandemi Sürecinde Hastaların Protetik Diş Tedavisine Karşı Yaklaşımları

		n	%
Diş fırçalama sıklığınız nedir?	Günde bir defa	55	54,50
	Günde iki defa ve daha fazla	42	41,60
	Haftada bir defa	4	4,00
En son ne zaman diş hekimine gittiniz?	1 yıl ve/veya daha yakın bir zaman	68	67,40
	1-5 yıl önce	27	26,60
	5 ve/veya daha fazla yıl önce	5	5,00
	Hiç gitmedim	1	1,00
Sigara kullanıyor musunuz?	Evet	23	22,80
	Hayır	78	77,20
COVID-19 hastalığı için yüksek risk grubunda olan kronik hastalığınız var mı?	Evet	20	19,80
	Hayır	81	80,20
COVID-19 aşısı oldunuz mu?	Evet	62	61,40
	Hayır	39	38,60
COVID-19'un bulaşma yollarını biliyor musunuz?	Evet	97	96,00
	Hayır	4	4,00
*COVID-19'un aşağıdaki yollardan hangisi veya hangilerinden bulaştığını düşünüyorsunuz?	Hastalığa yakalanmış insanlar öksürdüğünde ve hapşırdığında yayılan damlacıklar vasıtasıyla	80	34,48
	Virüs bulaşmış kişilerle doğrudan temas yoluyla kirlenmiş nesnelere ve yüzeylere dokunmak suretiyle	67	28,88
	Temiz olmayan suların içilmesiyle	5	2,16
	Kan nakliyle	11	4,74
	Hayvanlarla temas yoluyla	4	1,72
	Kirli ellerle buruna, göze ağza dokunmak suretiyle	62	26,72
	Diğer	3	1,29
COVID-19 pandemi sürecinde kendinizi nasıl hissediyorsunuz?	Endişeli	42	41,58
	Kayıtsız/sakin	48	47,52
	Korkulu/paniğe kapılma	11	10,89
Ağzınızda diş eksikliğiniz bulunuyor mu?	Evet, 1 ve daha fazla dişimi kaybettim.	54	53,47
	Evet, tüm dişlerimi kaybettim	4	3,96
	Evet, 6 ve daha fazla dişimi kaybettim	31	30,69
	Hayır	12	8,90
Sizce kaybedilen dişinizin yerinin doldurulması gerekli midir?	Evet	96	95,00
	Hayır	5	5,00
Daha önce protez yaptırdınız mı?	Evet	49	48,50
	Hayır	52	51,50
*Daha önce protez yaptırdıysanız en son ne zaman yaptırdınız?	Son 10 sene içerisinde yaptırdım	22	21,78
	Son 30 sene içerinde yaptırdım	6	5,94
	Son 4 sene içerinde yaptırdım	25	24,75
COVID-19 salgını sürecinde diş kliniklerini güvenilir buluyor musunuz?	Evet, güveniyorum ama evden dışarı çıkmak konusunda kaygılarım var	18	17,80
	Evet, diş kliniklerinin diğer sağlık kuruluşlarından daha fazla sterilizasyona ve dezenfeksiyona önem verdiğini düşünüyorum	62	61,40
	Hayır, aksine asıl bulaş yerlerinin diş klinikleri olduğunu düşünüyorum	5	5,00
	Hayır, çok fazla güvenmiyorum	16	15,80
COVID-19 pandemi sürecinde diş tedaviniz için aşağıdaki kuruluşlardan hangisini en güvenilir buluyorsunuz?	Ağız ve diş sağlığı merkezleri	6	5,94
	Diş hekimliği fakülteleri	65	64,36
	Özel muayenehane ve poliklinikler	30	29,70
Aşağıdaki diş tedavilerinden hangisinin virüs bulaşmasında en büyük riski oluşturduğunu düşünüyorsunuz?	Ağız içi muayene	34	33,66
	Diş çekimi	15	14,85
	Diş taşı temizliği	6	5,94
	Dolgu ve kanal tedavisi	29	28,71
	Protez işlemleri/diş teli	17	16,83
Durumunuz acil olmasaydı protez yaptırmak için diş kliniğine başvurur muydunuz?	Evet	34	33,70
	Hayır	67	66,30
*Pandemi döneminde protetik diş tedavisi kliniğine başvurma sebebiniz nedir?	Eski protezimin değiştirilmesi için	42	50,60
	Hareketli (kancalı protez) veya total protezimin (damak) tamiri için	12	14,46
	İmplant üstü protez yaptırmak için	13	15,66
	Kron ve köprülerimin yapıştırılması için	16	19,28
Diş hekimliği fakültesinde uygulanan COVID-19 tedbirlerini biliyor musunuz?	Evet	63	62,40
	Hayır	38	37,60
Diş hekimliği fakültesinde uygulanan COVID-19 tedbirlerine ek olarak sizce neler yapılmalı?	Diğer	17	16,80
	Hastane içerisindeki kişi sayısı minimuma indirilmeli	48	47,50
	Hastaneye girişlerde COVID-19 testi yaptırılmalı	14	13,90
	Sadece acil işlemler yapılmalı	22	21,80
*Protetik diş kliniğinde tedavi olma endişenizin sebebi nedir?	Diş hekimliği kliniklerinin yüksek risk oluşturması	10	10,00
	Kendime ve aileme bulaştırma riski	49	49,00
	Şikâyetimin geçmemesi	16	16,00
	Tedavimin uzun sürme riski	25	25,00

*Birden fazla yanıt işaretleme

COVID-19 pandemisinin kontrol altına alındığını düşünüyor musunuz?	Evet	54	53,50
	Hayır	47	46,50
Diş tedaviniz için günün hangi saatinde tedavi edilmek istersiniz?	Fark etmez	46	45,50
	İlk hasta	55	54,50
Haziran 2021 itibariyle, rutin diş tedavilerine sizce başlanmalı mı?	Evet	83	82,20
	Hayır	18	17,80
COVID-19 pandemi sürecinde diş tedavinizi özel bir poliklinikte yaptırabilecek bütçeye sahip olduğunuzu düşünüyor musunuz?	Evet	19	18,80
	Hayır	82	81,20
COVID-19 öncesinde diş kliniklerinde hastalık bulaşması ile ilgili bir endişeniz var mıydı?	Evet	58	57,40
	Hayır	43	42,60
Diş hekimliği fakültesinde kullanılan aletlerin sterilizasyonunu COVID-19 bulaşma riski açısından yeterli buluyor musunuz?	Evet	70	69,30
	Hayır	31	30,70
Diş hekimliği fakültesinde bekleme salonlarının kalabalık olması sizi endişelendiriyor mu?	Evet	81	80,20
	Hayır	20	19,80

*Cevap verenler arasında hesaplama

		n	%
*Diş hekimliği fakültesinde protez yaptırmayı düşünmüyorsanız hangi durumda veya durumlarda kliniğe başvurursunuz?	Ağrılı bir dişin çekimi	43	23,89
	Apse ile birlikte çenede şişlik	47	26,11
	Ağrılı bir dişin kanal tedavisi	62	34,44
	Düşen dolgu	28	15,56
Protez tedavinizin öncesinde dolgu, kanal, diş taşı temizliği gibi tedavilerinizin tamamlanmış olması gerektiğini biliyor musunuz?	Evet	80	79,20
	Hayır	21	20,80
COVID-19 pandemi döneminde protez tedavisi öncesinde şikâyeti olan bir dişiniz yoksa diğer tedavilerinizi ertelemeyi talep eder misiniz?	Evet	53	52,50
	Hayır	48	47,50
Diş tedavinizi ertelemenin direkt veya dolaylı olarak sistemik hastalıkları (kalp, diyabet, sindirim sistemi hastalıkları vb.) tetikleyebileceğini veya var olan sistemik hastalıkları şiddetlendirebileceğini biliyor musunuz?	Evet	65	64,40
	Hayır	36	35,60
Ertelediğiniz diş tedavisinin sistemik hastalığınızı tetiklediği veya şiddetlendirdiği bir durum ile karşılaştınız mı?	Evet	28	27,70
	Hayır	73	72,30

Tablo 3. Tedavi Erteleme Durumu ile Pandeminin Kontrol Altına Alınılma Durumu Arasındaki İlişkinin İncelenmesi

COVID-19 pandemi döneminde protez tedavisi öncesinde şikayeti olan bir dişiniz yoksa diğer tedavilerinizi ertelemeyi talep eder misiniz?		COVID-19 pandemisinin kontrol altına alındığını düşünüyor musunuz?		İstatistik test
		Evet	Hayır	
Evet	N	20	33	X2:11,09 p:0,01
	%	37,0%	70,2%	
Hayır	N	34	14	
	%	63,0%	29,8%	

Protez dışı diğer tedavileri erteleme durumu ile COVID-19 pandemisinin kontrol altına alınıldığını düşünme durumu arasında istatistiksel olarak anlamlı bir ilişki vardır (X^2: 11,09 $p<0,05$). Dağılımlara bakıldığında COVID-19 pandemisinin kontrol altına alınıldığını düşünenlerde ertelerim diyenlerin oranı %37 iken kontrol altına alınıldığını düşünmeyenlerde bu oran %70,2'dir.

TARTIŞMA

Çalışmamızda elde edilen bulgular göz önüne alındığında ''COVID-19 pandemi sürecinde hastaların diş hekimliği uygulamalarına karşı yaklaşımlarının değişeceği'' yönünde olan hipotezimiz kısmen kabul edilmiştir. Anket sonuçları, protez dışı tedavilerin ertelenmesi ile COVID-19 pandemisinin kontrol altına alındığı düşüncesi arasında istatistiksel olarak anlamlı bir ilişki olduğunu ortaya koymaktadır.

COVID-19'un dünya genelinde hızla yayılması sağlık sisteminde önemli sorunlara ve değişikliklere sebep olmuş, pandemiden etkilenen çoğu ülkede, diş hekimliği uygulamalarında virüsün bulaşma yolları sebebiyle gerekli ve güncel birçok tedbir alınmıştır. Dünya genelinde bireylerin hastalığa karşı ve pandemi sürecinde sağlık kuruluşlarına karşı olan yaklaşımları ülkelerdeki sağlık sistemine, ülkelerin izlediği sağlık stratejilerine ve alınan önlemlere bağlı olarak değişiklik göstermiştir (Coulhart, 2020). Bu sebeple COVID-19 pandemisinin ilk epidemiyolojik çalışmaların yayınlanmasının ardından bu küresel olayın bireylere ruhsal olarak nasıl etkileyebileceğine dair araştırmalar yapılması tavsiye edilmiştir (Sommerstein ve ark., 2020; Holmes ve ark, 2020). Dünya genelinde olduğu gibi, ülkemizde de COVID-19 normalleşme süreciyle birlikte hastaların diş hekimliği uygulamalarıyla ilgili yaşadıkları kaygı ve endişelerin belirlenmesi önem kazanmıştır. Ayrıca, diş tedavisi sırasında sağlık kuruluşlarından beklentilerinin tespit edilmesi ve hastaların tedavilerini ertelemeden alabilmeleri için güvenli bir ortamın sağlanması gerekmektedir. Pandemi sürecinde, hastaların diş tedavilerine karşı olan yaklaşımlarının anlaşılabilmesi adına bu tür araştırmalara daha fazla ihtiyaç duyulmaktadır.

Şahin ve Cinel Şahin'in haziran 2020'de 765 hasta üzerinde yaptığı çalışmada, hastaların haziran 2020 itibariyle rutin diş tedavilerine başlanabileceğini düşünenlerin oranı %34,37 iken başlanamayacağını düşünenlerin oranı ise %65,63'tür. Çalışmamızın sonuçlarına göre ankete katılan

hastaların büyük bir kısmı, %82,2 oranında, haziran 2021 itibariyle rutin diş tedavilerine başlanabileceğini düşünmekte olup, %17,8 oranında ise başlanmaması gerektiğini düşünmektedir. Şahin ve Cinel Şahin'in yaptığı araştırma ile araştırmamız arasında yaklaşık bir sene olduğu göz önüne alındığı zaman normalleşme süreci ile birlikte salgının hafiflemesinin hastaların diş tedavilerine karşı güven duygusunun arttığını söyleyebiliriz.

Şahin ve Cinel Şahin'in yaptığı araştırmanın bir diğer sonucuna göre "Diş tedavileri için başvurduğunuz birimdeki bekleme alanında kalabalık bir hasta grubu ile beklemek sizi COVID-19 bulaşma riski açısından endişelendirir mi?" sorusuna hastalar %97,64 oranında evet cevabını vermiştir. Çalışmamızda yine bekleme salonlarının hastaları endişelendirdiği sorgulandığında, hastalar %80,2 evet cevabını vermiş ve benzer sonuçlara ulaşılmıştır.

Ovalıoğlu ve ark, (2020)'nın 487 hasta üzerinde yaptığı çalışmada, hastaların pandemi karşısında kaygı düzeyleri sorulduğunda %51,5 sakin, %41,2 endişeli, % 4,3 korkulu, % 1,4 ise kayıtsız şeklinde cevap vermişlerdir. Çalışmamızda ise COVID-19 pandemi sürecinde kendinizi nasıl hissediyorsunuz diye sorulduğunda %41,58 endişeli, %47,52 kayıtsız/sakin, %10,89 ise korkulu/paniğe kapılmış şeklinde cevap vermiştir. Oranlar karşılaştırıldığı zaman anlamlı derecede bir fark bulunmamakta ve benzer sonuçlar görülmektedir, Ovalıoğlu ve ark.'nın 2020'de yapmış olduğu araştırmadan bu yana geçen sürede hastaların pandemi karşısındaki kaygı düzeylerinin çok fazla değişmediği görülmektedir.

Benli'nin (2021) Temmuz 2020'de üç farklı ülkeden protetik diş tedavisi uzmanları üzerinde yaptığı "Protetik diş tedavisi uzmanlarının COVID-19 bulaşına yönelik tutum ve farkındalık düzeyleri" isimli çalışmasında, COVID-19 bulaşı açısından en riskli görülen branş protetik diş tedavisi olup, bu açıdan en riskli bulunan tedavi türleri diş kesimi, diş taşı temizliği, pulpa ekstirpasyonu ve dolgu işlemi olarak belirlenmiştir. Çalışmamızda ise benzer şekilde virüs bulaşmasında en büyük riski oluşturan tedavi hastalara sorulduğunda, ağız içi muayene %33,66, dolgu ve kanal tedavisi %28,71 protez işlemleri %16,83, diş taşı temizliği ise %5,94 oranında riskli bulunmuştur. Araştırma yapılan gruplar arasındaki farklılıklar göz önünde tutulsa dahi ağız içi muayene haricinde diğer tedavilere karşı virüs bulaşmasındaki düşünceler benzer bulunmuştur.

Diğer bir araştırmaya göre, normal süreçte kadınların erkeklere oranla diş tedavilerine daha fazla uyumlu olduğu gözlenmiştir ancak pandemi sürecinde anketimize katılan hastalara "durumunuz acil olmasaydı protez yaptırmak için diş kliniğe başvurur muydunuz" şeklinde sorulduğunda: Acil durum olmadığında protez yaptırmak için diş hekimine giderdim diyen erkeklerin oranın %58,8 iken kadınların oranı %41,2'dir. Benzer şekilde gitmezdim diyenler arasında da erkeklerin oranı %53,7 iken kadınların oranı %46,3'tür. Sonuçlara göre istatiksel olarak anlamlı bir fark bulunamamıştır ve literatürdeki araştırmanın normal zamanda yapılan bir araştırma olduğunu göz önüne aldığımızda COVID-19 pandemi sürecinde benzer bir sonuç bulunamamıştır (Moser ve ark., 2016).

Çalışmamıza katılan hastaların COVID-19 pandemisinin kontrol altına alındığını düşünenlerin %37'si "COVID-19 pandemi döneminde protez tedavisi öncesinde şikayeti olan bir dişiniz yoksa diğer tedavilerinizi ertelemeyi talep eder misiniz?" sorusuna evet cevabını verirken, COVID-19 pandemisinin kontrol altına alındığını düşünmeyen hastaların %70,2'si evet cevabını vermiş ve bu iki durum arasında istatiksel olarak anlamlı bir ilişki bulunmuştur. Buna göre pandeminin kontrol altına alınmadığını düşünen hastaların diş tedavilerini ertelemeye daha eğilimli olduğu bulunmuştur.

Literatürde hastalar üzerinde yapılan çalışmaların az olması ve pandeminin gidişatına göre araştırmaların güncellik gerektirmesi sebebiyle araştırmamızın sonuçlarının karşılaştırılması, benzerliklerin kurulması ve tartışması sınırlı kalmıştır. Bu sebeple pandeminin farklı zamanlarında yapılan araştırmalar, verilerin karşılaştırabilmesi, benzerlik kurulabilmesi ve sağlıklı sonuçlara ulaşılması için önem arz etmektedir.

SONUÇ

Sonuç olarak, hastaların COVID-19 pandemi sürecinde dental tedaviye karşı yaklaşımları incelendiğinde, diş kliniklerindeki bekleme salonlarının kalabalık olmasının hastaları tedirgin ettiği görülmüştür. Buna yönelik tedbirlerde düzenlemeye gidilmesi ve bu tedbirlerin hastalara doğru bir şekilde aktarılması gerekmektedir. Hastalara diş kliniklerinde kullanılan malzemelerin sterilizasyonunun COVID-19 açısından yeterli olduğu açıklanmalı ve hastaların buna yönelik endişelerinin önüne geçilmelidir. Ayrıca hastaların tedavi beklentilerinin doğru yönetilebilmesi için pandemi sürecinde dental tedaviler-bulaş riski açısından bilgilendirilmesi gerektiği görülmüştür.

Çıkar Çatışması

Yazarlar arasında herhangi bir çıkar çatışması bulunmamaktadır.

Yazar Katkı Payı

Araştırma fikri: EK, Çalışmanın tasarımı: EK, Çalışma için verilerin toplanması: RMŞ, Çalışma için verilerin analizi: MH, Çalışma için verilerin yorumlanması: EK, YDH, Makale yazımı: YDH, Gözden geçirme: EK, Nihai onay: EK

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

Investigation of Turkish Periodontists' Attitudes and Behaviors During COVID-19 Pandemic: A Questionnaire Survey

COVID-19 Salgını Sırasında Türk Periodontologlarının Tutum ve Davranışlarının İncelenmesi: Bir Anket Çalışması

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Article History

Submitted	19.09.2024
Revised	18.12.2024
Accepted	18.12.2024
Published	31.12.2024

ÖZ

Amaç: Periodontologların kendilerini, hastalarını ve yardımcılarını korumada ve böylece enfeksiyonun yayılmasını önlemedeki rolü kritiktir. Bu çalışmanın amacı, Türk periodontologlarının Corona virüs (CoV) pandemisi sürecinde klinik uygulamalardaki tutum ve davranışlarındaki değişiklikleri incelemektir.
Gereç ve Yöntemler: Google Forms üzerinde oluşturulan 21 soruluk çevrimiçi anket formu veri toplama amacıyla kullanıldı. Anket linki, Ocak 2021 ve Mart 2021 tarihleri arasında 130 periodontoloğa gönderildi. Sayı ve yüzde değerleri hesaplanarak tanımlayıcı istatistikler elde edildi, gruplar arasında kategorik verilerin karşılaştırılması için ki-kare testi uygulandı.
Bulgular: Bu çevrimiçi çalışmaya, Türkiye'de görev yapmakta olan 126 periodontolog dahil edildi. COVID-19 pandemisi döneminde katılımcıların klinik işlemlerde koruyucu ekipman kullanım sıklığı konusunda; FFP/3 ve FFP/2 maske kullanımında % 100, gözlük kullanımında % 60.32'lık artış görüldü. 20 yıl ve üzeri mesleki tecrübe süresine sahip periodontolog grubu, hem 0-5 yıl hem de 5-10 yıl arası tecrübe süresine sahip periodontolog gruplarına kıyasla gözlük kullanımını artırdı ($p<0.05$). Ancak antibiyotik, antienflamatuvar ve analjezik reçete etme sıklığının değişmediği bildirildi. Pü çıkışı varlığı ve periodontal apse tedavisinde erkek periodontologlar, kadın periodontologlara göre daha fazla antibiyotik reçete ettiğini bildirdi ($p<0.05$).
Sonuç: Türk periodontologlar, COVID-19 pandemisi sırasında sürekli güncellenen tedbirlerle kişisel korunma önlemlerini arttırmış olsa da bilimsel birikim ve klinik tecrübeyle edinilen ilaç reçete etme sıklığı konusunda eski alışkanlıklarına olan bağlılıklarını devam ettirdi.
Anahtar Kelimeler: COVID-19 pandemisi, periodontolog, anket.

ABSTRACT

Objectives: The aim of this study was to investigate the possible COVID-19 changes in the attitudes and behaviors of Turkish periodontists in clinical practice during the pandemic.
Materials and Methods: A 21-question survey form created on Google Form was used as a collection tool. The survey link was sent to 130 periodontists between January 2021 and March 2021. While number and percentage values were calculated for descriptive statistics, chi-square test was used to compare categorical data between groups.
Results: This online study included 126 Turkish periodontists. Regarding the frequency of use of protective equipment in clinical procedures during the COVID-19 pandemic, an increase of 100 % in the use of FFP/3 and FFP/2 masks, 60.32 % in the use of goggles was observed. The group of periodontists with 20 years or more of professional experience increased the use of goggles compared to both the groups of periodontists with 0-5 years and 5-10 years of experience ($p<0.05$). The frequency of antibiotic, anti-inflammatory and analgesic prescription did not change during COVID-19 pandemic. However, male periodontists reported prescribing antibiotics more often than female periodontists in the presence of pus outflow and in the treatment of periodontal abscess ($p<0.05$).
Conclusions: Despite the implementation of enhanced personal protection measures by Turkish periodontologists in response to the ongoing pandemic, there has been a persistence in the frequency of medication prescription, which is guided by scientific knowledge and clinical experience.
Keywords: COVID-19 Pandemic, periodontists, questionnaire.

How to cite this article: Ozen B., Gungormek, H., S., Kuru L. Investigation of Turkish Periodontists' Attitudes and Behaviors During COVID-19 Pandemic: A Questionnaire Survey. *European Journal of Research in Dentistry,* 2024;8(3): 122-129. DOI: http://dx.doi.org/10.29228/erd.82

INTRODUCTON

Towards the end of 2019, cases of an unusual form of pneumonia of unknown etiology were observed in Wuhan, the capital of Hubei province of the People's Republic of China (Adhikari et al., 2020). The World Health Organization (WHO) has identified this pneumonia-inducing virus with unknown human effect as a new coronavirus (2019-nCoV) and dubbed it Severe Acute Respiratory Syndrome SARS-CoV-2 because to its taxonomic similarities to the virus linked with (SARS). The disease caused by SARS-CoV-2 has been called COVID-19. Coronaviruses are enveloped, single-stranded RNA viruses with the capacity for rapid mutation (Lai, 1990). Coronaviruses can cause mild colds with different strains found in humans, but they can also cause serious diseases such as SARS and Middle East Respiratory Syndrome (MERS) (Soysal et al., 2020).

The transmission of respiratory viruses is typically facilitated by droplets and aerosols, as well as direct or indirect contact. While there are various threshold values, WHO has established a criterion of 5 μm for particle diameter in differentiating between aerosols and droplets. Particles with a diameter of less than 5 μm are classified as aerosols, while larger particles are defined as droplets (WHO, 2007). The diameter of particles and ambient weather conditions are significant factors in the transmission of infectious diseases via aerosols (Cole & Cook, 1998). Infectious agents excreted from the respiratory tract can remain airborne for extended periods in a matrix of mucus and other secretions, largely due to rapid drying (Darquenne, 2012).

The main route of human-to-human transmission of SARS-CoV-2 is exposure to infective viral particles by inhalation of virus-carrying respiratory droplets produced by breathing, sneezing or coughing of an infected person. Individuals in good health may become infected indirectly by touching their hands to the mucous membranes of the mouth, nose, or eyes after touching contaminated surfaces (Leung, 2021). The viral load is reduced due to the dilution and accelerated inactivation of viruses in aerosolized particles that remain airborne for an extended period. Therefore, unless there is a significant exposure to SARS-CoV-2, the disease is not expected to be particularly severe through aerosol transmission (Imai et al., 2020). Nevertheless, research indicates that exposure to aerosolized particles with a high viral load in a confined space may elevate the likelihood of transmission (Liu et al., 2020). Viruses transported in droplets have been shown to persist on surfaces for a period of time. The viability of SARS-CoV-2 has been demonstrated to persist for up to 4 hours on copper surface, 24 hours on cardboard, 48 hours on stainless steel, and 72 hours on plastic surface (Van Doremalen et al., 2020). The most effective method to prevent the spread of the SARS-CoV-2 is to avoid exposure to the virus. However, this principle is not applicable or realistic for healthcare workers who are unable to maintain social distancing during the diagnosis and treatment of diseases and also exposed to patients' blood, saliva, and other body fluids and respiratory products for extended periods. Among healthcare workers, dentists are one of the occupational groups with the highest risk of contracting the novel coronavirus due to the transmission of aerosols, blood, and saliva, as well as close contact with patients. The isolation of the virus in the saliva of CoV-infected patients and the high expression of angiotensin-converting enzyme-2, in the oral mucosa and tongue dorsum (Guo et al., 2020) reveal the high potential risk of the oral cavity for COVID-19 transmission.

It has even been postulated that dental treatments may carry a risk of transmission of the SARS-CoV-2 virus as high as bronchoscopy (Wahidi et al., 2020). In addition to exposure to these pathogens, dentists and ancillary staff may even function as hosts for microorganisms (Peng et al., 2020). The patients serve in the incubation period, unaware of their infection status, or concealing their disease complicate the protection of dental personnel from contracting the COVID-19. This raises the possibility that dental clinics may become sites for cross-infection if appropriate precautions are not taken. In response to the sudden emergence of the pandemic, a few studies evaluating the protective methods, attitudes, and behaviors applied by dentists to safeguard themselves, their staff, and patients have been published (Kato et al., 2024; Kuldaş et al., 2022; Shah et al., 2021). However, to the best of our knowledge, no survey study has been conducted to evaluate the attitudes and behaviors of periodontists in Turkey during the course of the ongoing pandemic. The objective of this study was to investigate the possible alterations in the attitudes and behaviors of periodontists during the course of the COVID-19 pandemic.

MATERIALS AND METHODS

This cross-sectional study was approved by the Ministry of Health's Scientific Research Evaluation Commission (protocol number 2020-12-08T23) and the Marmara University Faculty of Dentistry Clinical Research Ethics Committee (protocol number 2020-442/01.10.2020). Prior to their participation in the study, volunteers were provided with a comprehensive explanation of the study protocol and were asked to provide their informed consent.

The sample size was calculated using the data obtained from a similar survey study conducted by Matteheos et al. (Mattheos et al., 2012). The number of volunteers was determined to be 110 with 80% power at an effect level of 0.5 with a 95% confidence interval using a computer program (PASS Sample Size Software, NCSS, LLC).

A 21-item questionnaire was specially constructed using Google Forms for the purpose of data collection. The initial section of the questionnaire encompassed inquiries pertaining to demographic data, including age, gender, and the duration of professional experience among periodontists. The subsequent section delved into the procedures and frequency of antibiotic administration by periodontists during SARS-CoV-2 pandemic. The concluding section focused on the evolving attitudes and behaviors of periodontists in the context of the ongoing pandemic. The survey link was distributed to 130 periodontists via email and WhatsApp between January 10 and March 27, 2021. 126 of these physicians answered the entire survey completely.

Statistical analysis

SPSS (Statistical Package for Social Sciences) Windows 25.0 package program was used for data analysis. Number and percentage values were calculated for descriptive statistics. Participants were grouped according to gender and educational status. Chi-square test was used to compare categorical data between groups. Results were evaluated at $p<0.05$ significance level.

RESULTS

This online study included 126 periodontists practicing in Turkey. Table 1 presents the demographic data, including age, gender, and years of professional experience. Among the volunteers, 65.09% were between the ages of 23 and 41, while 21.43% were between the ages of 48 and 65. The female respondents constituted 60.32% of the total number of participants. The distribution of periodontists according to the duration of their experience in the profession was as follows: 30.95% had been in practice for less than five years, 26.98% for a period between five and ten years, 17.46% for a period between ten and twenty years, and 24.60% for a period of twenty years or more. Table 2 presents the frequency of antibiotic administration in various clinical scenarios during the pandemic period according to gender and professional experience subgroups. A statistically significant difference was noticed in the prescription of antibiotics between male and female periodontists in the presence of pus formation. In this case, male periodontists prescribed more antibiotics than female periodontists ($p<0.05$). Following free gingival graft or connective tissue graft operations, a significant difference was observed in the frequency of antibiotic prescription based on according to the duration of professional experience. Physicians with 0-5 years of professional experience prescribed antibiotics more frequently than those with 11-20 years of experience ($p<0.05$) (Table 3).

Table 1. Demographic data of the participants

		n=126	%
Age	23-29	29	23,02
	30-35	32	25,40
	36-41	21	16,67
	42-47	17	13,49
	48-53	13	10,32
	54-59	10	7,94
	60-65	4	3,17
Gender	Female	76	60,32
	Male	50	39,68
Professional experience	5 years	39	30,95
	5-10 years	34	26,98
	11-20 years	22	17,46
	20 Years+	31	24,60
Postgraduate Education	PhD	87	69,05
	Specialists	39	30,95
	Master	0	0,00
Institution worked for	Clinic	26	18,71
	Private Polyclinic/ Hospital	34	24,46
	Public Hospital	11	7,91
	University Hospital	68	48,92

Table 2. Evaluation of participants' frequency of antibiotic administration in different clinical situations during the COVID-19 pandemic period according to gender and duration of professional experience

Clinical Situations	Frequency	Total (n=126)		Gender				p	Professional Experience								p
				Female (n=76)		Male (n=50)			5 Years (n=39)		5-10 Years (n=34)		11-20 Years (n=22)		20+ Years (n=31)		
		n	%	n	%	n	%		n	%	n	%	n	%	n	%	
Generalized gingival inflammation	**Never**	14	11,11	10	13,16	4	8,00	0,488	4	10,26	5	14,71	3	13,64	2	6,45	0,888
	Occasionally	96	76,19	58	76,32	38	76,00		29	74,36	26	76,47	17	77,27	24	77,42	
	Always	16	12,70	8	10,53	8	16,00		6	15,38	3	8,82	2	9,09	5	16,13	
Pus formation	**Never**	27	21,43	21[a]	27,63	6[b]	12,00	**0,029**	5	12,82	11	32,35	5	22,73	6	19,35	0,361
	Occasionally	85	67,46	50	65,79	35	70,00		31	79,49	19	55,88	13	59,09	22	70,97	
	Always	14	11,11	5[a]	6,58	9[b]	18,00		3	7,69	4	11,76	4	18,18	3	9,68	
Mean pocket depth> 5 mm	**Never**	4	3,17	2	2,63	2	4,00	0,764	1	2,56	1	2,94	1	4,55	1	3,23	0,994
	Occasionally	62	49,21	36	47,37	26	52,00		18	46,15	17	50,00	12	54,55	15	48,39	
	Always	60	47,62	38	50,00	22	44,00		20	51,28	16	47,06	9	40,91	15	48,39	
Mean bone loss ≥ %50	**Never**	4	3,17	3	3,95	1	2,00	0,825	0	0,00	2	5,88	0	0,00	2	6,45	0,641
	Occasionally	68	53,97	41	53,95	27	54,00		23	58,97	18	52,94	12	54,55	15	48,39	
	Always	54	42,86	32	42,11	22	44,00		16	41,03	14	41,18	10	45,45	14	45,16	
Periodontitis associated with systemic diseases	**Never**	12	9,52	7	9,21	5	10,00	0,941	5	12,82	3	8,82	0	0,00	4	12,90	0,257
	Occasionally	108	85,71	65	85,53	43	86,00		30	76,92	30	88,24	22	100,00	26	83,87	
	Always	6	4,76	4	5,26	2	4,00		4	10,26	1	2,94	0	0,00	1	3,23	
Patients who are thought to be unable to maintain oral hygiene	**Never**	3	2,38	2	2,63	1	2,00	0,814	0	0,00	2	5,88	1	4,55	0	0,00	0,068
	Occasionally	34	26,98	19	25,00	15	30,00		8	20,51	8	23,53	11	50,00	7	22,58	
	Always	89	70,63	55	72,37	34	68,00		31	79,49	24	70,59	10	45,45	24	77,42	
Patients who smoke more than 10 cigarettes a day	**Never**	2	1,59	2	2,63	0	0,00	0,121	1	2,56	1	2,94	0	0,00	0	0,00	0,172
	Occasionally	21	16,67	16	21,05	5	10,00		3	7,69	9	26,47	6	27,27	3	9,68	
	Always	103	81,75	58	76,32	45	90,00		35	89,74	24	70,59	16	72,73	28	90,32	

Chi-Square test, $p<0,05$

Tablo 3. Evaluation of participants' frequency of antibiotic administration in different treatment procedures during the COVID-19 pandemic period by gender and professional experience

Treatment procedures	Frequency	Total (n=126)		Gender				p	Professional Experience								p
				Female (n=76)		Male (n=50)			5 Years (n=39)		5-10 Years (n=34)		11-20 Years (n=22)		20+ Years (n=31)		
		n	%	n	%	n	%		n	%	n	%	n	%	n	%	
Scaling and root planning	Never	1	0,79	1	1,32	0	0,00	0,671	0	0,00	1	2,94	0	0,00	0	0,00	0,316
	Occasionally	55	43,65	32	42,11	23	46,00		22	56,41	14	41,18	9	40,91	10	32,26	
	Always	70	55,56	43	56,58	27	54,00		17	43,59	19	55,88	13	59,09	21	67,74	
Periodontal abscess	Never	43	34,13	27	35,53	16	32,00	**0,007**	10	25,64	12	35,29	12	54,55	9	29,03	0,109
	Occasionally	74	58,73	48	63,16	26	52,00		26	66,67	18	52,94	8	36,36	22	70,97	
	Always	9	7,14	1[a]	1,32	8[b]	16,00		3	7,69	4	11,76	2	9,09	0	0,00	
Frenectomy	Never	2	1,59	1	1,32	1	2,00	0,517	1	2,56	0	0,00	0	0,00	1	3,23	0,292
	Occasionally	22	17,46	11	14,47	11	22,00		9	23,08	2	5,88	6	27,27	5	16,13	
	Always	102	80,95	64	84,21	38	76,00		29	74,36	32	94,12	16	72,73	25	80,65	
Gingivectomy	Never	3	2,38	2	2,63	1	2,00	0,343	0	0,00	0	0,00	2	9,09	1	3,23	0,087
	Occasionally	27	21,43	13	17,11	14	28,00		10	25,64	3	8,82	6	27,27	8	25,81	
	Always	96	76,19	61	80,26	35	70,00		29	74,36	31	91,18	14	63,64	22	70,97	
Flap operation	Never	46	36,51	24	31,58	22	44,00	0,366	15	38,46	15	44,12	7	31,82	9	29,03	0,29
	Occasionally	66	52,38	43	56,58	23	46,00		22	56,41	17	50,00	12	54,55	15	48,39	
	Always	14	11,11	9	11,84	5	10,00		2	5,13	2	5,88	3	13,64	7	22,58	
Regeneration of periodontal defects with graft and membrane materials	Never	1	0,79	0	0,00	1	2	0,098	28	71,79	28	82,35	19	86,36	22	70,97	0,471
	Occasionally	28	22,22	13	17,11	15	28,00		11	28,21	6	17,65	3	13,64	8	25,81	
	Always	97	76,98	63	82,89	34	68,00		0	0,00	0	0,00	0	0,00	1	3,23	
Regeneration of periodontal defects with enamel matrix proteins	Never	54	42,86	32	42,11	22	44,00	0,788	14	35,90	14	41,18	15	68,18	11	35,48	0,095
	Occasionally	52	41,27	33	43,42	19	38,00		21	53,85	12	35,29	5	22,73	14	45,16	
	Always	20	15,87	11	14,47	9	18,00		4	10,26	8	23,53	2	9,09	6	19,35	
Free gingival or connective tissue graft	Never	24	19,05	13	17,11	11	22,00	0,381	2[a]	5,13	7[a,b]	20,59	7[b]	31,82	8[a,b]	25,81	0,038
	Occasionally	60	47,62	40	52,63	20	40,00		25	64,10	12	35,29	11	50,00	12	38,71	
	Always	42	33,33	23	30,26	19	38,00		12	30,77	15b	44,12	4	18,18	11	35,48	

Chi-Square test, p<0,05

Table 4. Evaluation of participants' frequency of use of protective equipment in clinical procedures during the COVID-19 pandemic period according to gender and professional experience

Protective Equipment		Total (n=126)		Gender				p	Professional Experience								p
				Female (n=76)		Male (n=50)			5 Years (n=39)		5-10 Years (n=34)		11-20 Years (n=22)		20+ Years (n=31)		
		n	%	n	%	n	%		n	%	n	%	n	%	n	%	
FFP3/FFP2 Mask	Increased	126	100,00	76	100,00	50	100,00	-	39	100,00	34	100,00	22	100,00	31	100,00	-
	Unchanged	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	
	Decreased	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	
Others	Increased	93	73,81	53	69,74	40	80,00	0,200	27[a]	69,23	20[a]	58,82	16[a,b]	72,73	30[b]	96,77	**0,005**
	Unchanged	33	26,19	23	30,26	10	20,00		12	30,77	14	41,18	6	27,27	1	3,23	
	Decreased	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	
Goggles	Increased	76	60,32	45	59,21	31	62,00	0,754	19[a]	48,72	18[a]	52,94	13[a,b]	59,09	26[b]	83,87	**0,017**
	Unchanged	50	39,68	31	40,79	19	38,00		20	51,28	16	47,06	9	40,91	5	16,13	
	Decreased	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	
Protective apron	Increased	100	79,37	59	77,63	41	82,00	0,553	32	82,05	23	67,65	17	77,27	28	90,32	0,148
	Unchanged	26	20,63	17	22,37	9	18,00		7	17,95	11	32,35	5	22,73	3	9,68	
	Decreased	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	
Bonnet	Increased	94	74,60	54	71,05	40	80,00	0,259	28	71,79	24	70,59	14	63,64	28	90,32	0,117
	Unchanged	32	25,40	22	28,95	10	20,00		11	28,21	10	29,41	8	36,36	3	9,68	
	Decreased	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	
Hand sanitizer	Increased	107	84,92	62	81,58	45	90,00	0,196	33	84,62	27	79,41	18	81,82	29	93,55	0,427
	Unchanged	19	15,08	14	18,42	5	10,00		6	15,38	7	20,59	4	18,18	2	6,45	
	Decreased	0	0,00	0	0,00	0	0,00		0	0,00	0	0,00	0	0,00	0	0,00	

Chi-Square test, p<0,05

Table 5. Evaluation of participants' attitude change in clinical procedures during the COVID-19 pandemic period by gender and professional experience

Attitude Change		Total (n=126)		Gender				p	Professional Experience								p
				Female (n=76)		Male (n=50)			5 Years (n=39)		5-10 Years (n=34)		11-20 Years (n=22)		20+ Years (n=31)		
		n	%	n	%	n	%		n	%	n	%	n	%	n	%	
Examining a patient with COVID-19 infection	Yes	79	62,70	37[a]	48,68	42[b]	84,00	0,001	26	66,67	25	73,53	10	45,45	18	58,06	0,168
	No	47	37,30	39[a]	51,32	8[b]	16,00		13	33,33	9	26,47	12	54,55	13	41,94	
Time to start periodontal treatment of the patient who has completed the quarantine period of COVID-19 infection	After 7-10 days	23	18,25	12	15,79	11	22,00	0,808	10	25,64	5	14,71	4	18,18	4	12,90	0,398
	After 14 days	31	24,60	20	26,32	11	22,00		12	30,77	9	26,47	4	18,18	6	19,35	
	After 21 days	35	27,78	22	28,95	13	26,00		10	25,64	12	35,29	6	27,27	7	22,58	
	After 28 days	37	29,37	22	28,95	15	30,00		7	17,95	8	23,53	8	36,36	14	45,16	
Work tempo	Increased	9	7,14	6	7,89	3	6,00	0,688	5	12,82	2	5,88	2	9,09	0	0,00	0,472
	Unchanged	12	9,52	7	9,21	5	10,00		4	10,26	5	14,71	0	0,00	3	9,68	
	Decreased	90	71,43	52	68,42	38	76,00		27	69,23	22	64,71	17	77,27	24	77,42	
Frequency of antibiotic prescription	Increased	14	11,11	9	11,84	5	10,00	0,239	5	12,82	3	8,82	1	4,55	5	16,13	0,225
	Unchanged	104	82,54	60	78,95	44	88,00		33	84,62	29	85,29	17	77,27	25	80,65	
	Decreased	8	6,35	7	9,21	1	2,00		1	2,56	2	5,88	4	18,18	1	3,23	
Frequency of prescribing anti-inflammatory and analgesic drugs	Increased	16	12,70	12	15,79	4	8,00	0,134	8	20,51	4	11,76	2	9,09	2	6,45	0,314
	Unchanged	103	81,75	58	76,32	45	90,00		30	76,92	29	85,29	17	77,27	27	87,10	
	Decreased	7	5,56	6	7,89	1	2,00		1	2,56	1	2,94	3	13,64	2	6,45	
Frequency of use of instruments that can cause aerosols	Increased	2	1,59	1	1,32	1	2,00	0,308	1	2,56	0	0,00	1	4,55	0	0,00	0,078
	Unchanged	53	42,06	28	36,84	25	50,00		13	33,33	21	61,76	10	45,45	9	29,03	
	Decreased	71	56,35	47	61,84	24	48,00		25	64,10	13	38,24	11	50,00	22	70,97	

Chi-Square test, p<0,05

In regard to the frequency of utilization of protective equipment in clinical procedures during the period of the global pandemic caused by the novel coronavirus, an increase of 100% was observed in the use of FFP/3 and FFP/2 masks, 60.32% in the use of goggles, and 73.81% in the use of other equipment. The findings demonstrated that the frequency of using goggles and other equipment varies significantly according to the duration of professional experience. The group with 20 years or more of professional experience increased goggles use more than the group with 0-5 years of experience during the COVID-19 pandemic (p<0.05) (Table 4). The least increase in other equipment use was observed among periodontists with five to ten years of professional experience (58.82%), whereas the highest increase was observed among periodontists with twenty or more years of professional experience (96.77%). In response to the question "Have you seen patients with COVID-19 infection during the pandemic?", 62.70% of periodontists indicated that they had encountered while 84% of male periodontists and 48.68% of female periodontists reported that they had examined such cases. This was statistically significant between gender groups. A greater proportion of male physicians than female physicians examined patients with a confirmed diagnosis of COVID (p<0.05) (Table 5). Regarding the frequency of prescribing antibiotics, the majority of participants (82.54%) reported no change. Similarly, the frequency of prescribing anti-inflammatory and analgesic drugs did not differ during the pandemic period by 81.75% of the periodontists (Table 5). Prior to the intraoral examination procedure, 83.33% of the participants reported having their patients use mouth rinse solution. The order of preference among these rinses was: 0.2% povidone iodine, 1.5% hydrogen peroxide, 0.2% chlorhexidine gluconate, 0.12% chlorhexidine gluconate+benzidamine hydrochloride, 0.05% sodium hypochlorite (Fig. 1).

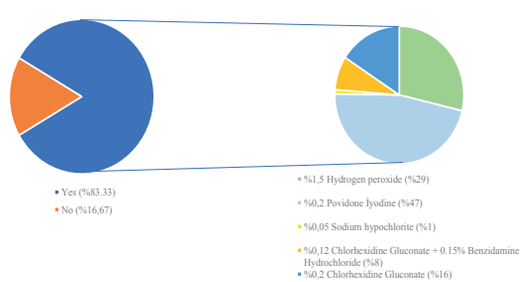

Figure 1: Participants' use of mouth rinse during the COVID-19 pandemic and preferred solution content

DISCUSSION

The history of humanity has been marked by the prevalence of infectious diseases, including the plague, Ebola, AIDS, SARS, and MERS. The global health crisis caused by the SARS-CoV-2, which originated in China and subsequently spread worldwide, has been incorporated into this series of pandemics. In addition, clinical trials became more difficult to conduct during this pandemic, and online tools such as Google Forms and WhatsApp became popular for efficient and secure data collection.

Of particular note is the impact on healthcare workers, who have been identified as the most affected professional group in terms of economic, mental, social, and routine working order (Shah et al., 2021). The considerable impact of the pandemic on the healthcare system has resulted in the postponement of addressing several health concerns, including antimicrobial resistance (Blandino, 2020). In the context of the challenging crisis management of the current situation, there have been reports of an increased use of antibiotics to treat the SARS-CoV-2 infection itself or to prevent co-infections (Iwu et al., 2020). It is imperative that periodontists adhere to the established guidelines regarding the interaction of their prescribed medications with those utilized for the treatment of COVID-19, particularly during this period of frequent drug use (Saglik.gov.tr, 2020).

Rational antibiotic use is defined as prescribing the right antibiotic and its form in the indicated situation, at the optimal dose and duration, by providing sufficient information to the patient, and then evaluating the treatment results. The physicians who perform treatments by adhering to these principles play an important role in the process. When antibiotic usage is required in dentistry, it is usually chosen empirically. The types of antibiotics selected may vary according to the systemic condition of the patient and the dental procedure to be performed.

Recently it has been suggested that periodontal disease can affect systemic health and is associated with most chronic non-communicable diseases (Genco & Sanz, 2020). In this context, periodontists frequently encounter patients with systemic diseases. During the pandemic process, periodontists have tried to adapt to the new situation by making changes in many areas such as the frequency of using of protective equipment, procedures in patient admission, frequency of antimicrobial use, and work tempo in order to protect themselves, their staff and patients against this new situation (Kato et al., 2024; Kuldaş et al., 2022; Rocha-Gomes et al., 2021; Tuncer & Karkaç, 2021). This study is the first survey study to evaluate the attitudes and behaviors of periodontists in Turkey during the COVID-19 pandemic.

Given that saliva is an active carrier of SARS-CoV-2 and the oral cavity is the site of initial replication of SARS-CoV-2 (Meister et al., 2022), dentists have adopted the practice of utilizing different mouth rinses prior to examinations as a straightforward and cost-effective method to reduce viral titers and prevent cross-contamination. The majority of periodontists (83.3%), who participated in the study reported that they instruct their patients to use mouth rinses before the intraoral examination. Our findings are corroborated by the fact that this rate ranged from 70.5% to 98.1% in a limited number of survey studies conducted on periodontists (Kato et al., 2024; Rocha-Gomes et al., 2021; Shah et al., 2021). Moreover, in other survey studies performed on general dentists, this rate ranged from 51.68% to 89.9% (Izzetti et al., 2021; Kuldaş et al., 2022; Tuncer & Karkaç, 2021). It is our contention that periodontologists, who interact frequently with patients suffering from systemic diseases, are more inclined to take additional precautions than general dentists, both in establishing potential disease links and in working in an aerosol-intensive environment during this treatment. In our study, it was observed that the order of preference of mouth rinse solutions was 0.2% povidone iodine with 47%, 1.5% hydrogen peroxide with 29%, and 0.2% chlorhexidine gluconate solution with 16%. Just as there are results consistent with our finding (Duruk et al., 2020), there are also differences in the rankings in some survey studies (Kato et al., 2024; Tuncer & Karkaç, 2021). Although the efficacy of solutions on SARS-CoV-2 is still under investigation, a recent meta-analysis revealed that povidone iodine is the most effective mouth rinse for reducing the viral load of this oxidation-sensitive virus (Lin et al., 2023).

Primary prevention plays a crucial role in the management of epidemics. This protection includes all measures taken to avoid contracting the disease. Considering the working conditions, dentists should always pay attention to the use of personal protective equipment to prevent splashing or scattering of blood, saliva and water droplets during dental treatment. While our respondents reported a 100% increase in the use of FFP2/FFP3 during the COVID-19 pandemic, similar surveys of general dentists have only found increases in the use of such filtering masks between 12.36% and 49.58% (Duruk et al., 2020; Kato et al., 2024). The difference between the increases in the percentage of utilization may be due to the procedures performed by physicians in the clinic, their level of knowledge about the COVID-19 pandemic and their financial possibilities. In order to prevent direct or indirect contact transmission of SARS-CoV-2, periodontists should pay special attention to hand hygiene. The ratio of our participants increasing the frequency of hand sanitizer use (84.92%) was higher than the ratio in similar studies (44.62% – 82.94%) (Duruk et al., 2020; Kato et al., 2024). In contrast to findings indicated that goggles is protective against COVID-19 transmission (Guo et al., 2023), the study suggested that it is ineffective (Navaratnam et al., 2024). Despite this uncertainty, there was an increase in goggles use in dental clinics between 21.92% and 53.52% during the pandemic (Duruk et al., 2020; Kato et al., 2024). It was observed that 60.32% of the periodontists participating in the study demonstrated an increase in the frequency of goggle use. Although no difference was present between females and males, it yielded a statistically significant difference according to the duration of professional experience. It is hypothesized that the observed statistical difference between the youngest and oldest groups may be attributed

to two distinct factors. Firstly, the observed increase in the percentage of physicians wearing goggles may have been less pronounced during the pandemic period due to the fact that younger physicians, who are more likely to be currently wearing goggles, may have been more likely to wear them throughout the period. Secondly, more experienced physicians, who are in the more risky group considering age and systemic diseases, may have increased their use of goggles more than other groups to protect themselves from COVID-19 transmission.

During the COVID-19 pandemic, although periodontists made changes in many areas to adapt to the new normal, they reported that they did not change the frequency of prescribing antibiotics and anti-inflammatory/analgesic drugs. Reduced work tempo and inability to get rid of some habits acquired through experience may have had an effect on this result. Male periodontists reported prescribing antibiotics more often than female periodontists in the presence of pus outflow and in the treatment of periodontal abscess ($p<0.05$). In this context, it is hypothesized that male physicians demonstrate a more reassuring approach than female physicians. In recent studies, it has been observed that the frequency of antibiotic prescription by periodontists ranged from 18.3 % to 48.8% in the presence of abscess and suppuration (Nourah & Aldahlawi, 2022; Yiğit et al., 2022; Yıldız et al., 2023). Although periodontists frequently utilize systemic antibiotics in the case of pus formation, which is an indicator of active periodontal destruction, antibiotics are recommended especially in the presence of systemic findings such as fever, malaise, cellulitis and lymphodenopathy (Herrera et al., 2000). Periodontists have long been aware of the negative impact of dental and gingival diseases, which are closely related to systemic diseases, on the general health of the individual. Indeed, our participants have stated that 70.63% always and 26.98% occasionally received antibiotic support for patients who they thought could not maintain good oral hygiene.

It has been reported that the antimicrobial effect of enamel matrix proteins (MMP) is at a level that effectively prevents bacterial invasion of the surgical site, obviating the need for antibiotic prophylaxis following MMP application (Sculean et al., 2011). Moreover, it has been proposed that the administration of antibiotics following the procedure in the regeneration of periodontal defects with MMP does not result in enhanced clinical attachment level gain or pocket depth reduction (Sculean et al., 2011). Among our respondents, 42.86% reported not prescribing antibiotics after regeneration with MMP. In a recent similar survey study, this rate was 38% (Yıldız et al., 2023). The discrepancy between our findings and those of Yıldız et al. (Yıldız et al., 2023) may be attributed to a greater proportion of experienced respondents (69.4%) in our survey compared to periodontists with 5 years or more of professional experience (28.6%). The answer to the question of "How many days after would you start the periodontal treatment of the patient who had Covid-19 and completed the quarantine process" varied considerably. This highlights a need for further research to elucidate the duration of SARS-CoV-2 persistence in oral fluids, such as saliva and gingival crevicular fluid, and its impact on infectiousness.

In the wake of the global pandemic caused by the SARS-CoV-2 virus, periodontists must identify and implement effective strategies to prevent future outbreaks and ensure the continued provision of essential health services.

he primary limitation of this study is the relatively small sample size. Secondly, the study lacked patient-specific evaluation criteria, as the questions did not inquire about the patients' systemic status. Thirdly, the reasons for alterations in the frequency of antibiotic utilization were not sufficiently detailed.

CONCLUSION

Despite the implementation of enhanced personal protection measures by Turkish periodontologists in response to the ongoing pandemic, there has been a persistence in the frequency of antibiotic and analgesic prescribing guided by scientific knowledge and clinical experience.

Ethics Committee Approval

Ethics committee approval was received from Marmara University Faculty of Dentistry Ethics Committee.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

No financial support was received for this research.

Authors' Contributions

B.O: Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Data curation, Writing – Original Draft, Visualization

H.S.G: Conceptualization, Methodology, Formal Analysis, Investigation, Validation, Writing – Original Draft, Visualization

L.K: Conceptualization, Methodology, Writing – Review and Editing, Supervision, Project Administration

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

The Effect of Acidic Beverages on Surface Characteristics of the Alkasite, Bulk-fill, and Universal Resin Composite Restorative Materials

Asidik İçeceklerin Alkasit, Bulk-fill ve Universal Rezin Kompozit Restoratif Materyallerin Yüzey Özellikleri Üzerine Etkisi

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Article History

Submitted	17.10.2024
Revised	19.12.2024
Accepted	19.12.2024
Published	31.12.2024

ABSTRACT

Objectives: This study evaluated surface roughness, gloss, and color changes of an alkasite, bulk-fill, and a universal micro-hybrid resin composite after immersion in two different acidic beverages.
Materials and Methods: In this study, self-cured, and dual-cured alkasite (Cention N, Ivoclar Vivadent AG, Schaan, Liechtenstein), bulk-fill (SonicFill3, Kerr Corporation, USA), and a micro-hybrid resin composite (Palfique Estelite Paste, Tokuyama, Japan) materials were tested. Eighty-four disk-shaped samples were randomly divided into 3 experimental groups (n = 7). Distilled water (control group), coke (Coca-Cola Company, USA), and turnip juice (Doğanay Gıda, Turkey) were used as immersion mediums. The disks were individually immersed in their respective test substance at 37 ºC, for 6 days. Surface roughness, gloss, and color values were measured at baseline, 1 day, and 6 days.
Results: Data were analyzed by the Friedman test and the Kruskal-Wallis test ($p<0.05$). Following the 6-day duration, coke, and turnip juice solutions caused a statistically significant increase in the surface roughness and a decrease in the gloss values of all materials ($p<0.05$). In all samples except those kept in distilled water, color changes exceed the acceptable threshold value ($\Delta E00=1.8$).
Conclusions: In the study, in some materials, turnip juice caused more color change than coke, while SonicFill 3 had lesser surface alterations than other restorative materials.
Keywords: Resin composite, surface roughness, gloss, color stability, CIEDE 2000

ÖZ

Amaç: Bu çalışmada iki farklı asitli içeceğin alkasit, bulk-fill ve üniversal rezin kompozit materyalin yüzey pürüzlülüğü, parlaklık ve renk değerleri üzerine olan etkisi incelenmiştir.
Gereç ve Yöntemler: Bu çalışmada self-cure ve dual-cure alkasit (Cention N, Ivoclar Vivadent AG, Schaan, Liechtenstein), bulk-fill (SonicFill3, Kerr Corporation, USA), ve bir üniversal mikro-hibrit rezin kompozit (Palfique Estelite Paste, Tokuyama, Japan) materyali test edilmiştir. Çalışmada 84 disk şeklinde örnek 3 alt gruba ayrılmıştır (n=7). Distile su (kontrol groubu), kola (Coca-Cola Company, ABD) ve şalgam suyu (Doğanay Gıda, Türkiye) solüsyon olarak kullanılmıştır. Örnekler ayrı ayrı solüsyonlarda 37 ºC'de 6 gün bekletilmiştir. Yüzey pürüzlülüğü, parlaklık ve renk ölçümleri başlangıçta, 1. günün sonunda ve 6. günün sonunda ayrı ayrı ölçülmüştür.
Bulgular: Veriler Friedman ve Kruskal-Wallis testleri ile analiz edilmiştir ($p<0.05$). 6 günlük bekleme süresi sonunda kola ve şalgam suyu her materyalin yüzey pürüzlülüğü ve parlaklık değerlerinde istatistiksel olarak anlamlı derecede artışa yol açmıştır ($p<0.05$). Distile su haricindeki solüsyonlarda bekletilen her materyalde klinik olarak kabul edilebilen eşik değeri ($\Delta E00=1.8$) aşan miktarda renk değişimi gözlenmiştir.
Sonuç: Çalışmada elde edilen veriler ışığında gözlenmiştir ki, bazı materyallerde şalgam suyu koladan daha fazla renk değişimine yol açmıştır. SonicFill 3 materyalinde diğer materyallere göre daha az yüzey değişimi meydana gelmiştir.
Anahtar Kelimeler: Rezin kompozit, yüzey pürüzlülüğü, parlaklık, renk stabilitesi, CIEDE 2000

How to cite this article: Bektas, B., B., Özbilgi, Ö., D., İyibilir, A., F., Berkman, M., Karabay, F., Tuncer, S., Demirci, M., Tekçe, N. The Effect of Acidic Beverages on Surface Characteristics of theAlkasite, Bulk-Fill, and Universal Resin Composite Restorative Materials. *European Journal of Research in Dentistry*, 2024;8(3): 130-137. DOI: http://dx.doi.org/10.29228/erd.83

INTRODUCTION

Resin composites have been widely used in dental restorations since they were first introduced in the mid-1960s. Their application area has expanded significantly, in line with developments in dental technology. From the past to the present, the progression in resin composites has been about compensating for the drawbacks or limitations of existing materials. The first dental composites were macrofills with filler particle sizes around 10–50 microns. Microfills were produced in order to eliminate problems such as poor wear resistance and poor polishing ability caused by large particle sizes, which lead to mechanical advantages but aesthetic disadvantages. Microfills with particles of 40–50 nm in size has proper polishing-ability but generally weak due to their relatively low filler content (Ferracane, 2011). Hybrid composites were created by combining macrofilled (10-50 μm) and microfilled (40nm) composites to provide desirable mechanical and optical qualities, as well as enhanced resistance to wear (Ferracane, 2011; Miletic, 2018). However, at that time, a composite material that had both aesthetic properties that could be used in the anterior region and mechanical properties that could be used in the posterior region, that is, a universal composite, had not yet been produced. Therefore, the micro-hybrids that are universal composites were invented containing 0.4–1 μm filler particles (glass, zirconia, or ceramic) in combination with smaller 40nm-sized amorphous silica particles (Miletic, 2018). Later, nanocomposites, which are the most common direct restorative materials today, have been developed. These materials consist of nanofillers that are incorporated and distributed in either dispersed or clusters. Nanofillers have small particle sizes that are generally invisible, so they have higher optical properties. Also, small sizes provide more inorganic filler rates, and lower polymerization shrinkage allows them to have better physical properties (Chen, 2010).

In restorative dentistry, the pursuit of scientists and manufacturers to develop novel products will persist until the discovery of the most optimal material, one that possesses identical characteristics and lifespan to natural enamel or dentine. Hence, various advanced restorative materials have been produced by making many modifications not only in filler particle size and ratio but also in other chemical features, which have bioactive properties (ion-releasing resin composites), time-shortening application methods (bulk-fills or self-adhering resin composites), or higher mechanical properties (low-shrinkage resin composites and fiber-reinforced resin composites) (Miletic, 2018). Among these materials, bulk-fill composites are much preferred by clinicians because they can be applied in 4-5 mm increments, provide time – savings, have less risk of voids and contamination between layers, and have similar clinical performance to conventional resin composites (Van Ende et al., 2017; Cidreira et al., 2019). Thanks to the presence of photoinitiators in their composition and enhanced translucency, bulk-fill composites can be applied in these thicknesses since they have deeper photopolymerization capabilities (Miletic, 2018). Bulk-fill composites can be divided into two groups according to their viscosities or clinical application strategies. Flowable bulk-fill composites have low viscosity and require an extra capping layer over the top surfaces due to their low wear resistance against oral environmental changes. Therefore, they are applied as a base bulk-fill layer beneath the conventional resin composites. Paste-like bulk-fill composites have high viscosity because of their high inorganic filler content which provides higher wear resistance. So they are named full-body bulk-fill composites and the entire restoration is created from this material, and there is no need for an extra cover layer (Van Ende et al., 2017; Miletic, 2018). Additionally, there are also numerous bulk-fill composite materials manufactured using various technologies by producers that are not fully included in either classification. SonicFill 3 (Kerr) bulk-fill material applied with the sonic activation technique is one of them. This product, which has a high rate of inorganic filler, utilizes sonic vibration to decrease viscosity during insertion in the cavity. The manufacturer claims that this application method provides in one product the mechanical strength of condensable composites and the good adaptation of flowable composites (Kerr Dental, 2024).

In recent years, bioactivity has been one of the most interesting and studied topics in the medical and dental fields. Bioactive materials refer to substances that can exert a biological effect or demonstrate biological activity. These materials are capable of forming a bond between tissues and the material itself (Vallittu et al., 2018). Considering that the most common cause of restoration loss, particularly in posterior resin composite restorations, is secondary caries. It is understood that there is a significant demand for restorative materials in restorative dentistry that have properties to prevent demineralization and provide remineralization through biological activity (Opdam et.al., 2007). There are a considerable number of permanent restorative materials in the dental market that are considered as bioactive due to their ion-releasing properties, which are produced for the purpose of remineralization and cariostatic effect (François et al., 2021). One of these products, Cention N (Ivoclar-Vivadent AG), which is a resin-based alkasite material, releases fluoride, calcium, and hydroxide ions due to the alkaline fillers it contains, such as Calcium Fluoro-Silicate Glass. This material has self-adhesive and self-curing properties and is also described as bulk-fill since it can be applied as a 4-5 mm layers (Van Ende et al.,2017; François et al., 2021).

The aim of this in vitro study was to assess and compare color stability, surface roughness, and gloss retention characteristics between alkasite, bulk-fill, and universal micro-hybrid resin composite restorative materials. The null hypothesis was that acidic beverages do not affect significantly the color stability, surface roughness, and gloss retention properties of restorative materials.

MATERIALS AND METHODS

Sample Preparation

In this study, alkasite (Cention N, Ivoclar Vivadent AG, Schaan, Liechtenstein), bulk-fill (SonicFill 3, Kerr Corporation, USA), and universal micro-hybrid (Palfique Estelite Paste, Tokuyama, Japan), materials were tested. Distilled water (control group), coke (Coca Cola Company, USA), and turnip juice (Doğanay Gıda, Turkey) solutions were used as immersion mediums. Details regarding restorative materials and solutions were presented in Table 1 and Table 2. The materials were divided into 4 main groups according to the polymerization methods. The Palfique Estelite Paste (PEP), SonicFill 3 (SF3), Cention N Dual-Cure (CNDC) were polymerized with LED light device, and Cention N Self-Cure (CNSC) was self-cured. A total of 84 disc-shaped samples (7 for each material) were prepared using Teflon molds with a diameter of 8 mm and a depth of 2 mm, according to the manufacturer's instructions.

Table 1. Restorative materials tested in the study

Materials	Type	Manufacturer	Components
Cention N	Alkasite	Ivoclar Vivadent AG, Liechtenstein	Liquid: UDMA, DCP, Aromatic aliphatic-UDMA, PEG-400 DMA, initiator. Powder: Barium aluminium silicate glass, Ytterbium trifluoride, Isofiller, Calcium barium aluminium fluorosilicate glass, Calciumfluoro silicate glass, Initiator, pigments. 78.4 wt%, 57.6 vol% Particle size: 0.1 – 35µm (Ilie, 2018)
Palfique Estelite Paste	Universal (Micro-hybrid)	Tokuyama, Japan	Bis-GMA, TEGDMA, Submicron Spherical Zirconia/ silica Particle size: 0,1 – 0,3 µm 82 wt%, 71 vol%
SonicFill 3	Bulk-fill (Nano-hybrid)	Kerr Corporation, USA	Bis-GMA Bis-EMA, TEG-DMA, EBPDMA, MPS; Barium glass, silicon dioxide 40 nm-10 µm 81 wt%, 65.9 vol%

UDMA: Urethane dimethacrylate, DCP: Tricyclodecan-dimethanol dimethacrylate, PEG-400 DMA: Polyethylene glycol 400 dimethacrylate, Bis-GMA: bisphenol A-glycidyl methacrylate, TEGDMA: Triethylene glycol dimethacrylate, Bis-EMA: ethoxylated bisphenol-A-glycidyl methacrylate, EBPDMA: ethoxylated bisphenol-A-dimethacrylate, MPS: 3-(trimethoxysilyl) propyl methacrylate

Table 2. Solutions used in the study

Solutions	Components	pH levels
Distilled Water	-	6.8
Coke (Coca Cola Company, USA)	Water, sugar, carbon dioxide, colorant (caramel), acidity regulator (phosphoric acid), natural flavorings, caffeine (max. 0.150 g/l)	2.50
Turnip Juice (Doğanay Gıda, Turkey)	Water, purple carrot, salt, wheat, turnip radish, preservative (sodium benzoate)	3.3-3.8

Each restorative material was inserted into the Teflon mold, with translucent matrix bands on either side. A glass slide, 1 mm thick, was placed on top of the sample. Excess material was then removed by applying consistent finger pressure. The light polymerization was conducted using a LED light device (Ultradent, South Jordan, UT, USA) with an intensity of 1000 mW/cm2 for 20 seconds. Before placing SF3 in the mold, it was activated with sonic energy by using a handpiece (SonicFill, Kavo/ Kerr, USA) to reduce the viscosity. Cention N powder and liquid were dispensed on a glass slab and manually mixed homogeneously with a spatula within 60 seconds, then transferred into the mold. CNDC samples were polymerized with LED light device, CNSC samples were self-cured after the 5 minute waiting period. All the samples were stored in distilled water at 37 °C in darkness for 24 hours. The finishing and polishing process for each sample was applied with aluminum oxide-coated discs (Sof-Lex™ XT Discs, 3M ESPE, Saint Paul, MN, USA) with coarse, medium, fine, and superfine grits respectively. New, unused disks were used for each sample with a low-speed handpiece at 10,000-30,000 rpm. Samples were divided into 3 subgroups according to the immersion mediums. For the simulation of approximately 6 months of the daily routine Ertas et al, 2006 of consumption of the beverages, samples were kept in distilled water, coke, and turnip juice for 6 days in the incubator. Solutions were refreshed every 12 hours to maintain acidity and prevent bacterial growth. Surface roughness, color, and gloss measurements were established before the immersion of the solutions, 1 day, and 6 days after immersion of the solutions. Before the measurements, samples were rinsed with 5 ml of distilled water and dried with high-pressure air.

Color Measurement

The color measurements of the samples were obtained with a spectrophotometer (Vita Easyshade V; Vita Zahnfabrik, Bad Säckingen, Germany) providing CIE L*, a*, and b* coordinates. The spectrophotometer was calibrated before each measurement, the color of each specimen was recorded as the average of three consecutive measurements, and the color changes were calculated using the CIEDE 2000 (ΔE00) formula (Ardu, 2019; Duc O, 2019).

Surface Roughness Measurements

A surface profilometer (Surtronic 3+, Taylor Hobson Ltd., Leicester, UK), with a cut-off of 0.25 mm and transverse length of 1.25 mm at a speed of 0.5 mm/s was used to measure surface roughness values of each sample. Three consecutive measurements were taken from the center of the samples and the average numerical value was accepted as the roughness value (Ra).

Gloss Measurements

Gloss was measured with a gloss meter (Novo-Curve, Rhopoint Instrumentation, East Sussex, UK) at a 60-degree angle (ISO 2813) which was calibrated with a reference value of 95.5 GU according to the manufacturer (Ereifej, 2012). To exclude ambient light, the measurement area was enclosed in a black box, and each sample underwent three consecutive measures, with the average result taken as the gloss value (GU).

Statistical Evaluation

The statistical analysis was conducted using the NCSS 2007 statistical software (NCSS, Utah, USA) with a significance level of 0.05. The data were analyzed by calculating the mean and standard deviation for each group, and the distribution of variables was examined with the Shapiro–Wilk normality test. For variables that did not show normal distribution, the Wilcoxon Test was used for two-measurement time comparisons, the Friedman Test was used for three-measurement time comparisons, and the Kruskal Wallis test was used for intergroup comparisons.

RESULTS

The mean values for the surface roughness, gloss, and color change values along with the corresponding standard deviation for each material group were displayed in Tables 3, 4, and 5.

When the changes in the roughness and color values of the material, it was seen that the surface alterations started at the end of 1 day in all materials that were kept in the coke and turnip juice solutions.

Table 3 demonstrates that following a 1-day immersion, coke, and turnip juice solutions resulted in a statistically significant increase in the surface roughness of all materials, except SF3. Following the 6-day duration, coke, and turnip juice solutions caused a statistically significant increase in the surface roughness of all materials ($p<0.05$).

Table 3. Mean and standard deviations of Ra values (μm) of restorative materials immersed in various storage solutions at different time periods

Materials	Solutions	Baseline	1 day	6 day
Cention N Dual-Cure	Distilled Water	$0,50\pm0,13^{Aa}$	$0,51\pm0,18^{Aa}$	$0,58\pm0,10^{Ba}$
	Coke	$0,45\pm0,15^{Ab}$	$0,51\pm0,13^{Ba}$	$0,65\pm0,08^{Ca}$
	Turnip Juice	$0,54\pm0,10^{Aa}$	$0,58\pm0,18^{Bb}$	$0,72\pm0,17^{Cb}$
Cention N Self-Cure	Distilled Water	$0,52\pm0,19^{Aa}$	$0,53\pm0,19^{Aa}$	$0,57\pm0,14^{Ba}$
	Coke	$0,58\pm0,21^{Aa}$	$0,69\pm0,19^{Bb}$	$0,74\pm0,14^{Cb}$
	Turnip Juice	$0,50\pm0,10^{Aa}$	$0,62\pm0,13^{Bb}$	$0,74\pm0,10^{Cb}$
Palfique Estelite Paste	Distilled Water	$0,13\pm0,05^{Aa}$	$0,14\pm0,03^{Aa}$	$0,17\pm0,05^{Ba}$
	Coke	$0,12\pm0,02^{Aa}$	$0,17\pm0,04^{Bb}$	$0,24\pm0,07^{Cb}$
	Turnip Juice	$0,16\pm0,08^{Ab}$	$0,24\pm0,11^{Bc}$	$0,32\pm0,12^{Cc}$
SonicFill 3	Distilled Water	$0,19\pm0,03^{Aa}$	$0,20\pm0,05^{Aa}$	$0,22\pm0,06^{Aa}$
	Coke	$0,18\pm0,05^{Aa}$	$0,22\pm0,05^{Ba}$	$0,25\pm0,06^{Ca}$
	Turnip Juice	$0,16\pm0,02^{Aa}$	$0,19\pm0,03^{Ba}$	$0,22\pm0,03^{Ca}$

* In each column, groups with different uppercase superscripts are significantly different ($p<0.05$).

** In each row, groups with different lowercase superscripts are significantly different ($p<0.05$).

Following the 6-day immersion, distilled water resulted a statistically significant surface roughness increase in all materials ($p<0.05$), except SF3.

Following the all immersion periods, CNDC and CNSC materials have the higher roughness values among the other restoration materials.

At the end of the 6 days, the lowest roughness values were observed for PEP in distilled water (0.17 μm), SF3 in distilled water (0.22 μm), and SF3 in turnip juice (0.22 μm), respectively.

Gloss values of the tested materials were presented in Table 4.

Table 4. Mean and standard deviations of Gloss Units (GU) of restorative materials immersed in various storage solutions at different time periods

Materials	Solutions	Baseline	1 day	6 day
Cention N Dual-Cure	Distilled Water	$24,59\pm7,69^{Aa}$	$23,95\pm6,14^{Aa}$	$20,88\pm6,60^{Ba}$
	Coke	$26,76\pm6,30^{Aa}$	$23,42\pm5,71^{Ba}$	$20,28\pm4,88^{Ca}$
	Turnip Juice	$29,53\pm3,96^{Aa}$	$26,7\pm5,73^{Ba}$	$23,16\pm4,25^{Ca}$
Cention N Self-Cure	Distilled Water	$12,62\pm4,16^{Aa}$	$12,06\pm3,87^{Aa}$	$09,45\pm3,78^{Ba}$
	Coke	$19,70\pm7,32^{Aa}$	$16,80\pm5,64^{Ba}$	$15,30\pm4,77^{Ba}$
	Turnip Juice	$16,94\pm4,32^{Aa}$	$13,45\pm4,00^{Ba}$	$10,43\pm3,15C^{Ca}$
Palfique Estelite Paste	Distilled Water	$65,24\pm11,77^{Aa}$	$58,11\pm13,87^{Ba}$	$48,98\pm18,24^{Ca}$
	Coke	$71,80\pm13,38^{Aa}$	$58,84\pm18,82^{Ba}$	$52,97\pm18,67^{Ca}$
	Turnip Juice	$58,22\pm8,29^{Aa}$	$57,97\pm14,05^{Aa}$	$47,02\pm11,07^{Ba}$
SonicFill 3	Distilled Water	$44,74\pm9,03^{Aa}$	$43,53\pm12,05^{Aa}$	$40,90\pm12,11^{Aa}$
	Coke	$34,78\pm10,91^{Aa}$	$32,90\pm7,14^{Aa}$	$28,93\pm9,58^{Ba}$
	Turnip Juice	$37,89\pm12,18^{Aa}$	$31,5\pm10,83^{Ba}$	$28,84\pm11,12^{Ca}$

* In each column, groups with different uppercase superscripts are significantly different (p<0.05).
** In each row, groups with different lowercase superscripts are significantly different (p<0.05).

The results showed that at the end of the 6-day period, cola and turnip solutions caused a statistically significant decrease in the gloss values of all materials (p<0.05). Distilled water resulted in a statistically significant gloss decrease in all materials (p<0.0001), except SF3.

After 1-day and 6-days immersion period, in CNDC samples, coke and turnip solutions caused statistically similar gloss values (p>0.05). SF3 samples immersed in coke and turnip solutions also showed similar gloss values (p>0.05). PEP material had the highest, CNSC had the lowest gloss values before and after immersion of the solutions among the other materials.

The gloss values of CNDC samples were statistically higher than the CNSC samples after all immersion periods in all solutions (p<0.05).

The gloss values of all materials in the groups that were kept separately for each solution were statistically different from each other at the beginning and at the end of the 6-day waiting period (p<0.05).

As shown in Table 5, the highest color change was obtained in the CNSC samples that were immersed in turnip juice, and the lowest color change was obtained in the SonicFill3 samples that were immersed in distilled water for all periods (p<0.05).

Table 5. The mean and standard deviations of ΔE00 values of restorative materials immersed in various storage solutions at different time periods

Materials	Solutions	ΔE_{001}	ΔE_{002}
Cention N Dual-Cure	Distilled Water	1,24±0,70^{Aa}	1,41±0,72 ^{Aa}
	Coke	1,28±0,87 ^{Aa}	1,84±0,89^{Ba}
	Turnip Juice	3,45±1,19^{Ab}	4,26±1,27 ^{Bb}
Cention N Self-Cure	Distilled Water	1,34±0,56^{Aa}	1,56±1,08^{Aa}
	Coke	4,30±0,62^{Ab}	4,57±1,23^{Ab}
	Turnip Juice	10,07±3,98^{Ac}	11,82±3,41^{Ac}
Palfique Estelite Paste	Distilled Water	1,09±0,98^{Aa}	1,74±0,74^{Ba}
	Coke	2,77±0,71^{Aa}	3,46±0,43^{Bb}
	Turnip Juice	3,07±1,96^{Aa}	3,47±0,85^{Bb}
SonicFill 3	Distilled Water	1,20±0,81^{Aa}	1,71±0,62^{Ba}
	Coke	1,71±0,28^{Ab}	1,87±0,36^{Ab}
	Turnip Juice	1,51±0,68^{Ab}	2,03±1,10^{Bb}

* ΔE001: average color change of samples following 1 day of immersion,
ΔE002: average color change of samples following 6 day of immersion,
** In each column, groups with different uppercase superscripts are significantly different (p<0.05).
*** In each row, groups with different lowercase superscripts are significantly different (p<0.05).

The color change values of all materials immersed in coke and turnip juice were significantly higher than the color change values of those immersed in distilled water (p=0.0001).

After both of the immersion periods, in SF3 samples, coke and turnip solutions caused statistically similar color change values (p>0.05). PEP samples immersed in coke and turnip solutions also showed similar color change values (p>0.05). After 6-days immersion period, rate of color change in PEP samples immersed in these solutions is statistically higher than that in SF3 material (Coke: p= 0.002; Turnip juice: p= 0.018).

After both of the immersion periods, statistically similar color changes were observed in CNDC and CNSC materials stored in distilled water (1-day period: p=0.565; 6-day period: p=0.949). Statistically, more color change was observed in CNSC material kept in coke and turnip compared to CNDC (p<0.05). At the end of the 6-day period, turnip solution caused statistically more discoloration than coke for both dual-cure (p=0.003) and self-cure (p=0.002) Cention N materials.

DISCUSSION

Regardless of the material utilized in dentistry, restorations have a finite lifespan. Once the initial restoration is performed on a tooth, a death spiral commences, because of the need for larger cavities in repeated restorations. This cycle progresses from endodontic treatments and ultimately ends with tooth extraction (Schwendicke et al., 2018). Therefore, it can be asserted that the life span of a tooth is essentially determined by the clinical longevity of the restoration. The main reasons for failure and replacement of composite restorations are secondary caries and discolorations which are the outcomes of increased surface roughness due to chemical, physical and mechanical dynamics in the oral environment (Alshehri et al., 2022). Each material exhibits a unique response to these parameters.

In this study, the acidic beverages, coke (pH: 2.5) and turnip juice (pH: 3.3-3.8), increased the surface roughness and decreased gloss of all tested materials, which was statistically significant (p<0.05). It was observed that all materials kept in both two solutions had discolorations. According to the Paravina et al, (2015), after aging and staining procedures, color stability should be assessed based on a 50:50% acceptability threshold, which was ΔE00=1.8. After 6-day, in all samples except those kept in distilled water, color changes exceed the acceptable threshold value (ΔE00=1.8). The null hypothesis asserting that various beverages do not influence the color stability, surface roughness, and gloss retention of restorative materials was rejected.

Acidic beverages with a low pH can produce erosive wear by softening the restorative material surface (Isabel et al., 2016). According to Borges et al, (2019), high acidity causes degradation in the organic matrix, which leads to the deterioration of the bond between the filler and the silane, thus the leaching of inorganic particles. In this case, the roughness on the softened and worn surface increases. It was stated that there may be a relationship between surface roughness parameter and gloss values or color stability (Dietschi et al, 1994;

Nasim et al., 2010; Hasoya et al., 2011; Ghinea et al., 2011). Increased surface roughness increases plaque and stain retention, and also increases the degree of diffuse reflection of light which causes gloss decrease (Hasoya et al., 2011; Bitencourt et al., 2020; Papathanasiou et al., 2022). Previous studies conducted with resin-based materials, it was observed that gloss values decreased and discoloration occurred in materials with increased surface roughness, similar to our findings (Lu et al., 2005; Reddy et al., 2013; Tavangar et al., 2018; Papathanasiou et al., 2022, Rohym et al., 2023). On the other hand, although the pH value of turnip juice is higher than coke, the staining it caused in Cention N materials was more than the coke solution. The color of the turnip juice comes from its purple carrot content which is rich in red anthocyanin pigment, like red wine (Toktaş, 2016). Manojlovic et al, (2015) conducted a study examining the relationship between the reflection spectra and the color change in the composite when it was immersed in various solutions with different absorption spectra. As a result of the study, the significant difference between the diffuse reflection spectra of the stained and baseline samples was observed for the anthocyanin containing red wine solution, but no significant changes in the reflection spectra with coke or distilled water. In parallel with this, the color change was significant in the composites immersed in red wine, and it was negligible in the sulfite ammonia caramel-containing coke group. The variations in color changes produced by the solutions in our research may be attributed to the diffuse reflection spectra generated in the materials, as indicated in the previous study.

According to results in this study, the highest roughness and lowest gloss values were obtained in dual-cure and self-cure Cention N samples before and after immersion in solutions. Surface roughness properties of resin-based restorative materials are dependent on size, geometry, distribution and amount of filler particles (Marghalani et al., 2010; Lepri et al., 2012). Marghalani et al, (2010) stated that inorganic fillers with spherical shapes and small particle sizes provide a smoother surface in the composite than those with irregular shapes and large sizes. In a previous study (Daabash et al., 2023), similar to our study, the roughness values of Cention N materials were higher than other resin composite material. This may be associated with the fact that Cention N contains larger-sized (0.1 – 35µm) inorganic particles than other materials (Ilie, 2018). On the other hand, in the previous study, the Cention N material was prepared by hand-mixing the powder and liquid as in our study. The authors stated the bubbles generated by this process may potentially contribute to the higher roughness values (Daabash et al., 2023).

In our study, the self-cure and dual-cure Cention N materials exhibited comparable roughness values; however, the most significant color change was observed in the self-cure Cention N samples. According to Dietschi et al., (1994), the susceptibility to stain in a resin-based material is influenced by monomer conversion rate, chemical properties, and water sorption rate. In our study, the less color change in dual-cure Cention N than in self-cure Cention N may be related to the high degree of monomer conversion with the light curing, thus providing less water absorption.

Bollen et al., (1997) stated that surface roughness above 0.2 µm increase the bacteria accumulation on the composite surfaces. The baseline roughness levels of Palfique Estelite and SonicFill 3 were below 0.2 µm, whereas the baseline roughness values of Cention N exceed this threshold. In addition, when the baseline roughness values were examined, it was seen that Palfique Estelite has the smoothest surface. This might be associated with the fact that although it has larger particle sizes (0.1-0.3 µm) than SonicFill 3 (40 nm-10 µm), the spherical form of the particles provides better polishability. However, after 6 days of immersion in the solutions, the greatest increase in roughness occurred in Palfique Estelite, and the color change was significantly greater than that in SonicFill 3. The organic resin matrix significantly influences the surface degradation characteristics and staining properties of materials due to its propensity for water sorption (Ertaş et al., 2006; Lepri et al., 2012). The organic matrix content of resin composites mainly consists of monomers such as bisphenol A glycidyl dimethacrylate (Bis-GMA), triethylene glycol dimethacrylate (TEGDMA), and urethane dimethacrylate (UDMA) (Wang et al., 2018). Among these, TEGDMA has the highest tendency to water uptake, while UDMA has the lowest (Sideridou et al., 2003). Additionally, many different monomers with different water sorption or polymerization kinetics are available in more recent restorative materials. Such as ethoxylated bisphenol-A-glycidyl methacrylate (Bis-EMA), ethoxylated bisphenol-A dimethacrylate (EBPDMA) which are more hydrophobic monomers than Bis-GMA (Sideridou et al., 2003; Ling et al, 2009). The lesser degree of roughness and color alterations in SonicFill 3, composed of organic components Bis-GMA, Bis-EMA, TEG-DMA, and EBPDMA, compared to Palfique Estelite, which contains Bis-GMA and TEGDMA, may be attributed to the disparity in water absorption among these monomers.

CONCLUSION

SonicFill3 demonstrated superior performance in surface roughness, gloss, and color stability among various restoration materials stored in different solutions. Differences in organic and inorganic compositions in materials may lead to different clinical results.

ACKNOWLEDGEMENTS

None.

Conflict of Interest

The authors affirm that they have no conflicts of interest relevant to this article.

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ERD European Journal of Research in Dentistry

ORIGINAL ARTICLE / ARAŞTIRMA MAKALESİ

Knowledge, Practices and Attitude among Sudanese Dental Students Towards Oral Health

Sudanlı Diş Hekimliği Öğrencilerinin Ağız Sağlığına Yönelik Bilgi, Uygulamalar ve Tutumları

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ÖZ

Amaç: Bu çalışmanın amacı, Hartum Üniversitesi'ndeki diş hekimliği öğrencilerinin ağız sağlığına yönelik bilgi, tutum ve uygulamalarını ve diş hekimliği eğitiminin akademik aşamalar boyunca ağız sağlığı davranışları üzerindeki etkisini değerlendirmektir.

Gereç ve Yöntemler: Tanımlayıcı prospektif bir çalışma, 664 kişilik bir popülasyondan rastgele seçilen 172 öğrenciden oluşan bir örneklem ile yürütülmüştür. Veriler, sosyo-demografik bilgileri ve ağız sağlığı konularını kapsayan, önceden test edilmiş yapılandırılmış bir anket aracılığıyla toplanmıştır. İstatistiksel analiz, tanımlayıcı istatistikler kullanılarak ve %95 güven aralığında ilişkiler değerlendirilerek SPSS sürüm 25 kullanılarak gerçekleştirilmiştir. Katılımcılardan etik onay ve bilgilendirilmiş onam alınmıştır.

Bulgular: Katılımcıların çoğunluğu kadındı (%75) ve ikinci sınıf öğrencileri en büyük grubu oluşturuyordu (%25). Bilgi değerlendirmesi, %74,8'inin iyi ağız sağlığı bilgisi sergilediğini, sadece %0,6'sının kötü puan aldığını ortaya koymuştur. Katılımcıların çoğu şeker (%18,6) ve bakteri kolonizasyonunu (%23,2) diş sorunlarına önemli katkıda bulunan faktörler olarak tanımlarken, %95,9'u düzenli diş muayenelerinin önemini kabul etmiştir. Uygulamada, %69,7'si diş sağlığı davranışlarının orta düzeyde olduğunu bildirmiş, ancak sadece %4,1'i iyi uygulamalar sergilemiştir. 96,2'si diş temizliğini kontrol etmek için boya kullanmasına rağmen, sadece %29,6'sı ağrı için diş hekimine başvurmuştur; bu da profesyonel hizmetlere erişimin önündeki engelleri göstermektedir. Diş sağlığına yönelik olumlu tutumlar gözlenmiş olup, %78,9'u diş sağlığını iyi olarak sınıflandırmıştır.

Sonuç: Bu çalışma, Hartum Üniversitesi'ndeki diş hekimliği öğrencileri arasında bilgi ve olumlu tutumları vurgulamakta, ancak özellikle diş ipi kullanımı ve proaktif diş hekimi ziyaretleri olmak üzere uygulamalardaki eksiklikleri ortaya koymaktadır. Bilgi ve uygulama arasındaki uçurumu kapatmak için önleyici bakım ve düzenli diş muayenelerine vurgu yapan hedefli eğitim müdahalelerine ihtiyaç vardır. Ek olarak, akademik ilerlemeyle birlikte ağız sağlığına yönelik bilgi, tutum ve uygulamalarındaki iyileşme, ağız sağlığı davranışlarının geliştirilmesinde sürekli öğrenmenin ve klinik maruziyetin öneminin altını çizmektedir.

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Article History

Submitted	14.10.2024
Revised	08.12.2024
Accepted	23.12.2024
Published	31.12.2024

ABSTRACT

Objectives: This study aimed to assess the knowledge, attitudes, and practices (KAP) toward oral health among dental students at the University of Khartoum and to evaluate the influence of dental education on their oral health behaviors across academic stages.

Materials and Methods: A descriptive prospective study was conducted with a randomly selected sample of 172 students from a population of 664. Data were collected through a pre-tested structured questionnaire covering socio-demographics and oral health topics. Statistical analysis was performed using SPSS version 25, employing descriptive statistics and assessing associations at a 95% confidence interval. Ethical approval and informed consent were secured from participants.

Results: The majority of participants were female (75%), with second-year students comprising the largest group (25%). Knowledge assessment revealed that 74.8% exhibited good oral health knowledge, while only 0.6% scored poorly. Most respondents identified sugar (18.6%) and bacterial colonization (23.2%) as significant contributors to dental problems, with 95.9% acknowledging the importance of regular dental check-ups. In practice, 69.7% reported fair dental health behaviors, but only 4.1% demonstrated good practices. Despite 96.2% using dyes to check tooth cleaning, only 29.6% sought dental care for pain, indicating barriers to accessing professional services. Positive attitudes toward dental health were observed, with 78.9% classified as having a good attitude. Statistical analysis revealed significant relationships between knowledge and attitudes with study year, and female students generally exhibited higher knowledge and positive attitudes compared to males.

Conclusion: This study highlights strong knowledge and positive attitudes among dental students at the University of Khartoum, but reveals gaps in practices, particularly in flossing and proactive dental visits. Targeted educational interventions are needed to bridge the gap between knowledge and practice, with an emphasis on preventive care and regular dental check-ups. Additionally, the improvement in KAP with academic progression underscores the importance of continuous learning and clinical exposure in enhancing oral health behaviors.

Keywords: Knowledge, Attitudes, Practices, Oral Health, Dental Students

How to cite this article: Mohamed W., H., I., Mohammed H., A., A. Knowledge, Practices and Attitude Among Sudanese Dental Students Towards Oral Health. *European Journal of Research in Dentistry,* 2024;8(3): 138-144. DOI: http://dx.doi.org/10.29228/erd.84

INTRODUCTION

Oral health knowledge is a fundamental prerequisite for developing health-related behaviors, playing a pivotal role in preventing oral diseases and maintaining overall health (Al Kawas et al., 2010). Dental education aims to not only impart knowledge but also instill a lifelong commitment to oral health in both dental students and the patients they will serve (Rahman & Al Kawas, 2013). This makes educating dental students in oral health critical, as their personal attitudes and practices can significantly influence their patients' health outcomes (Moslemi et al., 2017, Mamai-Homata et al., 2016). The process of fostering positive oral health habits among dental students, however, is not without challenges. Effective education in this area requires sustained effort, time, and a curriculum that emphasizes the importance of preventive care (Yildiz & Dogan, 2011).

Dental students engage with patients from diverse age groups and backgrounds, and as future oral health professionals, their own attitudes toward oral hygiene become reflective of the care they provide (Al-Wahadni et al., 2004). Several studies suggest that dental students' oral health behaviors improve significantly as they advance in their education. In particular, those in their final years exhibit better hygiene practices and attitudes than their junior counterparts, highlighting the positive influence of prolonged exposure to clinical training (Yildiz & Dogan, 2011, Peker & Alkurt, 2009). This transformation underscores the link between academic experience and personal health behaviors, which in turn impacts the quality of care students deliver to their patients.

While oral diseases are not life-threatening, they have a profound impact on an individual's quality of life, affecting self-esteem, nutrition, and overall well-being (Al Kawas et al., 2010). Oral diseases, such as dental caries and periodontal issues, are associated with pain, anxiety, and social impairments, making their prevention a critical public health concern. Despite substantial data on oral health issues in children and adults, there is a notable gap in understanding how these issues evolve in young adults, particularly among dental students who are expected to champion oral hygiene practices both personally and professionally. Studies examining the progression of dental students' oral health behaviors consistently show that education plays a key role in improving their attitudes toward oral hygiene, especially during the later stages of their academic careers (Al-Wahadni et al., 2004).

However, while health promotion efforts have been shown to increase knowledge levels, translating this knowledge into sustained behavioral changes remains a challenge. Effective oral health education must result in a meaningful shift in behavior and attitudes, not just knowledge acquisition. Although chair-side health promotion has proven to be more effective in influencing behavior, the quality of educational programs in dental schools requires ongoing enhancement to ensure students become advocates for oral health. This is particularly relevant given that dental students are future role models who will influence the oral health behaviors of their patients, family, and friends (Al Kawas et al., 2010, Yildiz & Dogan, 2011).

Globally, numerous studies have examined the oral health attitudes and behaviors of dental students, revealing significant variations across different cultural and academic contexts. For instance, a cross-cultural study comparing British and Chinese dental students found striking differences in their attitudes toward oral hygiene practices, with 77% of Chinese students concerned about gum color compared to only 18% of their British counterparts (Komabayashi et al., 2005). In another study conducted across four Asian countries, approximately 70% of dental students rated their oral health positively, though 72.6% visited a dentist only when experiencing problems, highlighting a discrepancy between knowledge and preventive behavior (Halawany et al., 2015).

Studies focused on specific regions, such as Iraq, Egypt, and Yemen, further emphasize the role of education in shaping dental students' oral health attitudes. In Iraq, for example, 75.3% of dental students reported regularly examining their teeth after brushing, while a significant proportion delayed dental visits until experiencing pain (Karem Hassan & Jabbar Ali, 2020). Egyptian dental students demonstrated significant improvements in oral health knowledge and behaviors as they progressed through their studies, underscoring the importance of incorporating comprehensive oral health education early in the curriculum (Al-Wesabi et al., 2019). Similarly, a comparative study in Yemen revealed that female students, particularly those attending public universities, exhibited better oral health behaviors compared to their male counterparts (Halboub et al., 2016).

Despite the extensive research conducted internationally, there is a paucity of data on the oral health attitudes and behaviors of dental students in Sudan. Only two recent studies have explored this topic, both concluding that Sudanese dental students, particularly those in clinical years, demonstrate better oral health practices compared to their regional and international peers (Al-Shiekh et al., 2014, Khalid et al., 2016). However, these studies also revealed that overall scores for oral health behavior and attitude were relatively low compared to students from other countries (Al-Wahadni et al., 2004, Yildiz & Dogan, 2011). Furthermore, it has been suggested that oral health promotion and prevention courses should be integrated earlier in dental curricula to reinforce positive behaviors from the outset (Halawany et al., 2015). By fostering positive attitudes and behaviors throughout their studies, dental students can better serve as advocates for oral health, benefiting both their personal health and the broader community they will ultimately serve (Al-Shiekh et al., 2014).

This study aimed to assess the knowledge, attitudes, and practices toward oral health among dental students at the University of Khartoum. It seeks to evaluate how dental education shapes their oral health behaviors, particularly in relation to their progression through different academic stages.

MATERIAL AND METHODS

A descriptive prospective study had been implemented, to assess knowledge, attitude and practice among University of Khartoum dental students towards oral health.

Study Area

Faculty of Dentistry, University of Khartoum, Khartoum, Sudan.

Study population

All dental students in the Dental College were selected as a case study; as they belong to the largest most ancient school of dentistry in Sudan.

Sample Size

The sample size for students was selected randomly using the following statistical formula: n=N/1+N(e)2

The sample was distributed using the simple random method where all participants of each level were chosen randomly using the students' names lists provided by the faculty of dentistry of Khartoum by the lottery method, where 172 from the Faculty of Dentistry from the population of 664 students.

Data management

Data was collected using a pre-prepared and pre-tested structured questionnaire directed to the students to collect data regarding their knowledge, attitude and practices regarding Oral Health. The structured questionnaire was constructed in two parts, the first addressing the socio-demographic data (age, gender and academic year). The second addressed the knowledge, attitude and practices of students regarding oral health. Questionnaires were distributed to students during their rest time, after classes were done, they were asked to participate and were questioned by the researcher and her assistants and filled by them.

Data was analyzed using Statistical Package for Social Sciences version 25, and the association between different variables is checked using descriptive data analysis of means and standard deviation at level 95% confidence interval.

Ethical approval

Ethical approval for the study was approved by Ethics Committee of SMSB, Noninvasive Clinic Ethics Committee (Approval date: 09/02/2022; NumberNA). All participants were informed about the objectives and purpose of the study before their participation. Written informed consent was obtained from each participant prior to data collection. Students were assured of the confidentiality and anonymity of their responses, and their participation was entirely voluntary, with the option to withdraw from the study at any time without any consequences. The data collected was used solely for the purposes of this research, and no identifying information was included in the analysis or reporting. Additionally, the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, ensuring the rights, safety, and well-being of all participants.

RESULTS

This prospective cross-sectional study included 172 students from the Faculty of Dentistry at the University of Khartoum, accounting for 51.7% of the intended population. The majority of participants were female, with 129 students (75%), while males made up 43 students (25%). Regarding academic year distribution, second-year students formed the largest group, comprising 43 students (25%), followed by third-year students with 39 (22.7%). First-year students accounted for 36 participants (20.9%), fifth-year students totaled 30 (17.4%), and fourth-year students were the smallest group with 24 students (14%). The results indicated that female students predominated in all academic levels, and second-year students had the highest representation, while fourth-year students were the least represented. A scoring system was used to evaluate dental health knowledge, attitudes, and practices among the students. Variations in KAP scores were observed across different academic years, shedding light on the influence of dental education on students' skills and behaviors.

Knowledge

The table 1 provides insights into respondents' knowledge about dental health. A notable portion of participants identifies **sugar consumption** (32, 18.6%) and **bacterial colonization** (40, 23.2%) as key factors contributing to dental problems, with 56 respondents (32.6%) acknowledging both as causes. The **Mixed Method** is the most commonly used brushing technique, favored by 106 individuals (61.6%), indicating a trend toward using various approaches. Regarding the best time to brush, the majority (118, 68.6%) recommend brushing both before bed and after meals, demonstrating a solid grasp of effective oral hygiene practices. Additionally, a remarkable 165 participants (95.9%) understand the importance of regular dental check-ups, which suggests effective public health messaging in this area. When considering reasons for dental visits, pain is the primary concern for 31 respondents (18.0%), but a significant majority (126, 73.3%) recognize the importance of multiple factors for seeking dental care. In terms of caries, **bacterial colonization** is acknowledged by 93 respondents (54.1%) as a leading cause, and 133 participants (77.3%) correctly state that toothbrushes should be replaced every 2-3 months. Lastly, most respondents (125, 72.7%) believe that gingival bleeding can be prevented, although 42 individuals (24.4%) are uncertain about this matter. Overall, the results indicate a high level of knowledge among the respondents, though additional education could further enhance their understanding of preventive oral health measures.

Table 1. Overview of respondents' knowledge regarding dental health

Category	Knowledge	N (%)
Knowledge about Reasons for Dental Issues	Sugar Consumption	32 (18.6)
	Bacterial Colonization	40 (23.2)
	Sugar and Bacteria	56 (32.6)
	Lack of Brushing	16 (9.3)
	All Reasons	28 (16.3)
	Total	172 (100)
Brushing Techniques	Horizontal Movement	6 (3.5)
	Vertical Movement	30 (17.4)
	Circular Movement	24 (14)
	Mixed Method	106 (61.6)
	Other Methods	6 (3.5)
	Total	172 (100)
Best Time to Brush	Before Bed	40 (23.2)
	After Meals	13 (7.6)
	Before Bed and After Meals	118 (68.6)
	Don't Know	1 (0.6)
	Total	172 (100)
Knowledge About Regular Dental Check-Ups	Know	165 (95.9)
	Don't Know	7 (4.1)
	Total	172 (100)
Main Reasons for Dentist Visits	Pain	31 (18)
	Gingival Bleeding	5 (2.9)
	All Reasons	126 (73.3)
	Others	5 (2.9)
	Don't Know	5 (2.9)
	Total	172 (100)
Knowledge About Caries Causes	Sugar Consumption	40 (23.3)
	Bacterial Colonization	93 (54.1)
	Lack of Brushing	12 (6.9)
	All Causes	6 (3.5)
	Others	9 (5.3)
	Don't Know	12 (6.9)
	Total	172 (100)
Knowledge About Changing Toothbrush	If Becomes Weak	12 (7)
	Every 6-12 Months	24 (14)
	Every 2-3 Months	133 (77.3)
	Don't Know	3 (1.7)
	Total	172 (100)
Knowledge About Avoidance of Gingival Bleeding	Yes, Can Be Avoided	125 (72.7)
	No, It Can't Be Avoided	5 (2.9)
	Don't Know	42 (24.4)
	Total	172 (100)

A scoring assessment of dental students' knowledge reveals that a significant majority exhibit a strong understanding of oral health. Specifically, 129 students (74.8%) demonstrate good knowledge, while only one student (0.6%) scores poorly. This distribution underscores anotable level of competence in oral health knowledge among the students, as illustrated in Table 2.

Table 2. Level of Knowledge Scores

Knowledge Level	Frequency	Percent
Poor (0-10)	1	0.6%
Fair (11-17)	42	24.4%
Good (18+)	129	74.8%
Total	172	100.0%

Statistical analysis revealed varied associations between demographic factors and knowledge levels among dental students. The p-value of 0.824 indicates no significant association between gender and knowledge levels. In contrast, a significant difference was found in knowledge scores based on gender (p=0.005). This suggests that female students possess higher knowledge scores compared to their male counterparts. Furthermore, a p-value of 0.025 indicates a statistically significant association between the year of study and knowledge levels, suggesting that knowledge may increase with advancing years of study. Moreover, ($p < 0.001$), indicating significant associations between knowledge levels and both attitudes and practices concerning dental health.

Practice

The results presented in Table 3 highlight various aspects of dental health practices among respondents, revealing both commendable behaviors and areas requiring improvement. A notable 96.2% of participants reported using dyes to check the effectiveness of their tooth cleaning, indicating a strong engagement in personal oral hygiene assessments. However, only 29.6% indicated they would seek dental care when experiencing pain, suggesting significant barriers to accessing professional dental services. While a commendable 64.3% reported brushing their teeth before bed, the 35.7% who do not could benefit from education on the importance of nighttime brushing. The majority (62.2%) brush twice daily, but the 34.3% who brush only once highlight a need for increased awareness regarding optimal brushing frequency. Additionally, the data revealed that only 33.3% of respondents regularly use dental floss, emphasizing a critical gap in effective oral hygiene practices. Alarmingly, only 7.7% brush after meals, suggesting a lack of understanding of its importance in preventing decay. On a positive note, 87.2% of respondents have visited a dentist previously, indicating general recognition of the importance of professional dental care.

Table 3. Summary of Dental Health Practices

Category	Practices	Frequency N (%)
Use of Dye to Check Cleaning of Teeth	Have Used Dyes	165 (96.2)
	Have Not Used Dyes	7 (3.8)
	Total	172 (100)
Seeking Dental Visits When Feeling Dental Pain	Yes	51 (29.6)
	No	121 (70.4)
	Total	172 (100)
Brushing Before Bed	Yes	111 (64.3)
	No	61 (35.7)
	Total	172 (100)
Number of Times Brushing	Brushing Once	59 (34.3)
	Brushing Twice	107 (62.2)
	Brushing 3 Times and More	6 (3.5)
	Total	172 (100)
Use of Dental Floss	Using Floss	57 (33.3)
	Not Using Floss	115 (66.7)
	Total	172 (100)
Brushing After Meals	Brushing	13 (7.7)
	Not Brushing	159 (92.3)
	Total	172 (100)
Previous Dental Visits	Have Visited a Dentist	150 (87.2)
	Have Not Visited a Dentist	22 (12.8)
	Total	172 (100)

The data presented indicates the distribution of practice levels among respondents concerning their dental health habits. A significant majority, 69.7%, reported a fair level of practice, suggesting that while they engage in some positive behaviors, there is considerable room for improvement in their dental health practices. In contrast, only 4.1% of participants achieved a good practice level, highlighting a lack of optimal adherence to recommended dental hygiene guidelines. Meanwhile, 26.2% of respondents were classified as having a poor level of practice, indicating a concerning number of individuals potentially neglecting essential oral health behaviors. This distribution underscores the need for targeted educational interventions to enhance overall dental hygiene practices and promote healthier oral health behaviors among the students. (Table 4.)

Table 4. Levels of Practice Distribution

Practice Level	Frequency	Percent
Poor	45	26.2%
Fair	120	69.7%
Good	7	4.1%
Total	172	100.0%

The analysis indicates that a very small p-value (e.g., $p < 0.001$) would suggest a significant relationship between practice levels and attitudes. However, the current p-value of 0.503 is above the conventional significance threshold of 0.05, leading us to fail to reject the null hypothesis. Therefore, we conclude that there is no statistically significant correlation between gender and practice levels in this sample. Similarly, the p-value of 0.1497 also exceeds the typical significance level of 0.05, further supporting our decision to fail to reject the null hypothesis. Thus, we find no significant association between the year of study and practice scores among the participants.

Attitude

Table 5 summarizes participants' attitudes toward various facets of dental health. A significant portion, 64.5%, view chewing gum positively. Conversely, only 14.5% have a negative perception, which may stem from worries about sugar levels or associated health risks, while 21% remain indifferent. In terms of toothbrush preference, 78.5% choose fine toothbrushes, reflecting a tendency towards gentler oral care, while only 7% prefer medium and 14.5% select hard toothbrushes. When considering smoking and nicotine use, only 14.5% of respondents maintain a positive outlook, whereas a striking 84.9% express disapproval, indicating a robust public health message regarding the dangers of tobacco. Additionally, 71.5% of participants hold a favorable view of dental visits, recognizing their importance for maintaining oral health; only 7% have negative feelings. Support for teeth replacement as individuals age is considerable, with 87.8% endorsing the practice, while just 4.1% disagree. Furthermore, 87.2% advocate for teeth replacement when they are lost, indicating a proactive stance on dental care. Overall, these results demonstrate a largely positive attitude toward dental health practices among respondents, underscoring the need for ongoing education and awareness to promote good oral hygiene.

Table 5. Summary of Attitudes

Attitude Category	Attitude	Frequency (N) (%)
Attitude Towards Chewing Gum	Positive	111 (64.5)
	Negative	25 (14.5)
	Neutral	36 (21)
	Total	172 (100.0)
Attitude Towards Choice of Toothbrush Type	Fine Toothbrush	135 (78.5)
	Medium Toothbrush	12 (7.0)
	Hard Toothbrush	25 (14.5)
	Total	172 (100.0)
Attitude Towards Smoking and Nicotine Consumption	Positive	25 (14.5)
	Negative	146 (84.9)
	Neutral	1 (0.6)
	Total	172 (100.0)
Attitude Towards Dental Visits	Positive	123 (71.5)
	Negative	12 (7.0)
	Neutral	37 (21.5)
	Total	172 (100.0)
Attitude Towards Teeth Replacement When Getting Old	Positive	151 (87.8)
	Negative	7 (4.1)
	Neutral	14 (8.1)
	Total	172 (100.0)
Attitude Towards Teeth Replacement When Losing Them	Positive	150 (87.2)
	Negative	10 (5.8)
	Neutral	12 (7.0)
	Total	172 (100.0)

The data reveals the distribution of respondents' attitudes towards dental health practices. A significant majority, 78.9%, are categorized as having a "Good" attitude, indicating a strong understanding and appreciation for the importance of oral hygiene. This suggests a high level of awareness about maintaining dental health. Conversely, 20.5% fall into the "Fair" category, which implies that while their attitudes are generally positive, there is potential for enhancement through further education on dental care. Only one individual (0.6%) was classified with a "Poor" attitude, demonstrating that most respondents possess a commendable positive outlook towards their dental health practices. In summary, the results indicate that the majority of participants not only recognize the significance of good dental health but also actively endorse effective oral care practices, as shown in table 6.

Table 6. Levels of Attitude Distribution

Attitude Level	Frequency	Percent
Poor (<4)	1	0.6%
Fair (5-9)	35	20.5%
Good (10+)	136	78.9%
Total	172	100.0%

Furthermore, the p-value of 0.011 indicates a statistically significant association between the year of study and attitude levels among students in this study. In contrast, the p-value of 0.212 suggests an absence of a statistically

significant relationship between sex and attitude levels. Notably, the analysis reveals that female students exhibit a more favorable attitude compared to their male counterparts, with no females categorized within the "Poor" attitude level. This finding underscores a potential need for targeted engagement strategies specifically aimed at male students to enhance their overall attitude levels, despite the lack of significant differences in attitudes between male and female students.

DISCUSSION

The findings from this study at the University of Khartoum offer important insights and align with existing research on dental students' knowledge, attitudes, and practices (KAP) in oral health. While the results are generally positive, they also highlight specific areas that need improvement, especially when compared to similar studies conducted in other regions.

The high level of knowledge demonstrated by the students, with 74.8% scoring "good," reflects a solid foundation in oral health education. This is consistent with studies from Palestine (Kateeb, 2010) and Jordan (Al-Batayneh et al., 2014), where dental students also showed a strong understanding of key dental health issues, such as the role of bacterial colonization and sugar in dental problems. In the Khartoum study, 54.1% of students identified bacterial colonization as a major cause of dental issues, and 32.6% recognized both bacteria and sugar as contributing factors, reflecting similar comprehension.

However, while most students (95.9%) understood the importance of regular dental check-ups, only 73.3% acknowledged multiple reasons for visiting the dentist, indicating that some students might not fully grasp the broader benefits of routine dental care. This contrasts with research from Lay et al., (2023), where a higher percentage of dental students viewed regular dental visits as essential for maintaining overall oral health. This presents an opportunity to further enhance students' understanding of preventive dental care in Khartoum.

The discrepancy between knowledge and practices is evident, as only 4.1% of students displayed "good" oral health practices, with 26.2% showing "poor" practices. While 62.2% of students brushed twice daily—comparable to other global studies, like that of Peltzer and Pengpid, (2017) other essential practices, such as flossing and brushing after meals, were less common. Only 33.3% of students in Khartoum used dental floss regularly, and just 7.7% brushed after meals. This pattern of inadequate oral hygiene behaviors despite sound theoretical knowledge is seen worldwide. Mekhemar et al,. (2021) noted that more advanced students in Germany showed better adherence to practices like flossing, suggesting that experience plays a role in improving hygiene behaviors over time.

Additionally, the reluctance to visit the dentist unless in pain (29.6%) reflects a common issue globally, as seen in ASEAN countries, where many students delay dental care until necessary (Peltzer & Pengpid, 2017). This reliance on reactive rather than preventive care indicates a need for more education on the long-term benefits of regular dental check-ups in maintaining oral health.

The generally positive attitudes toward dental health in this study, with 78.9% of students exhibiting a "good" attitude, are consistent with findings from other regions. For example, Riad et al., (2022) reported similarly positive attitudes among German dental students regarding the importance of preventive care and routine dental visits. These attitudes in Khartoum suggest a strong understanding of oral health, but they don't always translate into optimal practices.

An interesting finding in this study is the difference in attitudes between male and female students. Female students showed higher knowledge and more positive attitudes, with no females falling into the "poor" category. While this gender difference wasn't statistically significant, it mirrors similar findings from who observed significant gender gaps in dental health attitudes, particularly regarding preventive behaviors. This suggests that gender-specific strategies may be needed to engage male students more effectively and improve their oral health attitudes and practices.

One of the key findings in this study is the significant increase in knowledge and positive attitudes with advancing academic years. This trend is also observed in other studies, where senior dental students tend to have better knowledge and practices than their junior counterparts. For instance, Mekhemar et al., (2021) found that German students in clinical stages were more likely to follow recommended oral hygiene practices than those in preclinical years. In this study, the significant association between year of study and knowledge scores ($p = 0.025$) underscores the importance of continuous education and clinical experience in improving students' oral health behaviors.

CONCLUSION

This study focused on KAP of dental students at the University of Khartoum. While the students generally demonstrated strong knowledge and positive attitudes, there were notable gaps in their practices, particularly with regard to flossing, brushing after meals, and proactive dental visits. These results are consistent with international trends, highlighting the need to close the gap between knowledge and practice through targeted education and interventions.

A key focus should be on preventive care, encouraging students to adopt more consistent oral hygiene routines and to visit the dentist regularly, even when there are no symptoms of dental problems. Furthermore, the gender differences in KAP scores suggest the potential benefit of targeted strategies to improve male students' engagement with oral health practices. Finally, the finding that knowledge and practices improve with academic progression emphasizes the importance of continuous

learning and clinical exposure in fostering better oral health behaviors.

Conflicts of Interest
The authors declare that they have no conflict of interest.

Author Contributions
Research idea: WHIM, HAAM;Design of the study: WHIM,HAAM; Acquisition of data for the study: WHIM; Analysis of data for the study: WHIM; Interpretation of data for the study: WHIM, HAAM; Drafting the manuscript: WHIM, HAAM; Revising it critically for important intellectual content: WHIM, HAAM; Final approval of the version to be published: WHIM, HAAM.

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ERD European Journal of Research in Dentistry

CASE REPORT / OLGU SUNUMU

Peripheral Ossifying Fibroma: Series of Three Cases

Periferal Ossifiye Fibroma: Üç Olgu Sunumu

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Article History

Submitted	13.06.2024
Revised	28.06.2024
Accepted	05.08.2024
Published	31.12.2024

ÖZ

Periferal ossifiye fibroma (POF), ağırlıklı olarak kadınları etkileyen ve genellikle interdental papillada görülen reaktif bir yumuşak doku büyümesidir. Rengi soluk pembeden koyu kırmızısına kadar değişir ve pürüzsüz bir yüzeye veya saplı geniş bir tabana sahip olabilir. Bu çalışmanın amacı üç farklı POF vakasını histopatolojik ve radyolojik incelemelerle değerlendirmek ve karşılaştırmaktır. Farklı yaşlarda iki kadın ve bir erkek hasta kliniğimize interdental papilla alanının anterior bölgesinde asemptomatik, yumuşak doku büyümeleri şikayeti ile geldi. Lezyonlar cerrahi olarak eksize edildi ve POF tanısını doğrulayan histopatolojik incelemeye gönderildi. POF'un etiyolojisi net olmamakla birlikte, plak, diş taşı, iyi oturmayan protezler ve uyumsuz diş restorasyonları gibi travma veya lokal irritasyonun POF gelişimini hızlandırdığı bilinmektedir. Diş hekimleri pyojenik granülom, fibroma ve periferal odontojenik fibroma gibi klinik ayırıcı tanıları göz önünde bulundurmalıdır.

Anahtar Kelimeler: Ayırıcı tanı, periferal ossifiye fibroma, oral diagnoz, histopatolojik değerlendirme

ABSTRACT

Peripheral ossifying fibroma (POF) is a reactive soft tissue growth that predominantly affects females and usually seen on the interdental papilla. Its color ranges from pale pink to cherry red, and it might have a smooth surface or a broad base with pedunculation. This study's purpose is to evaluate and compare three different POF cases with histopathological and radiological examination. Two female and one male patients of different ages came to our clinic with a complaint of asymptomatic, soft tissue growths in the anterior region of the interdental papillae area. The lesions were surgically excised and sent for histopathological examination which confirmed the diagnosis of POF. Even though the etiology of the POF is unclear, trauma or local irritation such as plaque, calculus, ill-fitting dental appliances, and poor-quality dental restorations are all known to precipitate the development of POF. Dentists should consider clinical differential diagnoses such as pyogenic granuloma, fibroma, and peripheral odontogenic fibroma.

Keywords: Differential diagnosis, peripheral ossifying fibroma, oral diagnosis, histopathologic evaluation

How to cite this article: Ünal, S., Y., Yülek, H., Keser, G., Pekiner F., N., Yaltkaya, S. Peripheral Ossifying Fibroma: Series of Three Cases. *European Journal of Research in Dentistry,* 2024;8(3): 145-150. DOI: http://dx.doi.org/10.29228/erd.85

INTRODUCTION

Because of its proximity to various tissues, including the bone and the periodontal ligament, as well as its relationship to various microbiological environments, the gingiva is oral cavity's most frequently occurring site for reactive lesions (Sihavong et al., 2024). Difficulty over the clinical diagnosis arises from a number of lesions with very similar clinical characteristics (García, et al., 2010). These lesions include peripheral ossifying fibroma (POF), irritation fibroma, pyogenic granuloma, peripheral giant cell granuloma and inflammatory gingival hyperplasia and to reach the certain conlusion histopathological examination needs to be done (García, et al., 2010; Hunasgi et al., 2017).

POF can appear as a pedunculated growth or have a broad base of attachment. These growths range in color from red to pink and may show areas of ulceration. Lesion's surface can be either smooth or irregular. Typically, they are smaller than 2 cm in diameter, though they can vary significantly in size, with reports indicating dimensions from 0.2 cm to 8 cm (Agarwal et al., 2019).

While uncommon, there have been instances of tooth migration and bone destruction associated with POF. The prevalence in females compared to males varies in reported studies, with ratios ranging from 1.22:1 and 1.7:1 to as high as 4.3:1. Most cases are found in individuals in their second decade of life, with a decreasing frequency in older age groups. The lesion can persist for months to years before being excised, influenced by the degree of ulceration, discomfort, or functional interference. Around 60% of POF cases occur in the maxilla, predominantly in the anterior region, with 55%-60% of these presenting in the incisor-cuspid area (Kumar et al., 2006; Phore et al., 2016).

POF exhibits a distinct histopathological profile. Typically, the surface epithelium of POF is ulcerated in many instances, revealing a connective tissue stroma beneath. This stroma is predominantly cellular with a significant fibroblastic component, especially noticeable in ulcerated lesions. Conversely, nonulcerated POFs tend to display more collagenized connective tissue. A hallmark of POF is the presence of mineralized material within the lesion. This can include woven bone, lamellar bone, and cementum-like calcifications (Buchner & Hansen, 1987; Neville et al., 2002).

Dystrophic calcifications are also a common feature, particularly in areas of the lesion that have experienced ulceration. Chronic inflammatory cells, such as lymphocytes and plasma cells, infiltrate the tissue, contributing to the inflammatory response observed in these lesions. Over time, the mineralized components may act as nidi, promoting osteoblastic activity and leading to the formation of new osteoid and bone. Additionally, the presence of multinucleated giant cells is sometimes noted, further contributing to the complex histological landscape of POF. This intricate interplay of cellular and mineralized elements underlines the dynamic nature of the lesion and its potential for growth and calcificationThese calcifications can be observed as scattered calcifications on panoramic or periapical radiographs (Buchner et al., 1987; Cavalcante et al., 2022).

In this case series, three distinct POF cases are examined, each differing in age, gender, and clinical presentation.

CASES

Case I:

A 55-year-old female patient with a significant medical history of hypertension and diabetes mellitus presented to our clinic for evaluation of an oral lesion. She reported a smoking habit of approximately five cigarettes per day. The patient had noticed the lesion several months prior but had not experienced any pain or discomfort. During the intraoral examination, a painless, solitary mass was identified in the mandibular gingiva, specifically in the area between tooth numbers 32 and 33. The lesion measured approximately 1 x 1.5 cm in diameter (Fig. 1). It exhibited a pinkish color and had a smooth surface texture.

Figure 1: Smooth textured gingival mass between tooth numbers 32 and 33.

Further investigation with periapical radiography revealed the presence of calcifications within the lesion, which is a characteristic finding for peripheral ossifying fibroma (Fig. 2). Given the clinical and radiographic findings, an excisional biopsy was performed under local anesthesia to completely remove the lesion (Fig. 3). The excised specimen was sent for histopathological analysis.

Figure 2: Periapical radiography revelaed the presence of calcifications.

Figure 3: Excisional biopsy specimen

Histopathological examination of the biopsy confirmed the diagnosis of peripheral ossifying fibroma, demonstrating the typical features of this lesion, including a fibroblastic stroma with areas of calcification and ossification. The patient was instructed on post-operative care and scheduled for a follow-up visit to monitor healing and ensure there were no complications.

One week post-surgery, the patient returned for a follow-up appointment. Clinical examination at this time revealed that the surgical site was healing well, with no signs of infection or recurrence (Fig. 4). The patient reported no pain or discomfort and expressed satisfaction with the treatment outcome. Further follow-up visits and periodontal treatment were planned to ensure long-term monitoring and management.

Figure 4: One week following the patient's biopsy, the surgically removed region had healed properly, with no evidence of infection or recurrence.

Case II:

A 53-year-old male patient presented to our clinic with a complaint of a painless mass located in the mandibular gingiva, specifically in the area between tooth numbers 32 and 33. The patient reported smoking a pack of cigarettes per day, which is a significant factor in his medical history. He had noticed the lesion several months ago but sought evaluation only recently due to its persistent presence.

Upon intraoral examination, a solitary, smooth-surfaced, pink-colored hypertrophic lesion was observed in the specified area (Fig. 5). The lesion measured approximately 1.5 x 1.2 cm and was non-tender upon palpation. Given the clinical presentation, an excisional biopsy was deemed necessary to remove the lesion and obtain a definitive diagnosis.

Figure 5: A solitary, smooth-surfaced, pink-colored hypertrophic lesion was observed between 32 and 33.

The excisional biopsy was performed under local anesthesia, ensuring complete removal of the lesion along with a margin of healthy tissue to minimize the risk of recurrence (Fig. 6). The excised specimen was subsequently sent for histopathological examination.

Figure 6: Intraoral appearance of the area after the excisional biopsy.

Histopathological analysis confirmed the diagnosis of peripheral ossifying fibroma, characterized by a fibroblastic stroma with areas of mineralization, including bone and cementum-like material. The cellular composition and the presence of calcifications were consistent with typical features of this type of lesion.

The patient was provided with detailed post-operative care instructions and was scheduled for a follow-up visit to assess the healing process. However, the patient was unable to attend the follow-up visit as he was out of town. Despite his absence, we received the histopathology

report confirming the diagnosis of peripheral ossifying fibroma.

Further follow-up visits will be arranged once the patient returns, to ensure continued monitoring and to check for any signs of recurrence. The patient was also advised on smoking cessation to improve overall oral health and reduce the risk of future oral pathologies.

Case III:

A 15-year-old female patient with no history of systemic disease or cigarette use presented to our clinic with the chief complaint of a mass located between tooth numbers 21 and 22. The patient had noticed the mass several weeks prior but reported no pain or discomfort associated with it.

Intraoral examination revealed a solitary mass situated in the palatal interdental papilla and the attached gingiva between teeth 21 and 22 (Fig. 7). The lesion was approximately 1 x 1 cm in size and exhibited a pinkish color with a smooth surface. However, the side of the lesion facing the occlusal surface was focally ulcerated, likely due to trauma from occlusal forces.

Figure 7: Palatally, a partially ulcerated mass can be seen between teeth 21 and 22.

Given the clinical presentation, an excisional biopsy was performed under local anesthesia to completely remove the lesion and to facilitate a definitive diagnosis. The excised tissue was sent for histopathological examination. Histopathological analysis confirmed the diagnosis of peripheral ossifying fibroma, showing typical features such as a fibroblastic stroma with areas of calcification and ossification. The presence of these mineralized components, along with the cellular characteristics, was consistent with the diagnosis.

The patient was provided with detailed post-operative care instructions and scheduled for a follow-up visit one week later to assess the healing process (Fig. 8). During the follow-up visit, the surgical site was examined and found to be healing well, with no signs of infection or complications. The patient reported no pain or discomfort and was satisfied with the treatment outcome.

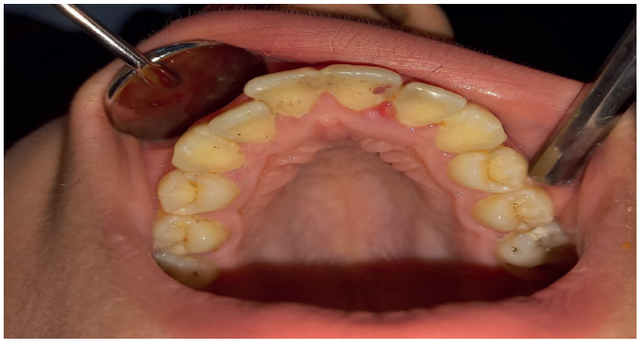

Figure 8: Intraoral image after excisional biopsy

Further follow-up visits were planned to ensure long-term monitoring and to check for any signs of recurrence. The patient and her guardians were also advised on maintaining good oral hygiene to support healing and prevent future issues.

DISCUSSION

POF is a benign tumor predominantly affecting the alveolar mucosa and gingiva. If left untreated, it can grow to a size that causes significant discomfort to the patient and may adversely impact oral hygiene. Although the exact etiology of POF remains unclear, it is generally believed to arise from the periodontal ligament or gingival connective tissue in response to chronic irritation or trauma. Contributing factors include poor oral hygiene, ill-fitting dental appliances, and hormonal changes. Additionally, local irritants such as dental plaque, calculus, and foreign objects embedded in the gingiva have been implicated in its pathogenesis (Mergoni et al., 2015; Franco-Barrera et al., 2016).

In a study by Cuisia et al. examining 134 POF lesions in patients aged 0-19 years, the average female-to-male ratio was found to be 1:1.5. The most common site was the maxillary anterior region, accounting for 37% of cases, with lesion sizes ranging from 0.3 to 3 cm (Cuisia & Brannon, 2001).

Buchner et al. investigated 341 POF lesions in patients aged 15-63 years and reported an average female-to-male ratio of 1:1.5. Similarly, the maxillary anterior region was the most frequently affected area (34%), with the most common age range being 20-39 years (Buchner et al., 2010).

Cavalcante et al., in their study of 270 POF lesions in patients aged 0-87 years, observed an average female-to-male ratio of 1:2.6. They identified the most common age range as 20-39 years and lesion sizes ranging from 0.2 to 7 cm (Calvante et al., 2022).

Clinically, POF can present similarly to other oral lesions, making differential diagnosis a challenge. Conditions that may resemble POF include pyogenic granuloma, peripheral giant cell granuloma, fibroma, and peripheral odontogenic fibroma. Histopathologically, POF is characterized by stratified squamous epithelium overlying a dense mass of

connective tissue. This tissue consists of plump fibrocytes, fibrillar stroma, and plump fibroblasts, with areas of mineralization and occasionally multinucleated giant cells. The mineralization may include bone, cementum-like material, or dystrophic calcifications. Early ulcerated lesions typically show dystrophic calcifications, whereas older, mature, non-ulcerated lesions exhibit well-formed bone and cementum-like material (Lazare et al., 2019; Shrestha et al., 2021). Our cases were compatible with the findings in the literature because of the age and macroscopic appearance.

The differential diagnosis of POF from other gingival proliferative lesions can be particularly challenging due to overlapping clinical and histological features. Peripheral Giant Cell Granuloma (PGCG), for instance, is another reactive lesion originating in the periodontal ligament or periosteum. PGCG is typically seen in females in the fourth to sixth decades of life, presenting as a soft nodular mass with histological features that include mesenchymal cell proliferation and multinucleated giant cells with prominent vascular growth. However, the presence of bone components in approximately one-third of PGCG cases necessitates careful differentiation from POF (Shrestha et al., 2021; Takagi et al., 2024).

Chaitra et al. first considered pyogenic granuloma for the lesion in the mandibular premolar region of a 16-year-old male patient, but histopathological evaluation showed that the lesion was a peripheral ossifying fibroma. This case resembles our third case, where the differential diagnosis included lesions typically induced by trauma (Chaitra et al., 2022). Moreover, Katanec et al. reported that the lesion in the mandibular posterior region of a 70-year-old male patient who had recently undergone implant treatment was primarily considered an irritation fibroma, but histopathological evaluation showed that the lesion was a peripheral ossifying fibroma. This highlights the diagnostic overlap with other fibromatous lesions, a challenge also encountered in our first and second cases (Katanec et al., 2022).

Shah & Sharma reported that a 14-year-old patient presented with an asymptomatic swelling in the mandibular lingual region. The preliminary diagnosis of the lesion, which was thought to be traumatic fibroma or peripheral osteoma, was observed to be POF as a result of histopathological evaluation. This case mirrors the clinical ambiguity seen in our younger patient (Shah & Sharma, 2018). In addition, Parihar et al. reported that a 16-year-old patient presented with an ulcerated swelling in the anterior palatal region of the maxilla. The preliminary diagnosis of the lesion was thought to be pyogenic granuloma traumatized by occlusal forces. As a result of histopathological evaluation, it was observed that the lesion was POF. The clinical presentation of an ulcerated mass due to occlusal trauma closely parallels our third case (Parihar et al., 2015).

The standard treatment for POF involves conservative local resection. Complete excision, including the adjacent periodontal ligament or periosteum where the POF originates, is crucial to eliminate the risk of recurrence. In cases where malignancy is suspected, as illustrated by the unusual features in some reported POF cases, a thorough histological examination is essential for accurate diagnosis and appropriate treatment planning (Topcuoglu et al., 2023; Parsegian et al., 2024).

Kale et al. examined 5 different ossifying fibromas and found that calcification was present in the periapical radiographs of three cases and no calcification was observed in two cases. In our study, calcification was observed in one case and no calcification was observed in the radiographs of the other two cases (Kale et al., 2014).

Bashkar et al. analyzed 376 cases of POF and found that 185 cases contained calcifications, 97 of which showed mature and immature bone formation and 86 of which showed calcified foci. It should be taken into consideration that these calcifications must reach a certain size in order to be observed on periapical and panoramic radiographs (Bhashkar et al., 1966).

To effectively manage reactive gingival lesions, it is essential to eliminate or correct injurious agents, maintain effective plaque control, ensure good patient motivation, and perform precise surgical excision. Various treatment options have been used for surgical excision of overgrowth for many years, including conventional scalpel techniques, electrosurgery, and cryosurgery. The introduction of laser technology represents an innovative approach to the surgical management of overgrowth (Gulati et al., 2019). In all of our cases, periodontal treatment with total excision was performed and patients were encouraged for regular check-ups for recurrence.

CONCLUSION

In conclusion, this study highlights the variability in clinical presentation, age, and gender distribution of peripheral ossifying fibroma, underscoring the importance of thorough histopathological evaluation for accurate diagnosis and effective management.

Acknowledgements
This case report was presented as a poster presentation in 28th BaSS congress that was held on 25-27 April, 2024.
Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
Conflicts of Interest
The authors declare no conflict of interest.
Author Contributions:
Research idea: FNP
Design of the study: SYU, GK, FNP
Acquisition of data for the study: HY, SY, GK
Analysis of data for the study: SYU, HY, SY
Interpretation of data for the study: SYU
Drafting the manuscript: SYU, FNP
Revising it critically for important intellectual content: GK, FNP, SYU
Final approval of the version to be published: SYU, GK, FNP

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